A Modified Approach of Valuing Unpaid Household Work in the UK Considering Multitasking and Adjusting for Quality and Productivity

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A thesis submitted to the University of Gloucestershire in accordance with the requirements of the degree of Doctor of Philosophy (Ph.D.) in the Gloucestershire Business School

October 2022

Abstract

While unpaid work activities contribute significantly to a country's economy, a large amount of those activities is not included in the Gross Domestic Product (GDP), but various approaches can be applied to estimate this contribution, and assign a monetary value to them. However, the currently dominating approach used for the valuation of labour (VoL) does have some known weaknesses that lower the accuracy of calculations. The aim of this research is to modify that approach by taking consideration of simultaneous activities, quality and productivity. This is hoped to increase the accuracy of the valuation. Further, gender differences are considered and the impact of selected demographics on quality is investigated. Based on the findings, recommendations to policy makers and practitioners are given to support the development of a harmonised approach.

In line with a review of the literature, a quantitative research design was applied for the modifications. The original contribution to knowledge of this study is the implementation of up to three adjustments to the dominating VoL approach. One adjusts the time to account for multitasking, the other two adjust the specialist wage rates for quality and productivity. This is the first time three adjustments were implemented in a single approach. This study relied on secondary data from the UK Time Use Survey and the Annual Survey of Hours and Earnings, and used an online questionnaire to collect primary data for adjustments, gender effects, and a regression analysis on demographics. The VoL was calculated for various adjustments and the magnitude of the modifications was compared to the dominating approach using a housekeeper and unadjusted specialist wage rates. The regression investigated whether selected demographics affect the quality of unpaid household work.

The findings suggest that the commonly applied housekeeper wage rate may not act as a lower boundary for the VoL. The results also showed that wage adjustments on quality and productivity vary by gender and the activity performed. Contrary to previous recommendations, an equal split of multitasking activities ($\frac{1}{n}$) could not be confirmed, because splits differed up to 9%. Further, estimated adjustments levels were different to the often arbitrary recommendations in literature. This was also the case when all three adjustments were considered together. For the total UK economy, the implementation of adjustments would improve the VoL by up to 5.29% of the UK's annual GDP, depending on the chosen modification.

Unexpected was the finding that women reported a higher productivity level than men. The presence of children, gender, marital status, education and personal level of health were found to be relevant demographics to impact on the quality of unpaid household work.
The major implications this study hopes to make are to increase the accuracy of the VoL and support the development of a harmonised approach for the VoL.

keywords
unpaid work, time use, simultaneous activities, multitasking, quality, productivity, specialist wage rates, housekeeper wage rate, replacement cost approach, value of labour

Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of the thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.
Any views expressed in the thesis are those of the author and in no way represent those of the University.

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doi:10.46289/88PDC5D9

Acknowledgements

I would like to express my gratitude to all those who have made the completion of this thesis possible.

First, I would like to express my thanks and gratitude to my first supervisor Dr. Xiaoling Hu for her great support, professional guidance and constructive feedback I received throughout this research journey. I have also very much appreciated her patience, her experience and enjoyed the inspiring discussions and meetings that finally contributed to my motivation. Also, I would like to extend my appreciation to my second supervisor Dr. Ying Yu. Without their support, encouragement, and dedication to assist me, this dissertation would not have been possible.

I also have to thank the organisations who provided me with access to their data and a special acknowledgement goes to the respondents who participated in this research. Without the rich data this project would not have been possible.

I would like thank Dr. Philippa Ward and Dr. John Hockey for their valuable knowledge of the research philosophy and methodology which allowed a solid foundation for my study. I would also like to express my thanks to the academic staff at the University of Gloucestershire who accompanied me on my academic journey, in particular Dr. Keith Donne, Dr. Robin Bown, Susan Turner and the library team.

I wish to express my special thanks to Erwin Nickl and Brendan Mai who supported me from the very beginning of this research project and always believed in me. A big thanks goes to my fellow students who were a great source of feedback, inspiration and motivation. I would like to express a very special acknowledgement to Vanessa Schmitz who graciously contributed her time to provide me with moral support and feedback during tough times and in particular during the last phase of this study.

And finally, eternal thanks to my wife Claudia, my daughter Mary and my sons Luke and Noah. I would have never been able to complete this work without their patience, never-ending encouragement and moral support when the going got tough. I would like to thank them for their supportive understanding when I was not available for family time during this long period of time and the sacrifices they have made on my behalf.

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List of Abbreviations

ASHE	Annual Survey of Hours and Earnings
ATUS	American Time Use Survey
CTUR	Centre for Time Use Research
CSV	Comma-separated Values
DRM	Day Reconstruction Method
ESM	Experience Sampling Method
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GPS	Global Positioning System
HETUS	Harmonised European Time Use Survey
HHSA	Household Satellite Account
MTUS	Multinational Time Use Study
NatCen	National Centre for Social Research
NSO	National Statistical Office
OLS	Ordinary Least Squares
ONS	Office for National Statistics
PDF	Portable Document Format
SNA	System of National Accounts
SOC2010	Standard Occupational Classification 2010
SPSS	Statistical Package for the Social Sciences
TUS	Time Use Survey
UK	United Kingdom
UKTUS	United Kingdom Time Use Survey
US	United States
VIF	Variance Inflation Factor
VoL	Value of Labour

Chapter 1

Introduction

1.1 Introduction to Chapter

This research focuses on unpaid household work and its monetary valuation. The first chapter of this thesis provides an overview of the research project, contextualises it into the research field and points out the significance of the research problem. The author outlines his personal motivation for undertaking this research and presents the research aim, questions, objectives and the methodology applied to answer the research questions. An overview of the structure of this thesis is provided at the end of this introductory chapter.

1.2 Context of this Research

Every day the average person in the United Kingdom (UK) spends more than 3 hours (194.5 minutes) on unpaid work activities that cover household chores such as cleaning, washing and food preparation, activities such as gardening and maintenance work, types of shopping, care and travel activities and volunteering (OECD, 2022a). The time spent on those activities is unequally divided between men and women. While men only conduct 140.1 minutes on a daily basis, women spend 248.6 minutes on unpaid work in the UK (OECD, 2022a). This difference is referred to as the gender gap in time allocation which is a central reason for the necessity of gender-based analysis (Ferrant et al., 2014; Gimenez-Nadal & Molina, 2020; Shelton, 2006). Although those unpaid work activities are considered economically relevant, a large amount remains outside the scope of economic measures. For example, other than paid work activities, many unpaid work activities are not included in a country's Gross Domestic Product (GDP) figure. Nevertheless, the contribution of unpaid work towards the economy is significant. The following statement from the UK Office for National Statistics (ONS) and its latest release of its 2016 Household Satellite Account (HHSA) shows this clearly.

> "In 2016, the value of the UK's unpaid household service work was estimated at £1.24 trillion - larger in size than the UK's non-financial corporation sector; overall unpaid household service work was equivalent to 63.1% of gross domestic product" (Office for National Statistics [ONS], 2018b, p. 3).

It therefore seems less convincing that only a fraction of this tremendous contribution is part of a country's total production value, while many unpaid work activities remain unconsidered from an economic perspective. For decades, this exclusion has been heavily debated in literature, as outlined in the literature review chapter.

Although there is still no prospect of including all economically relevant activities in a country's GDP measure, the literature offers approaches that allow for estimating the monetary contribution of unpaid work activities separately to the GDP calculation, and further allows comparing the results with the GDP numbers. Those approaches range from simply estimating the labour value of unpaid work activities to the development of a full HHSA covering the entire household sector of an economy. This study focuses on the labour value of unpaid household work activities only, disregarding all other factors of household production. Also omitted from this research are activities performed outside one's own household, leaving volunteering, travelling and shopping activities out of scope.

Even though several approaches are available to calculate the monetary value of unpaid household work, their results vary significantly, and it is well known that the applied approaches are lacking accuracy. According to Poissonnier and Roy (2017), the monetary value of all unpaid work activities differs significantly by country. For example, in the United States (US) that value was equivalent to 27% of the 2004 GDP, in Finland it was equivalent to 39% of GDP in 2006, in the UK 63% of GDP in 2000, and in Germany 43% of GDP in 2001 (Poissonnier & Roy, 2017). Although those percentage rates for the UK were similar with 63% in the year 2000 and, according to the above quotation, 63.1% in the year 2016, Ahmad and Koh (2011) stated in their paper that using a different approach for the valuation could reduce that number down to just 25% of annual GDP in the UK. This demonstrates the existence of a significant range within the same country and justifies the need for research to improve the accuracy of the valuation approaches, as well as finding an agreement on the most suitable approach.

This need has been discussed in literature for many decades; for example, by Quah (1986), United Nations (2017), and Varjonen et al. (2014). Some of the valuation approaches have become established in literature and, despite their known and debated limitations, they are commonly used for the valuation of unpaid work. The following quote is more than 30 years old but is still as valid as if it had been published recently. If no accurate approach is found "any household production study would undoubtedly be questionable and any estimates if generated, would remain estimates of curiosity" Quah (1986, p. 244). The United Nations (2017) recommends scholars and practitioners endeavouring to find something better than the existing approaches "until they have what can be considered as a sensible result, based on a set of reasonable and clear assumptions" (p. 29).

The above discussions show the urgent need for research that assists in finding acceptable solutions and certifies its significance. This is exactly the point at which the research of this work begins.
To maintain the consistency in the terminologies used in this thesis, the terms *unpaid work*, *unpaid labour* and *household work* are used interchangeably as they have the same meaning, unless otherwise explicitly stated.

1.3 Research Problem and Importance

One commonly used approach to value unpaid work is the Value of Labour (VoL) approach, that, in its simplest form, values time spent on certain activities with a monetary value. It comes with advantages and disadvantages that are evaluated in the literature review chapter.
The VoL approach uses time duration data of certain activities performed by household members, most commonly from Time Use Surveys (TUSs), and values that time by multiplying it with an hourly wage rate, usually adopted from a labour force, population or earnings' survey conducted by a National Statistical Office (NSO)

(United Nations, 2017). Often, the applied wage rate is the hourly wage of a professional housekeeper in the market, or the wage rate of a specialist worker (Chadeau, 1992; Dong & An, 2015; Hawrylyshyn, 1976). As market wage rates between men and women are different – which is called the gender wage gap – it is recommended to also apply them on a gender basis to reflect this inequality (Maani & Cruickshank, 2010; Matteazzi & Scherer, 2021; McHenry, 2013).

The review of the literature, presented in Chapter 3, reveals three key limitations of the VoL approach. The first limitation is that activities performed while doing a main activity, so called simultaneous activities or multitasking, are (1) excluded from the valuation. The second and third limitations are that wage rates are not appropriately adjusted for (2) quality and (3) productivity differences between workers in the market and those at home. It needs to be pointed out that the literature does not offer a precise definition of the terminologies *quality* and *productivity* as both are very much dependent on the experience and skills of each individual. This fact will be further explained in Chapter 3. According to Błaszczak-Przybycińska and Marszałek (2019), United Nations (2017, 2020), and Varjonen et al. (2014), further work is required to improve the accuracy of the VoL. Based on the three key limitations, the following three areas for improvements were identified.

1) Although Budlender (2007), Hunter (2010), and Quah (1989) point out the necessity of including simultaneous or multitasking activities into the VoL estimates to ensure accurate calculations, Błaszczak-Przybycińska and Marszałek (2019), Ironmonger (2003), Nordhaus (2006), United Nations (2017), and Williams and Donath (1994) state that there is currently still no agreement on how best to treat simultaneous activities in the calculation. Recommendations on improvements range from splitting time equally amongst activities (Drago, 2011; Williams & Donath, 1994; Zaiceva & Zimmermann, 2011) over the development of utility functions that supply necessary weights (Stinson, 1999) and modified household production functions (Kalenkoski & Foster, 2015), to activity combinations for simultaneous activities (Gershuny & Sullivan, 1998).
Although none of these recommendations is claimed to be ideal, the United Nations (2017, 2020) highlight that further research is utterly required to properly include simultaneous activities.

2) A missing adjustment for different quality levels between unpaid household members and paid market workers was identified, in case the market wage rates of a specialist are assigned to unpaid work activities performed by a household member. A review of the literature showed that a necessity of those adjustments is supported by many researchers and organisations including the European Commission et al. (2009), Folbre (2015), Landefeld et al. (2009), National Research Council (2005), Poissonnier and Roy (2017), Schreyer and Diewert (2014), and Varjonen et al. (2014). Although a quality adjustment is recommended, the exact scale for such adjustments has not been established yet (Schreyer & Diewert, 2014).
Hence, many prior studies either avoided adjustments or implemented arbitrary selected adjustments, often based on subjective assumptions. Therefore, it is clearly visible that there is a need for further improvements in this field of research.

3) The third limitation concerns a missing adjustment for differences in productivity between a household member and a paid specialist in the market. Similar to quality, it is assumed that a market professional achieves a different level of productivity than the average household person. Blades (2000), Fischer (1994), Lowen and Sicilian (2015), National Research Council (2005), and van de Ven and Zwijnenburg (2016) recommend that productivity adjustments are necessary to account for these differences, while Lowen and Sicilian (2015) argue they are essential to avoid an overestimation of the VoL. Similar to quality adjustments, the magnitude for those adjustments is uncertain (Salamon et al., 2011) and there is no agreement on appropriate adjustments so far (United Nations, 2020). Lowen and Sicilian (2015) state that the productivity in households is lower than in the market, while Fitzgerald and Wicks (1990) showed in their study that this does not necessarily apply to all activities. In some instances, households may achieve a higher productivity than market professionals. As a consequence of the missing consensus on appropriate adjustments, arbitrary numbers are often applied, or no adjustments at all are made. It is believed that further research is required on identifying the magnitude of the productivity adjustment and its implementation.

Overcoming those three limitations is an essential step towards achieving a higher accuracy of the VoL estimates and therefore justifies this research thesis. It was pointed out, above, that the VoL estimates, based on the currently used approaches, differ significantly, depending on the type of approach used and the assumptions applied. Those differences can easily reach magnitudes of several billions of pounds, as indicated by the GDP percentage rates above, and also may lead to wrong VoL estimates.

1.4 Motivation

My first in-depth contact with the topic of valuing unpaid work was made during an overseas job role as a statistical analyst in a governmental NSO, where I spent a significant amount of my time working on macroeconomic topics, in particular the contribution of the non-measured economy. For a few years, the main focus of my work was on the valuation of unpaid household work, the economic contribution of volunteering for or through non-profit organisations, charity work and the development of a HHSA. This work was strongly linked with the analysis of existing TUS data, as well as playing an advisory role for unpaid work-related questions in the development of the next TUS. After the new TUS data were collected, the role also allowed to check the coding, and later included the analysis of unpaid work-related data.

It was interesting to see, not only confirmed by literature but also in practice, that the main focus of researchers and practitioners is typically on the primary activity only, regardless of it being unpaid work, leisure or any other type of activity. Although many TUSs record additional activities that are done simultaneously, they are typically excluded from the existing valuation methods. I also found it interesting that a large amount of published research studies on the VoL were based on arbitrary and superficial assumptions, rather than scientifically based data. These assumptions were, for example, applied for the treatment of simultaneous activities as well as the wage rates used for the valuation. Quite often budget issues as well as pure simplicity were put forward as explanations for those choices.

I realised that this area was not well researched and started investigating the key problems, building up in-depth knowledge about it and looking into options for improvement, in particular for the problem of the treatment of simultaneous activities in the VoL, out of personal curiosity. After I moved countries and changed job roles as well as the professional field, I lost track of the original topic for a few years.

In 2017 I came across an article in a newspaper that presented new insights into household activities. This article was based on the most recent time use data. This was also at a time when I was doing a lot of renovation work at home, which made me wonder whether I would be able to achieve a similar quality of work compared to a hired market professional and complete the tasks in a similar time. This brought back the memories of my work on valuing unpaid household activities and out of curiosity I started researching to see how far the limitations in this research area, which I had identified about 7-8 years ago, had developed over time. I found that many of them still existed and this was the starting point of this research project.

1.5 Research Aim

The aim of this research is to modify the currently dominating approach on valuing unpaid household work by taking consideration of simultaneous activities, quality and productivity. This aim is achieved by answering the following research questions.

1.6 Research Questions

This research tries to find answers to the following research questions:

1. What is the currently dominating approach for the valuation of unpaid household work?

2. How can the currently dominating approach on valuing unpaid household work be modified to consider simultaneous activities and adjust for quality and productivity, taking gender differences into account?

3. What are the magnitudes of the modifications compared to the dominating approach based on relevant UK data?

4. How is the quality of unpaid household work affected by selected demographics?

5. What recommendations can be made to policy makers and practitioners on the implementation of splits and adjustments, and the development of a harmonised approach for valuing unpaid household work?

1.7 Research Objectives

To answer the research questions, five research objectives were defined. This research seeks:

1. to evaluate the existing and identify the currently dominating approaches on valuing unpaid household work.
2. to modify the currently dominating approach on valuing unpaid household work by assigning splits for simultaneous activities and weights to adjust for quality and productivity, also taking gender differences into consideration.
3. to validate the outcome of the modifications by comparing the results based on the modified approach with the dominating approach using relevant UK data.
4. to evaluate the demographic factors and their impact on the quality of unpaid household work.
5. to make suggestions to policy makers and practitioners towards developing a harmonised approach for valuing unpaid household work, and make recommendations for the implementation of splits and adjustments.

1.8 Methodology

To meet the aim of this research and provide answers to the research questions, the following research methodology is applied.

This research adopts a positivist philosophical position in line with Bryman (2008), as this research is based on numbers and facts. Data are collected rather than observed and the researcher allows for bias, errors and limitations. Following this tradition, a deductive approach to reasoning as outlined by Cooper and Schindler (2014), Given (2008), and Punch (2005), is implemented. For the research design, a quantitative research approach (Creswell, 2014) and a descriptive type with small elements of an exploratory and explanatory type (Babbie, 2011; Cooper & Schindler, 2014; Sekaran & Bougie, 2010), as outlined in Chapter 4, is used. Further, a survey research strategy (Creswell, 2014; Kumar, 2019) is applied. The data are only collected at a single point in time and therefore this study applies a cross-sectional time horizon, in line with Cooper and Schindler (2014) and Sekaran and Bougie (2010).

Both primary and secondary data are used in this research. The secondary data consists of two different data sources. The first data source is TUS data from the 2014/2015 United Kingdom Time Use Survey (UKTUS) and the second one is supplementing wage data from the Annual Survey of Hours and Earnings (ASHE). Both will feed into the modified VoL approach and its validation on a gender basis for men and women and for both genders combined.
The UKTUS data are accessible from the UK data service, and wage data through the UK's NSO.

The secondary datasets will be checked for consistency and completeness with the key variables being identified. The UK Statistics and Registration Service Act (UK Statistics Authority, 2022) ensures a high quality of published national statistics. A high quality of the secondary data is also attested by the supplementary methodology papers (Centre for Time Use Research [CTUR], 2016; Morris et al., 2016; ONS, 2018a).

Primary data were collected by an online questionnaire that was distributed to UK residents using the online service of SurveyMonkey and its panel of individuals aged 18 years and over. The purpose of the questionnaire is to obtain the views of UK residents, regarding their own experiences with unpaid household work, and collect data on how they would rank themselves compared to market professionals. The responses were used to determine the magnitude of adjustments towards the currently dominating approach for the VoL. The questionnaire was designed as a structured questionnaire with closed questions. During the Covid-19 pandemic situation this was a secure and reliable way to achieve a high response rate and reach out to a variety of individuals.

In a further step, different models are built that reflect the individual adjustments of the VoL. These models consider multitasking, adjustments for quality, adjustments for productivity and a variety of combinations of them. This is hoped to overcome the above-mentioned limitations of the VoL. Based on those models, the VoL estimates were calculated and compared to the dominating VoL approach prior to any modifications being made, using the housekeeper wage rate and the unadjusted specialist wage rate. To allow gender-based comparisons, the VoL is presented for men, women and both genders combined. The VoL results will also be evaluated regarding the magnitude of adjustments and how those influence the VoL.

Furthermore, Statistical Package for the Social Sciences (SPSS) is used for descriptive and inferential statistics on the primary data. Moreover, a regression analysis is performed to investigate the demographic effects on the quality of unpaid household work.

1.9 Contribution of Study

Based on the above identified limitations in the current literature, the original contribution to knowledge of this study is the modification of the dominating approach of the VoL by taking multitasking splits into consideration and allowing for the adjustment of quality and productivity in one valuation approach. This is the first time three adjustments were implemented in one approach. It is also the first time that all three adjustments were supported by primary data, specifically collected for the purpose of evaluating the modifications. In addition, this study investigated whether selected demographics impact on one of the adjustments, the quality of unpaid household work. This is also considered unique and, by breaking new grounds, this contributes to knowledge.
It is hoped that the modified approach of estimating the VoL supports practitioners and policy makers with the development of a harmonised approach to VoL, which then may be used by the NSOs and research organisations.

1.10 Structure of the Thesis

The thesis consists of seven chapters, including this introduction.

Chapter 2 introduces the economic framework of the System of National Accounts (SNA) and identifies it as the basis for the explanation of approaches used for measuring and valuing unpaid household work.

Chapter 3 presents a review of the current literature on the TUS, which is the main source of data to identify unpaid work activities, their duration and time spent on multitasking. Furthermore, the main VoL approaches are evaluated and different wage rates for the valuation are explained. Moreover, the current state of research on quality and productivity adjustments for specialist wage rates is provided. This literature review is used to identify existing gaps in knowledge that justify this research. The chapter concludes with the conceptual framework and the research steps.

Chapter 4 outlines the methodology of this research. The choices for the philosophical tradition, approaches to reasoning and the research design are justified. The secondary data, UKTUS and ASHE data are explained in detail before the primary data and their collection method is addressed. In addition, the data preparation steps prior to the data analysis, the method of data analysis, data protection and research ethics are discussed.

Chapter 5 provides the empirical data analysis that is required to allow the implementation of the adjustments for quality and productivity and the consideration of multitasking. Before any adjustments can be implemented into the dominating approach, essential preparatory work needs to be completed which involves various steps of mixing time use, wage and primary data to make them fit the different VoL models that are developed for each of the investigated modifications. This also requires the description of the primary data in great detail. At the end of Chapter 5, the various models for the VoL calculation are introduced and will be tested with data in the following chapter. In addition, a regression model is built that allows for evaluating the effects of selected demographic factors on the quality of unpaid work.

Chapter 6 presents the results of the VoL calculations based on the various models introduced in the previous chapter. The VoL results are provided for men, women and both genders combined to allow a gender comparison and they are also shown for different groups of activities. A comparison of the results with the dominating approach of the VoL is done to show the magnitude of the modifications. In addition, the results of the regression analysis are presented. The chapter is completed by a detailed discussion of the main results for the VoL, the regression analysis and their connection with the existing literature. This helps to answer the five research questions outlined above.

Chapter 7 concludes this thesis by highlighting the main research findings, stating the implications this research may have for the policy makers and practitioners and pinpointing its contribution to knowledge. The strengths of this thesis are presented and its limitations are addressed. Based on the findings and limitations of this study, suggestions for future research are provided.

1.11 Chapter Conclusion

This introductory chapter provides an overview of this research by addressing the significance of the chosen topic and the researcher's motivations for undertaking this research. It sets out the research aim, research questions and research objectives. Furthermore, the research problem and its importance are explained and the contribution of this study towards knowledge is highlighted. To build on a solid foundation for this research, the research methodology is outlined which explains the philosophical underpinnings of the research and justifies the research design chosen by the researcher. Moreover, an overview of the structure of this thesis is presented. The following chapter describes the macroeconomic framework of the study and positions the VoL into that framework.

Chapter 2

The Macroeconomic Framework and the Valuation of Unpaid Work

2.1 Introduction to Chapter

Based on the research background, the research questions and objectives set out previously, this chapter positions the research topic into the wide area of economic research, in particular on the VoL. This is done by introducing the macroeconomic framework for the valuation of unpaid household work, the SNA. The need for the valuation of unpaid work, why it is measured, the problems of its valuation and reasons for not fully accounting for unpaid work in the SNA are highlighted. It is also shown that if economic activities are not valued accordingly, it misrepresents the total economic activity of a country. While women spend significantly more time on unpaid work than men (OECD, 2022a), a larger proportion of their economic contribution, compared to men, would remain unnoticed. Furthermore, the importance of the GDP with regard to the evaluation is also highlighted. Moreover, the main approaches for the valuation of unpaid household work and how they fit into the SNA framework are presented.

2.2 The System of National Accounts and Unpaid Work

This section introduces the SNA and its different sectors with a main focus on the household sector. The concept of the production boundary, which hinders the inclusion of unpaid household work fully into the SNA, is explained. Relevant problems and ongoing criticism are outlined and possible solutions are presented.

2.2.1 Purpose, Importance and Sectors of the SNA

The SNA is an internationally agreed standard that supports countries on how to produce their National Accounts and thus on how to measure and evaluate their economic activities (European Commission et al., 2009). Its foundation sits on the Keynesian macroeconomic theory (United Nations, 2022a). Rather than acting as a set of strict rules, the SNA acts as a flexible framework, a guideline, that allows countries to make it fit their own needs and adjust it to meet country-specific requirements. Examples of a varied SNA are the New Zealand System of National Accounts (Statistics New Zealand, 2001) for a single country or, for larger areas, the European System of Accounts introduced by Eurostat (2013).
Although it is not mandatory, the SNA has been adopted by many countries worldwide. Due to the broad use, it allows international organisations and researchers to compare the economic activities of different countries (European Commission et al., 2009). The SNA is required for further detailed analysis of economic activities within a country, such as measuring and valuing unpaid work (Statistics New Zealand, 2001).
However, the key limitation of the SNA, is that it measures market activities but does not include large parts of productive non-market activities such as household production (Bridgman et al., 2012).

One of the key indicators used by the SNA that reflects the economic activity of a country is GDP (Froyen, 2012; Lequiller & Blades, 2014). As already pointed out in the previous chapter, it is also used to demonstrate the monetary size of unpaid household work contribution towards the economy. It was shown that for the year 2016 that contribution was claimed to be 63.1% of the UK's annual GDP or "£1.24 trillion, equivalent to £18,932 per person" (ONS, 2018b, p. 4). In order to better classify this large number, Table 2.1 lists the annual GDP numbers for the UK for the years between 2014 and 2021 (ONS, 2022a).

Table 2.1: Annual GDP in the UK

Year	Annual GDP in million £
2014	£1,876,162
2015	£1,935,212
2016	£2,016,638
2017	£2,097,143
2018	£2,174,380
2019	£2,255,283
2020	£2,150,381
2021	£2,317,054

Source: ONS (2022a)

For a better understanding of what parts of the economy contribute most to the whole economy, the SNA splits the national economy into five, non-overlapping sectors (Government units, financial corporations, non-financial corporations, non-profit institutions serving households and households), all of which may have several subsectors, and an additional sixth sector that covers activities outside the national economy (European Commission et al., 2009).
While this study focuses on the household sector only, which is described in more detail below, it completely disregards the other sectors and also omits further explaining them.

2.2.2 The Household Sector

The household sector within the SNA consists of the households within an economy. Its size is claimed to be similar to that of market production and hence, due to its size, it is fair to call the household sector also the household economy (Bittman & Ironmonger, 2011; Ironmonger, 2000). The household economy is defined "as the productive activities conducted by households using household capital and the unpaid labor of their own members to process goods and provide services for their own use" (Ironmonger, 1996, p. 42).

According to Błaszczak-Przybycińska and Marszałek (2019) as well as Schreyer and Diewert (2014), households have two roles; one as producers because people produce goods and services in their own households, and the more traditional one of consumers, because they buy goods and services on the market.
Goldschmidt-Clermont (1993) stated that this household production process is sim-

ilar to market production and requires capital and labour as classic input factors. Therefore, Colman (1998) considered including each sort of capital that is part of the household production process, and listing these in addition to household appliances – for example, buildings and properties – while Goodwin et al. (2008) proposed including only a proportion of the machineries such as cars and appliances used in production.
Nevertheless, newer studies provided a different view and resulted in another recommendation. A study by Duernecker and Herrendorf (2015) showed that household production is highly labour intensive and capital input is negligibly small. They explained that in market production a capital-to-output ratio is usually around 3, but only as low as 0.5 within a household.
This is in line with an earlier study by Carrasco and Serrano (2011), which found only a fraction of 0.3% of the value of household production coming from the capital side. They therefore concluded that the main focus of household production should be on the labour input side (Carrasco & Serrano, 2011). Thus, capital inputs, apart from labour, should be excluded from household production.

While market production is fully accounted for in the SNA, this does not apply to all productive activities carried out by and within households (Nordhaus, 2006). What is considered as production and what is left out is defined by the SNA production boundary.

2.2.3 The Production Boundary

The SNA distinguishes between two boundaries, a general and a more restricted production boundary that draw the line between the inclusion or exclusion of household services (European Commission et al., 2009; United Nations, 2017; van de Ven & Zwijnenburg, 2016).
According to the European Commission et al. (2009) the general production boundary considers each productive activity within an economy "that uses inputs of labour, capital, and goods and services to produce outputs of goods or services" (p. 97).

While the general production boundary allows the inclusion of household services, the more restricted production boundary of the SNA excludes most household services apart from owner-occupied housing and production of domestic and personal services by employing paid domestic staff (United Nations, 2017; van de Ven & Zwijnenburg, 2016).

2.2.3.1 Criticism of Production Boundaries

The exclusion of household services from the SNA is a massive point of critique because it leads to wrong measurements and provides a wrong picture of the economy (Chadeau, 1992). The criticism started in the 1920s but still goes on in the 21st century, for example, by Budlender and Brathaug (2010) and United Nations (2017, 2020).

Chadeau (1992) criticised that the exclusion of unpaid household work may lead to the impression that those activities are not productive and of no value. But the opposite is true and its value is clearly substantial (Chadeau, 1992). Its exclusion from the SNA and GDP measures will also undervalue the contribution of the household sector towards the economy (Suh & Folbre, 2016).

More explicitly, Goldschmidt-Clermont (1991) postulated that without the recognition of household production and unpaid household work, an accurate measure of the standard of living as well as the introduction of better welfare and population policies are not possible. A reason not to neglect it is the social status of unpaid household workers.

The reason why household production should be measured is simply because it is not fully accounted for in the SNA (Blades, 2000). Moreover, unpaid work should finally be seen as work although no payment is received for those tasks (Hirway, 2015). She criticised that unpaid work does not get the attention it deserves because it is "invisible, repetitive, boring, time consuming and strenuous" (Hirway, 2015, p. 5). It is further stated that unpaid work may also be seen as "a dead-end job" that does not allow retirement or promotions (Hirway, 2015, p. 5). In line with many researchers, Hirway also argued that the sheer size of the unpaid work and its interdependences with the market sector justify a full inclusion in the SNA (Hirway, 2015). From a feminist perspective, she also mentioned that the exclusion goes hand in hand with an exclusion of women's contribution to the economy because generally women do more unpaid work than men (Hirway, 2015). An identification of their share of the contribution can only be achieved by a gender-based analysis.

Although there are many critical voices that argue for including unpaid household work in the SNA, there are also counter arguments why it should not be included.

2.2.3.2 Problems of Extending the SNA Boundary

One way of including household production to its full extent would be to change the SNA production boundary to allow for a full inclusion. Although this sounds like a doable task, its impact would change macroeconomic aggregates of the SNA, such as expenditure, income and GDP, and may lead to serious inconsistencies in the SNA (van de Ven & Zwijnenburg, 2016). It may further complicate its use for economic analysis and policy decisions or, at worst, would make them useless (Chadeau, 1992).

Statistics New Zealand (2001) named three main reasons why the SNA boundary does not include unpaid work or household production in the way it should be: 1) Since households also consume self-produced services, it can be argued that this self-consumption does not have the same economic value as produced goods on the market. 2) The amount of products and services produced in households is hard to measure. 3) Estimating or imputing household products, services and corresponding prices would be possible but would then impact on the rest of the SNA (Statistics New Zealand, 2001).

A further problem was identified by the European Commission et al. (2009). If the boundary would be extended to allow for the inclusion of all household activities in the SNA, everyone involved in those tasks would, by definition, need to be treated as a self-employed person. Due to the fact that most household members are engaged in at least some sort of household activities, this would destroy the concept of unemployment.

One solution to work around this problem of extending the boundary is the production of satellite accounts; for example, a HHSA (Goldschmidt-Clermont, 2000; Hirway, 2015; van de Ven & Zwijnenburg, 2016). Another solution would be the use of Input-Output tables for households, similar to their use for market production (Ironmonger, 1999).

The recognition of unpaid work and household production within the entire economy, whether done by including it into the SNA framework, or by keeping it separate with the production of satellite accounts, shows that it is possible to connect the household work at the micro level with the macro level of the economy (Goldschmidt-Clermont, 1993; İlkkaracan, 2017).

2.2.3.3 Productive and Non-productive Activities

Another central problem in household production is to draw a clear line between productive and non-productive activities. According to Goldschmidt-Clermont (2000), the activities performed by individuals can either belong to the group of economic activities or the group of non-economic activities. While the latter includes mostly personal and leisure activities, the economic activities cover all productive activities, whether included or excluded from the SNA production boundary.

The identification of productive activities is done by the *third party criterion* based on Margaret Reid (Eurostat, 2019). According to her criterion, activities that can be delegated to a third person or group are considered to be productive while all other activities are not (Reid, 1934). For example, taking a bath cannot be delegated to someone else instead of oneself, and is therefore declared as a non-productive activity. However, washing an infant can be delegated to someone else, hence this is considered a productive activity.

Although the criterion has undergone various steps of clarification, its major problem is its simplicity. The definition of the criterion is quite wide and thus can be interpreted in several ways depending on the view of the researcher and the aim of the research. Reich (2001) criticised the third party criterion for its subjectivity and its vagueness. Subjective is the decision of what is covered by this criterion and the appointment of who makes those decisions. Vague is the definition itself, because it does not offer a clear-cut boundary and allows for flexibility (Reich, 2001).
This lack of a clear-cut boundary concerns activities not considered entirely productive; for example, because they involve recreational, travel or leisure elements (Chadeau, 1992; Poissonnier & Roy, 2017).
Travelling activities could be either seen as productive or non-productive depending on the purpose of the travelling (Chadeau, 1992; Statistics New Zealand, 2001), but there is no consensus on the correct treatment of travel activities. A consequence is a mix of inclusions and exclusions of travel activities in research studies (Poissonnier

& Roy, 2017).
A similar problem is caused by 'leisure type activities' which can consist of a productive and a non-productive element (Statistics New Zealand, 2001). Poissonnier and Roy (2017) suggested calling productive activities with elements of leisure time "productive leisure" and listed "gardening, home repairs and decoration, fishing and hunting" as examples (p. 361). Whether to treat those activities fully, partially or not at all as productive activities is a call that needs to be made by the researcher individually based on the purpose of a study.

Based on the explanations and problems of the SNA regarding valuing unpaid household work, the following section introduces different approaches to measure household production and value unpaid work.

2.3 Approaches of Measuring and Valuing Unpaid Work

As previously mentioned, Hirway (2015) highlighted the necessity of accounting for unpaid work in national economies and argued that excluding it from national accounting is not justifiable because it contributes significantly to a country's economy. Hence, ignoring unpaid work only reflects a certain proportion of an economy and therefore does not provide the full picture of that economy (Hirway, 2015). She proposed regular production of quality data sources such as TUSs as well as the use or development of tools to analyse the collected data accordingly and achieve a high quality standard of the valuation (Hirway, 2015). She further requested a full inclusion of unpaid work into policy making, rather than still having it kept separate from paid work (Hirway, 2015).

The literature provides two key approaches that can be applied to measure and value unpaid work. Both approaches, the output and the input approach, will be discussed in the following two sections.

2.3.1 The Output Approach

The output approach follows the concepts and guidelines of the SNA. Its purpose is to measure the quantity of produced goods and services within a household and assign the market price of equivalent goods or services produced in the market (Dong & An, 2015; Hirway, 2015; Sharpe & Abdel-Ghany, 1997). Thus, this approach is designed to measure the *total output of household production*. The quantity of produced goods and services means that data on how many meals were cooked, how many fences painted, how many shirts cleaned or ironed, etc. needs to be collected.

The main advantages of this approach are as follows. Due to its consistency with the SNA, it is recommended to be the most suitable approach for the valuation of unpaid household work (Chadeau, 1992; Goldschmidt-Clermont, 2000; Hirway, 2015; Holloway et al., 2002; Sharpe & Abdel-Ghany, 1997). Because of its design and nature, the output approach has another key advantage. Unlike the input approach, which is introduced below, it does not have to adjust for different levels of productivity (Budlender & Brathaug, 2010; Goldschmidt-Clermont, 1993; Soupourmas & Ironmonger, 2002) between household workers and market professionals, as this is automatically taken into account appropriately. In a similar way, the output approach also accounts accordingly for simultaneous activities and multitasking (Goldschmidt-Clermont, 1993; Ironmonger, 1996; Ironmonger & Soupourmas, 2009).

However, the output approach comes with the following four main disadvantages, which may be the reason why the output approach is rarely applied (Varjonen et al., 2014).

First, a problem with the output approach is the application of a correct market price (Chadeau, 1985; Poissonnier & Roy, 2017). It is difficult to find appropriate substitutes for home-produced goods and services because market prices usually include country specific tax rates and a profit margin which typically do not apply to households (Chadeau, 1985; Dong & An, 2015; Nordhaus, 2006). This makes the output approach extremely complicated to use (Hirway, 2015). For example, the price for a dinner can vary depending on the type of restaurant as well as the size of the meal, which makes it hard to find suitable market prices (Holloway et al., 2002).

Second, a more in-depth question on the market price is whether producer or consumer prices should be used. While consumer prices are the ones that the consumers pay when they buy something in the market, the producer prices are lower because they exclude taxes and profit margins (Goldschmidt-Clermont, 1991). Holloway et al. (2002) recommend using consumer prices because they are more consistent with the SNA (Holloway et al., 2002).

Third, Ironmonger and Soupourmas (2009) point out that counting the volumes of household production outputs is a very complicated task (Ironmonger & Soupourmas, 2009). Its complexity can be illustrated by looking at the enormous amount of different goods and services available within an economy and the variety of nuances that differentiate commodities.

Fourth, to account for the problems of finding appropriate prices and collecting correct output volume data, the formulation of a long list of assumptions may be required (Landefeld et al., 2009). This might influence the accuracy of the output approach.

Although the output approach is often referred to as being ideal for the valuation of household production, there is a second best alternative, the input approach (European Commission et al., 2009).

2.3.2 The Input Approach

As opposed to the output approach, which offers a direct measure of the produced output, the input approach exists as an indirect measure of household production and unpaid work (Fitzgerald & Wicks, 1990). Contrary to the output approach, the input approach is based on the different costs of production, or simply the input costs of household production (Varjonen & Aalto, 2006). Those costs mainly include an imputed value for the labour input but additionally take capital consumption, intermediate consumption, taxes and subsidies into consideration (Chadeau, 1992; European Commission et al., 2009; Eurostat, 2003; Goldschmidt-Clermont, 2000). The different parts of the input approach are illustrated in Figure 2.1. However, a precise description of each individual part was deliberately omitted, since this would go beyond the scope of this thesis. All terminologies mentioned in Figure 2.1 are standard terms of the SNA and hence do not need further explanation. All those input costs added up provide the sum of all costs of production, the *value of total output*, “an estimate of the value of non-market household production” (Chadeau, 1992, p. 90).

Value of labour (VoL)	Value of labour component of unpaid work (time x wages)
+ Taxes on production	Transfer payments made by households to government
- Subsidies on production	Transfer payments made by government to households
+ Consumption of fixed capital	Depreciation of household durables used in the household production process
= Gross value added	The value of output after the cost of bought-in materials and services has been deducted but including consumption of fixed capital
+ Intermediate consumption	Non-durable goods and servides acquired by households that are used up in household production
= Value of total output (sum of costs)	Value of all the goods and services produced in a household

Figure 2.1: Input approach and the value of labour

Source: Adapted from Statistics New Zealand (2001) and based on Chadeau (1985, 1992), Goldschmidt-Clermont (2000), United Nations (2017), and Varjonen and Aalto (2006)

The input approach, compared to the output approach, has two unbeatable advantages. It is easier to apply because most of the required data already exists as it comes from classical surveys regularly done by most NSOs, and therefore, it is considerably cheaper than the output approach (Varjonen et al., 2014).

Similar to the output approach, the input approach also comes with downsides. One main disadvantage is the lower accuracy of the input approach compared to the output approach, which is owed to the fact that the total output of household production is not measured directly but estimated (United Nations, 2017). A lower accuracy is also claimed by Hirway (2015), Poissonnier and Roy (2017), and Soupourmas and Ironmonger (2002), who highlighted that the input approach does not properly account for productivity differences between households and paid market workers. Nevertheless, they are among those researchers who recommended the input approach as a good alternative to the output approach (Hirway, 2015; Poissonnier & Roy, 2017; Soupourmas & Ironmonger, 2002). Further, Young-Sook and Larson (2006) critiqued the input measure and questioned its inferences for two main reasons. The quality of the services provided by households and the skills of workers at home may not be similar to services provided or commodities produced in the market (Young-Sook & Larson, 2006). However, this divergence is not accounted for accordingly in the input approach (Young-Sook & Larson, 2006).

Because the advantages of the input approach outweigh its disadvantages, the input approach is more commonly applied in research studies than the output approach (Folbre, 2015; Varjonen et al., 2014). Examples of studies that applied the input approach include the valuation of unpaid work in South Africa by Budlender and Brathaug (2010), the Finnish HHSA by Varjonen and Aalto (2006) and Varjonen et al. (2014) and the French HHSA by Poissonnier and Roy (2017).
However, there is no denying that the input approach needs a significant amount of different data which makes it complex to apply in its entirety (United Nations, 2017).
As shown in Section 2.2.2 above, the majority of input into household production is labour (Carrasco & Serrano, 2011; Duernecker & Herrendorf, 2015). Therefore, researchers, practitioners and NSOs often choose to apply only the first part of the input approach presented in Figure 2.1, and thus only focus on the VoL while completely disregarding the other input factors such as intermediate consumption and taxes (Eurostat, 2003; United Nations, 2017). This makes the VoL the most common method applied for the valuation of unpaid household work (Eurostat, 2003; Folbre, 2015).

The VoL is derived by multiplying the time spent on producing a good or service with an appropriate wage rate (Blades, 2000; Eurostat, 2003; Varjonen et al., 2014). Adopted from Folbre (2015) is the following example. If a household member cleans a dwelling for two hours, that individual's VoL would be £16 if an hourly wage rate for cleaning personnel in the market is £8.
Using the variable t for the time and w for the wage rate, this leads to the Equation 2.1 for the VoL in its most basic form.

$$\text{VoL} = t * w \tag{2.1}$$

Based on Equation 2.1, the following chapter focuses on the VoL and both its variables t and w in detail.

2.4 Chapter Conclusion

This chapter connects the introduction with the literature review by presenting the macroeconomic framework for this research study and outlining its production boundary which does not include all productive activities within the household sector. The problems caused by this, the criticism on the exclusion of a large part of the economy and possible solutions were outlined. The two approaches for measuring and valuing household production and unpaid work were explained and the VoL as one part of the input approach was found to be the most common valuation approach for unpaid household work. This insight lays the foundation for this research and the literature review presented in Chapter 3.

Chapter 3

Literature Review on Valuing Unpaid Household Work

3.1 Introduction to Chapter

Following the research questions, objectives and purpose of this research, this chapter reviews the existing literature on the valuation of unpaid household work and, in particular, the time spent on unpaid work activities and corresponding wage rates for its valuation. The chapter considers the extent to which the available literature adequately addresses the research questions and what knowledge is needed to achieve the research aim. This serves the purpose of justifying the need for this study and the literature review will help to provide a conceptual framework for the research topic. The chapter begins with an overview of TUSs and the methods used.

3.2 Time Use Survey

Based on the VoL outlined in the previous chapter, this section focuses on the time as a variable and explains where the necessary information to value unpaid work and how people spend their time are obtained. A TUS is described as an indispensable data source to estimate the VoL (İlkkaracan, 2017; Varjonen et al., 2014). The usability of TUS data is essential for macroeconomic analysis (İlkkaracan, 2017). Therefore, it is necessary to review the TUS literature and identify the main issues therein in relation to the valuation of unpaid household work. In doing so, possible research gaps can be identified.

3.2.1 Development of Time Use Surveys

The main purpose of the TUS is to collect information on how people allocate and use their time (United Nations, 2013). Due to their large sample size, the complexity involved and their resource-intensive nature, TUSs are typically undertaken by or on behalf of NSOs or larger research institutions (Eurostat, 2019; UN Women, 2021; United Nations, 2013). Further details are provided below, after a brief overview of the development of TUSs over time.

According to Chenu and Lesnard (2006), the first family monographs that collected information on paid work and time spent on housework were those of Frédéric Le Play, produced in the 1840s. These works involved the standardised collection of data rather than the advanced surveys conducted today, and they are not considered to be as representative as more recent studies (Chenu & Lesnard, 2006). The development of larger TUSs started in the 1910s and 1920s (Chenu & Lesnard, 2006; Harvey, 1996; Merz, 2009; Ramey, 2008; Stinson, 1999).
In the second half of the twentieth century, the cross-national time use study published by Szalai (1972) laid the foundation for many countries to examine how people spend their time (Soupourmas & Ironmonger, 2002). Kalenkoski and Foster (2008) stated that in the mid-1980s, the extent to which economists value TUSs began to increase. Today, most countries have completed at least one TUS (Córdova Cazar, 2016) and the number of TUSs is increasing considerably, and it is believed that more TUSs will be conducted in one decade of the current century than in the entire previous century (Folbre, 2015).
A very large project is the Multinational Time Use Study (MTUS), which was started in the 1980s by Jonathan Gershuny and brings together time use data collected over a number of decades from many countries (CTUR, 2022; Fisher & Gershuny, 2013; Gershuny, 2000, 2013).

A problem, first addressed by Goldschmidt-Clermont (2000), is that the development of TUSs happens at a completely different pace (fast) compared to the development of suitable valuation approaches (slow). This makes it difficult to obtain international agreement on a harmonised methodology for how to value unpaid work and household production. Although worldwide organisations and statistical offices offer guidelines that allow for the production of harmonised TUSs to increase

comparability (Eurostat, 2009, 2019; United Nations, 2013, 2021), the development of valuation approaches continues to lag behind. This can further be illustrated by the fact that the gaps this thesis identifies have been known for decades, and that the same criticisms have been raised for over 30 years.
In addition, the review of the empirical literature shows that the majority of the work done regarding the improvement of the valuation approaches is relatively old and new studies are sparse. Therefore, even in newer publications quite old references need to be used. For example, in their study, Dong and An (2015) cite the same old texts that were also used years earlier. This is a result of a lack of up-to-date literature and justifies that some important references used in this thesis are not that recent.

3.2.2 Methods for Measuring Time Use

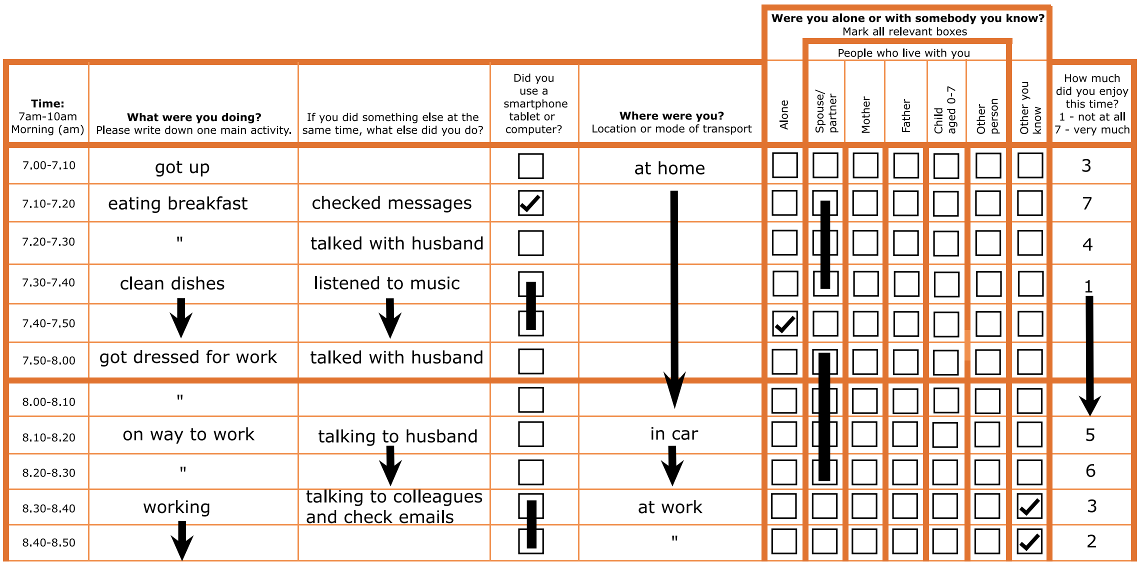
There are two traditional methods for gathering data on time use: diaries and stylised questionnaires (Gørtz, 2006). Both are explained next, starting with the diary, which is considered the "gold standard" of TUS collection methods (Trübner, 2019, p. 1239).

3.2.2.1 Diary

Time use diaries traditionally take the form of paper booklets that respondents are asked to complete by themselves (Chatzitheochari et al., 2018; Juster et al., 2003). Respondents are asked to write down how they allocated their time to various activities, such as work, leisure and care, during a consecutive 24-hour period, with some diaries only focusing on a single day, although the timeframe can also extend to a full week (Chatzitheochari et al., 2018; Córdova Cazar, 2016; Gershuny, 2011; Juster et al., 2003). Longer periods of collection, such as months or even years, are rarely used, but also possible (Córdova Cazar, 2016).

In earlier TUSs respondents were free to write down the start and end time and the corresponding activities (Stinson, 1999). The newer time use diaries are structured to allow respondents to record their actions easily. Therefore, the 24 hours or 1440 minutes of one day are broken down into smaller time slots, also called episodes or intervals (Chatzitheochari et al., 2018; Eustat, 2006; United Nations, 2013). Depending on the structure of the survey, the length of a predefined time slot can vary between 5 and 30 minutes (Chenu & Lesnard, 2006; United Nations, 2013). According to Chatzitheochari et al. (2018), Gørtz (2006), and UN Women (2021), the common length is either 10 or 15 minutes. However, the 2003 Basque Country TUS used the minimum diary time slot length of 5 minutes (Eustat, 2006).

Figure 3.1 shows a partially filled page of the 2014/2015 UKTUS diary adapted from Morris et al. (2016). It is clearly visible that the data collected in newer diaries is very detailed and, in addition to the time and activity, data on simultaneous activities, usage of smart devices, location, company and level of enjoyment is collected. The arrows and bars in Figure 3.1 indicate that the recorded data of one time slot remains consistent for the consecutive time slots until a new entry is made.



					Were you alone or with somebody you know? Mark all relevant boxes	People who live with you						
Time: 7am-10am Morning (am)	**What were you doing?** Please write down one main activity.	If you did something else at the same time, what else did you do?	Did you use a smartphone tablet or computer?	**Where were you?** Location or mode of transport	Alone	Spouse/ partner	Mother	Father	Child aged 0-7	Other person	Other you know	How much did you enjoy this time? 1 - not at all 7 - very much
7.00-7.10	got up			at home								3
7.10-7.20	eating breakfast	checked messages	✓									7
7.20-7.30	"	talked with husband										4
7.30-7.40	clean dishes	listened to music										1
7.40-7.50					✓							
7.50-8.00	got dressed for work	talked with husband										
8.00-8.10	"											
8.10-8.20	on way to work	talking to husband		in car								5
8.20-8.30	"											6
8.30-8.40	working	talking to colleagues and check emails		at work							✓	3
8.40-8.50				"							✓	2

Figure 3.1: Example of a completed Time Use Survey diary

Source: Adapted from Morris et al. (2016, p. 61)

Another diary form that does not use predefined intervals is *open* diaries that allow the respondent to either write down the duration of activities or record start and finish times (United Nations, 2013). A third form of diaries is called *light* diaries. Those are usually based on fixed interval diaries and are designed to be less detailed but often include predefined activities, allowing respondents to simply tick boxes and thus reducing response time and lowering respondent burden (United Nations, 2013). Respondent burden is defined as:

> "The degree to which a survey respondent perceives participation in a survey research project as difficult, time consuming, or emotionally

> stressful is known as respondent burden. Interview length, cognitive complexity of the task, required respondent effort, frequency of being interviewed, and the stress of psychologically invasive questions all can contribute to respondent burden in survey research" (Graf, 2008, p. 739).

While the data quality of open interval diaries is assumed to be more accurate, the United Nations (2013) recommended using fixed interval diaries. However, *light* diaries should not be used for time use studies on a national level because they do not collect the amount of in-depth data that is needed for a nationwide analysis. An additional benefit of fixed interval diaries is that they make it easier to record simultaneous activities (United Nations, 2013).

Although the time use diary usually comes with detailed information and examples on how it is supposed to be filled in, respondents may still need further support and explanation. This is usually done by interviewers, who will explain the diary prior to filling it in and talk it through again after completion to clarify any misunderstandings, problems or questions that occurred during the recording phase (Chatzitheochari et al., 2018; Morris et al., 2016; Sullivan et al., 2020). This is hoped to ensure a high data quality of the TUS.

Alternatively, time diary information can also be collected over the phone, either administered or computerised (Robinson, 1997; Stinson, 1999). This improvement made the time use collection reasonably cheaper than the standard collection methods but has not prevailed due to research design issues (Stinson, 1999). Newer, non-paper-based collection methods are provided online through web-based diaries or through smartphone apps (Chatzitheochari et al., 2018; Daum et al., 2019; Elevelt et al., 2019; Minnen et al., 2014; Sullivan et al., 2020; Zeni et al., 2020).
Chatzitheochari et al. (2018) mentioned that although newer technology is available, diaries are still the preferred method, because most web or app-based collection methods are claimed not to be able to replace a full diary method, because they tend to collect less and more standardised information.

3.2.2.2 Stylised Questionnaire

The second traditional method, apart from diaries, is stylised questionnaires. They are used to ask respondents to recall the activities they have done in the past, within a given timeframe, such as the last month or last year (Gershuny, 2011; Juster et al., 2003). Respondents typically are asked for the number of times or for how long they have done specific activities. TUS diaries are often supplemented by stylised questionnaires, typically a household questionnaire and individual questionnaires for all household members (Eurostat, 2019; Kan, 2008). While the latter one collects information about a particular household member, the household questionnaire is a general questionnaire picking up the basic information about income and composition of the household and its members (Eurostat, 2019).

One problem with the stylised questionnaire is that time diary data recordings are usually more accurate (Gørtz, 2006; Kan, 2008) and of much greater detail than those of stylised questionnaires (Harvey, 1996; Kan, 2008). Juster and Stafford (1991) argued that stylised questionnaires tend to overestimate time spent on most activities, but in the case of rarely performed activities such as home repairs, time may even be underestimated (Juster & Stafford, 1991; Juster et al., 2003). A direct comparison between diary data and stylised questions revealed that stylised questionnaires only report 50 percent of the time spent on maintenance work compared to a diary (Juster & Stafford, 1991). It is assumed that the cause for this is that the recall period is often too short to pick up the activity or it may not come to people's minds when recalling what they have done – too rare, too short, too unimportant (Juster & Stafford, 1991).

Robinson et al. (2002) outlined that using questions to ask respondents how much time they spent on certain activities often leads to an overestimation of the total time. While a 7-day week only allows 168 hours to spend, they identified reports that showed a total of 187 hours and more, up to a maximum of 250 hours per week in another survey.
Kan (2008) also noticed that in a stylised questionnaire men have a tendency to overestimate time spent on unpaid household activities on typical manly tasks such as maintenance work. She claimed that this result is particularly interesting, because usually men had the tendency to report fewer hours on unpaid household activities than they really spent, to fit their socially expected bread-earner role (Kan, 2008). This difference between men and women requires TUS data to be analysed on a gender basis.

Further, Gershuny (2011, p. 4) mentioned "desirability effects" as a problem of stylised questionnaires, because respondents tend to report "positively-valued activities" although their participation in them was not active but only passive (p. 4). This may also lead to biased information.
A further downside of stylised questionnaires is mentioned by Juster et al. (2003) and UN Women (2021), who stated that respondents may not be able to accurately report simultaneous activities.

3.2.2.3 Newer Methods for Measuring Time Use

Apart from the above introduced two traditional methods that were developed in the first quarter of the 20th century, over time, more sophisticated methods have been implemented (Juster et al., 2003). For example, the Experience Sampling Method (ESM) and continuous observation may be used in addition to the traditional methods (Gershuny, 2011; Hunter, 2010; United Nations, 2013) as well as the Day Reconstruction Method (DRM) by Kahneman et al. (2004).

The ESM, also referred to as the beeper study, randomly notifies respondents by a beeper or similar device to take a moment and write down their activities plus additional information, as requested by the researchers conducting the survey (Gershuny, 2011; Juster et al., 2003). Claimed to be superior to the ESM is the DRM which is a hybrid method of a diary that collects the allocation of time of daily activities and combines those with reportings of feelings and experiences from the respondents (Kahneman et al., 2004).

Another collection method is continuous observation, either done by a direct observer or by an observation device such as the Global Positioning System (GPS) or even a mobile phone (Gershuny, 2011). In addition to this tracking information, the respondent also needs to provide additional information; for example, on the duration of activities (Gershuny, 2011).

New technologies may be used in the future to be combined with the above-mentioned collection methods and should make data collection more efficient and user-friendly (Chatzitheochari et al., 2018). This includes, for example, measuring the time use of people in a smart home environment (Nam et al., 2011), or wearable cameras for time use collection (Kelly et al., 2015).

3.2.3 Advantages and Disadvantages of Time Use Surveys

The list of advantages of a TUS is short but nevertheless convincing. The level of detail of the data collected by a TUS is very rich and there are no other surveys available that collect a similar level of detail of individuals' time allocation or how they spent their time (Maani & Cruickshank, 2010). In other words, those surveys are without better alternatives.
Due to the variety of data collected through TUSs, they can be used in many different research areas for analytical or policy-related purposes (Chatzitheochari et al., 2018). Examples of those areas are climate, culture, environment, health, sport, transport and work (United Nations, 2013).

Compared to these advantage, the list of disadvantages is long and criticisms come from various directions. In their paper, Ironmonger and Soupourmas (2009) quoted "much time use research is slow, painstaking, meticulous work, grinding through large datasets with the aim of finding important results" (Ironmonger & Soupourmas, 2009, p. 242). This statement is reflected by discussing the following five disadvantages: irregular data collection, difficulty for international comparison, problems with certain activities, level of detailed data, and activities not measured.

1. van de Ven and Zwijnenburg (2016) critiqued that TUSs are not done on a regular basis, sometimes with many years in between two surveys. Those long periods between surveys, in combination with a lower level of consistency compared to other national surveys, make it unnecessarily complicated to compare two consecutive surveys within one country and make it even harder to compare surveys of two or more countries (van de Ven & Zwijnenburg, 2016). Furthermore, the results usually become available a few years after the completion of the survey (van de Ven & Zwijnenburg, 2016) and therefore the information collected is not current. Although van de Ven and Zwijnenburg (2016) criticised a lot, they also relativised their critique by acknowledging that it is a very hard process to solve current problems, in particular with tight funding policies in NSOs and a not-to-be despised burden for all survey participants.

2. Significant problems and limitations regarding international comparison of TUSs were identified. Charmes (2015) named five key issues that limit international comparison of TUS results.

    - A major issue is claimed to be the variety of different concepts used in TUSs and their definitions, which are often country-specific and not directly comparable (Charmes, 2015).
    - The methodology used to select the samples may not necessarily ensure a high representativeness of the total population (Charmes, 2015). This issue was also raised by Maani and Cruickshank (2010).
    - The collection period of the TUSs is not always representative of a full year and therefore, if adjustments are not made adequately, the data will have some seasonal overstatement of certain activities, which complicates an international comparison (Charmes, 2015).
    - The variety of age groups that are allowed in the TUSs is huge. Some countries start with small children from the age of three years, while others exclude under 12-year-olds (Charmes, 2015). Further research in this area using different age groups of children was done by Ziviani et al. (2008), who investigated time diaries for children, Molina et al. (2017), who looked at children's time spent online, and Larson and Verma (1999), who analysed the time spent by children around the world. A similar inconsistent situation is found at the other end of the bar, with age limits ranging from a maximum age of 65 to a maximum age of 74 for some TUSs (Charmes, 2015), while others do not have a maximum age limit, for example, the UKTUS (Morris et al., 2016).
    - The applied classifications to record respondents' activities are often developed based on harmonised classifications, but are then fitted to country specific needs, making them unique rather than harmonised (Charmes, 2015).

3. The third problem of TUSs is their design, which does not necessarily allow for accurately recording those activities that require respondents' presence while they are not actively doing something; for example, being 'on-call' if someone needs attention, or activities that contain parts of supervision (Folbre, 2015). Those activities are predominantly caring activities, when parents are

not physically spending time caring for their children, but are present, waiting to be needed. Those activities may – but do not necessarily have to – be combined with another simultaneous activity, and therefore are seen as a massive problem when it comes to the valuation of unpaid household work. More generally, Maani and Cruickshank (2010) indicated that a central problem with TUSs is the treatment of simultaneous activities, but that problem is outlined in more detail in the multitasking section below.

4. van de Ven and Zwijnenburg (2016) claimed that, although the TUS offers a very high potential, it is currently not used to its full extent. They stated that TUSs often do not have the same quality standard as most other national statistics, but also do not collect the level of detail that would be possible to collect with those surveys (van de Ven & Zwijnenburg, 2016).

5. Although the TUS collects a massive amount of data, it is criticised for still missing out essential information. For example, TUSs do not account for human effort and thus do not note a difference if an activity or work is done under severe conditions such as in the cold or in a pleasant environment (Goldschmidt-Clermont, 1991, 2000; Goldschmidt-Clermont & Pagnossin-Aligisakis, 1999). Nevertheless, that environment in combination with human effort may bias activity recordings.
   Also not measured by TUSs is data on household production outputs and their volumes (De Vaus et al., 2003; Varjonen & Aalto, 2006), direct utility of a performed activity (Goldschmidt-Clermont, 1991), the quality of a produced product or service (Varjonen & Aalto, 2006), robust data on wages (Maani & Cruickshank, 2010; Merz, 2002), data on productivity (Jankiewicz, 2017) and information about the efficiency of the time spent on activities (Varjonen & Aalto, 2006). In their TUS guide, the United Nations (2013) suggested including new questions that will help to shed some light on less explored areas but they do not offer examples of what those questions might look like. Those newly to be developed questions may then be able to collect data on, for example, the quality or productivity of household members during their activities.

Although the list of disadvantages is long and with the TUS offering many points for critique, it needs to be acknowledged that it is the only survey that does collect this amount of data on time allocation and therefore is without alternative, as already pointed out above by Maani and Cruickshank (2010).

3.2.4 Theoretical Underpinning of Time Use Surveys and Unpaid Household Work

This research about the valuation of unpaid work spans across a broad area and thus uses a range of different theoretical concepts from the micro- and macroeconomic area. This section situates the TUS in the theoretical framework by explaining its connection with microeconomic as well as macroeconomic theory. The microeconomic theory of the allocation of time is presented as one of the most important theories of TUS research and the valuation of unpaid work. However, that theory needs to be applied to the macroeconomic level, which entails various problems.

3.2.4.1 Theoretical Background

According to Gørtz (2006) and Juster and Stafford (1991) TUS, data can be used at the micro as well as at the macro level. While the microeconomic focus of the TUS lies in household behaviour and the decision making of how time should be allocated to different activities, the macroeconomic focus lies in the monetary valuation of produced goods and services in the economy and the household sector (Gørtz, 2006; Juster & Stafford, 1991). Nevertheless, the analysis of TUS data on the microeconomic level may lead to significant differences in results compared to its macroeconomic use (Juster & Stafford, 1991). This view is also supported by Ruuskanen (2004), who clearly states that the key purpose of a TUS is to collect information on how people – not individuals, but an entire society – spend their time during an average day. A TUS does not record the allocation of time of a household as it would be desired by microeconomists. Therefore, its purpose is clearly seen in macroeconomics and thus should not be applied to microeconomic models without further adjustments (Ruuskanen, 2004).

However, research on household production and unpaid work started in the area of microeconomics. In his 1980s paper, in which he analysed 20 different research studies on household production, Quah (1989) claimed that most of them looked at household production from the microeconomic perspective and only a few from the macroeconomic side. Almost 30 years later, this view has been confirmed by

İlkkaracan (2017), who argues that the majority of research on unpaid work is still done within the theoretical framework of microeconomics, while research on unpaid work within the macroeconomic framework is newer and started to grow within the past decades.

While microeconomic theory focuses on small units and is based, for example, on rational choice, utility maximisation, equilibrium, etc. (Goldschmidt-Clermont, 2000), macroeconomics focuses on the economy as a whole, on the aggregated picture of a particular field of research (Froyen, 2012).
Linking both theories, a practice not unusual to official statistics, is required for this research. In general, NSOs collect their data through surveys from individuals, households and firms (microeconomic), while the national accounts focus on the economy as a whole, consisting of different, specific sectors (macroeconomic) (Coli & Tartamella, 2015). These linkages cause problems that researchers need to be aware of.
The concepts of a TUS further rest on the theoretical foundation of Becker's theory of the allocation of time (Ironmonger, 1995).

3.2.4.2 Theory of the Allocation of Time

The theory of the allocation of time is based on work from Becker (1965), who introduced a completely new perspective on how time allocation should be looked at. The traditional view of economists on time allocation was based on the simple allocation of the available 24 hours each day between work and leisure (Harvey, 1996). In his work, Becker refused to only distinguish between work and leisure time, and also rejected the view that the entire time not used for work is automatically treated as leisure (Peters, 2016). Becker believed that individuals use both their own time and market goods as inputs into their production of an abstract product, a commodity (Becker, 1965; Peters, 2016). This terminology is explained by Pollak and Wachter (1975), who stated, "if a household activity is a production process, we call the outputs commodities" (p. 272). The production of those commodities is based on the household's production function (Zaiceva & Zimmermann, 2011), and the commodities will then be entered into the individual's utility function (Becker, 1965; Peters, 2016). This way, utility is generated not solely by the purchased goods or the time, but also by the commodities themselves (Pollak & Wachter, 1975). To allow for this, Becker's central assumption was to extend the classical view of seeing companies as producers and households solely as consumers. He believed that households and their individuals do also act as producers, the producers of commodities (Becker, 1965). This can be seen as the starting point of the household production theory.

Becker's theory of the allocation of time is based on maximising a utility function subject to two constraints; a monetary budget constraint and a time budget constraint of 24 hours per day (Philp & Wheatley, 2011). According to Heckman (2015), the work of Becker laid the foundation for in-depth research on household production, unpaid work and the collection of necessary data within those areas.

Almost at the same time as Becker, Lancaster (1966) came up with a similar approach but within the following decades Becker's theory of the allocation of time became more famous. Although seen as a milestone, Becker's theory was not protected from further criticism.
Following Mincer (1962), Gronau (1977) criticised Becker's model because it did not differentiate between leisure time and unpaid work time. Gronau (1977) therefore claimed that Becker's theory in its original form is not suitable for any time use data or unpaid work analysis, and extended his theory by adding household production to the household utility function (Gørtz, 2006; Gronau, 1977, 1980; Zaiceva & Zimmermann, 2011). Gronau's model was later called the "classical household production model" and it is seen as a milestone for the valuation of unpaid work at home (Gørtz, 2006, p. 115).
More than a decade later, Goldschmidt-Clermont (1993) highlighted that the aforementioned "models were then extrapolated to the macroeconomic level and gave rise to a number of valuations of households' unpaid labour time based on average wages" (p. 421). Williams and Donath (1994) allowed for the inclusion of simultaneous use of time and included this into a Cobb-Douglas production function (Williams & Donath, 1994; Zaiceva & Zimmermann, 2011).
Ten years later, Ruuskanen (2004) upgraded the two-person household model of Solberg and Wong (1992), which rests on prior work from Graham and Green (1984) and Gronau (1977), by adding productivity parameters for men and women to account for different levels in productivity.
Kalenkoski and Foster (2010) added multitasking in childcare to the household pro-

duction model and Sanchis (2016) extended Becker's theory of the allocation of time by accounting for multitasking with Becker's original model being a special case of the improved theory (Sanchis, 2013, 2016).
In one of the recent works, Diewert et al. (2018) generalised Becker's theory by allowing utility functions for leisure time, household work time and household labour supply. This generalisation contains Becker's original theory as a special case.

Next, the factors that can influence the allocation of time are examined.

3.2.5 Factors Impacting on the Allocation of Time

In this section the key factors that directly impact on the allocation of time with the main focus on unpaid household work are presented, while factors influencing paid work or leisure activities are disregarded. The seven key factors identified are gender, age, children living in own household, level of employment, marital status, level of education and health, which are explained in more detail.

Gender as a factor influences the allocation of time. Ruuskanen (2004) claimed that men perform fewer activities within 24 hours than women. While Roncolato and Radchenko (2016) stated that empirical literature identified gender as a major determinant for unpaid work, Hunady et al. (2014) found in their research that gender was identified as a key factor for all unpaid work activities. Their findings confirmed the existing gender gap in time allocation mentioned earlier. Similar findings that gender seems to have the largest impact on the allocation of time compared to other demographics were presented by Gimenez-Nadal and Molina (2020) and Shelton (2006). However, Shelton (2006) claimed that apart from demographics many other, non-demographic factors influence the allocation of time. The importance of gender as a factor is also justified by the fact that the following demographics – apart from age – clearly differentiate between men and women.

De Vaus et al. (2003) claim that the age of an individual, in particular if looking at people aged 65 years and older, may influence the duration of certain activities and may extend the time that is required to complete them, mainly due to a change in circumstances of their life; for example, retired people may do activities differently from the working age population. They may see activities with a different eye;

more relaxing, more leisure and less as a duty. This was confirmed by Gørtz (2006), who stated that retired people allocate the spare time from market work to all types of activities, including leisure, unpaid household work and personal care.

Bloemen and Stancanelli (2014), Destatis (2015), and Hunady et al. (2014) showed that the number of children living in a household also impacts on the time spent on household work. This is in line with the Australian study by Craig and Bittmann (2005), who concluded that younger children have a higher impact than older children, but they claimed that additional children will not add the same amount of time as the first child because of high economies of scale associated with additional children (Craig & Bittmann, 2005). Blekesaune (2005) mentioned that, even if caring activities are not taken into account, children are responsible for an increase in unpaid household activities, but the amount differs for mothers and fathers depending on the age of the children.

Shelton and John (1996) summarised earlier studies that investigated the impact of the employment level of men and women on household unpaid work activities. However, they found no consistent result in their study because the employment level may have a negative, a positive or no impact on unpaid household activities (Shelton & John, 1996).

Bloemen and Stancanelli (2014) reported that the marital status affects time spent on typical household activities. From the point of marriage, women increase their time spent on those activities (Bloemen & Stancanelli, 2014).

Shelton and John (1996) compared several studies on the impact of the education level on housework. Their comparison revealed that the majority of studies see higher education levels of women as being negatively – and higher education levels of men positively – related to unpaid household work (Shelton & John, 1996). Higher education of an individual leads to more activities being done throughout the day and also allows for more variety and less routine (Ruuskanen, 2004). Higher education further positively impacts on time spent on childcare activities (Bloemen & Stancanelli, 2014). Guryan et al. (2008) also identified that the level of education impacts on the time allocation, in particular on childcare.

Gimenez-Nadal and Molina (2015) did a cross-country study about health status and allocation of time, which also included the UK. They found that for men and women, good health leads to a decrease of time spent on unpaid work. This association was strong in the UK for men but not for women (Gimenez-Nadal & Molina, 2015). An opposing result was presented by Podor and Halliday (2012), who reported that a better health level leads to an increase of time spent on unpaid work.

3.3 Simultaneous Activities and Multitasking

As mentioned in the previous section on the TUSs, the diary is one of the most useful methods to collect information on more than one activity. This section introduces the meaning of simultaneous activities and explains why in this thesis the terminologies multitasking and simultaneous activities are used interchangeably. Furthermore, problems of recording simultaneous activities in TUS diaries are outlined, a short neuroscience detour provides an in-depth understanding of multitasking and, back to economics, it is shown how multitasking is treated when valuing unpaid work.

3.3.1 Definition of Simultaneous Activities and Multitasking

Kenyon (2010) stated that multitasking is important in time use research and that its correct consideration leads to a more accurate view of how people spend their time. Hence, the United Nations (2013) recommended recording at least one simultaneous activity in addition to primary activities in a TUS. If those activities are not collected despite being productive, they then cannot be valued and would lead to an underestimation of household unpaid work activities (Kenyon, 2010; Lowen & Sicilian, 2015). Although this problem has been known for many decades, in-depth analysis of multitasking within this area only started within the past 20 years. While being important, some TUSs nevertheless do not collect data on simultaneous activities (Lowen & Sicilian, 2015). One prominent example is the American Time Use Survey (ATUS) which, apart from some childcare activities, completely disregards simultaneous activities in its published data (U.S. Bureau of Labor Statistics, 2021).

One central problem is that the literature does not offer an agreed definition on the terminology of simultaneous activities, neither within the same research field

in the social sciences nor in the time use research area (Kenyon, 2010; Ruuskanen, 2004). Ruuskanen (2004) pointed out that the definition is often dependent on the aim of the research. He claimed that a commonly used definition is “doing many distinct activities in the same time period” (Ruuskanen, 2004, p. 191).
However, in the paid work environment multitasking is defined differently to the terminology used in TUS research and unpaid work. In paid work, multitasking rather means “the performance of a job by multiple people simultaneously” or “a worker performing several tasks in order to provide one specific service” (Kalenkoski & Foster, 2015, p. 1848). Moreover, in their research on multitasking in paid work, Buser and Peter (2012) defined multitasking as “switching back and forth between two ongoing tasks”, while switching is defined as “redirecting attention from one task to another” (pp. 642, 644). Those tasks can either be connected or completely different. However, Buser and Peter also outlined that, depending on the field of research, there are other definitions available such as “the performance of multiple tasks at one time” (Buser & Peter, 2012, p. 644). The last definition is in line with the above suggestion used by Ruuskanen (2004).

Kenyon (2010) stressed that the lack of consensus on the definition also makes it difficult to compare research results that include multitasking activities, even if they stem from the same field or research. The absence of a clear-cut definition complicates the creation of a uniform understanding of the terminology among TUS users and also its participants. Different interpretations by participants may bias responses and, therefore, Kenyon (2010) questioned the reliability of studies lacking clear definitions. It further reduces the chances of a study's replicability (Kenyon, 2010). For example, she analysed a British internet survey about multitasking, done in 2006 with 1000 participants and identified many different types of multitasking, which were clustered into six groups: consecutive multitasking, simultaneous multitasking, active multitasking, passive multitasking, on-call multitasking and absent multitasking (Kenyon, 2010). The exact meanings of them will not be further discussed in detail, but this variety of responses confirms the existing problems of lacking one unified definition of multitasking.

Therefore, Roncolato and Radchenko (2016) and Suh and Folbre (2016) also supported the view that each research paper about multitasking should be treated with care in terms of the applied definitions and provided two further examples.

Firstly, Suh and Folbre (2016) used the term “joint production” as a synonym for simultaneous activities and multitasking (p. 672). They applied a meaning to this terminology which differs from most other economic literature. Typically, *joint production* means the combination of home production time and leisure (Graham & Green, 1984; Gronau, 1980; Sanchis, 2016).
Secondly, Roncolato and Radchenko (2016) used the word *simultaneous* differently from most other studies by expanding the definition in a way that also includes activities performed sequentially – in their case, one paid work and one unpaid work activity – that are consecutively done, immediately one after the other, and vice versa.

In addition to the problem of having no agreement on one definition, in social sciences there are many different terminologies used for simultaneous activities, which most of the time – but not necessarily all of the time – do have the same meaning. According to Ironmonger (2003) and Ruuskanen (2004), those other terms used are ‘multitasking’, ‘overlapping activities’, ‘concurrent activities’, ‘parallel activities’, and ‘primary and secondary activities’ in case there are only two, and ‘polychronic time use’ for more than two activities. According to Ruuskanen (2004) the term polychronic is not found as often as the others in literature. Researchers who used the term polychronic time were, for example, Kaufman et al. (1991).

In line with the guidelines of Eurostat (2019) and United Nations (2013, 2017), this research thesis applies the terminology *simultaneous activities* to those activities that are done simultaneously and thus includes all activities that are recorded in addition to another activity, and the term *multitasking* as the verb of performing these simultaneous activities. Both terms, *simultaneous activities* and *multitasking*, are used interchangeably. Whenever one performs more than one activity simultaneously, that person is multitasking. Multitasking also covers individuals performing secondary, tertiary and quaternary activities. This choice for a definition is in line with the above introduced general definition of “doing many distinct activities in the same time period”, as outlined by Ruuskanen (2004, p. 191).

3.3.2 The Importance of Multitasking and Simultaneous Activities

A review of time use literature shows that the first TUSs only collected information on one activity, the primary activity. According to Ironmonger (2003), the awareness that ignoring additional multitasking activities will bias the results of an analysis started to increase in the 1970s. With a growing awareness, more researchers started to support the view of collecting simultaneous activities and recommended including them in the valuation of unpaid work to enhance the estimates and increase their accuracy (Floro & Miles, 2003; Ruuskanen, 2004).

The collection of information on those activities is usually done by a time use diary, as illustrated in Figure 3.1 in the previous section; for example, by using the question "What else were you doing?", as suggested by the United Nations (2013, p. 62). It is important to note that the United Nations (2013) recommended letting the respondent, rather than TUS interviewers, coders or a rule book, decide what activity should be considered the primary activity and what activities are the simultaneous activities. Nevertheless, TUS interviewers may assist with this decision when collecting the diary and talking it through to ensure that the diary is complete (United Nations, 2013).
Kenyon (2010) identified, in her comparison paper of almost 200 TUS methodology papers, that the instruction given to respondents, either via supplementary TUS information or by the interviewers, will affect their response behaviour.

Most TUS diaries provide respondents with guidelines and examples on how to fill in the diary. Research by Kitterød (2001) revealed that the opportunity for respondents to write down more than one activity in a TUS diary affects the behaviour of respondents on how they capture those activities. There is a tendency that the order of primary and secondary activities provided in TUS examples may be adopted by respondents, although the correct order would be different (Chenu & Lesnard, 2006). This view was supported by Drago and Stewart (2010), who argued that respondents may classify a primary activity as a secondary activity, although it is their primary activity. An example, based on work from Drago (2011), may clarify this. During a time slot of 15 minutes, a household member spends 6 minutes on one task, then does another task for 2 minutes, before switching back to the first one for the remaining 7 minutes. This person may report 15 minutes of task one as the primary and the other task as the secondary activity, providing a wrong picture of the real situation.

Kenyon (2010) also found that there is a variety of ways in which the collection of simultaneous activities is done. While a significant amount of the investigated TUSs allow respondents to write down the main and a secondary activity for each time slot, only a small proportion of TUSs allow the recording of more than two activities in a diary (Drago, 2011). In their sociological study, Gershuny and Sullivan (1998) used time use data from the 1987 British Social Change and Economic Life Survey, which allowed the recording of up to four simultaneous activities for each of the 15 minute time slots in their time use diary. Furthermore, the UKTUS 2014/15 collected up to four simultaneous activities (CTUR, 2016; Morris et al., 2016; Sullivan & Gershuny, 2021).
However, Kitterød (2001) and the United Nations (2013) highlighted that although some TUSs collect more than two simultaneous activities, so far, not a lot of attention has been given to those additional activities in research analysis.

The above-mentioned growing awareness of the importance of recording multitasking activities also resulted in a need to investigate the treatment of simultaneous activities in TUSs and its impact on the valuation of unpaid household work. In her thesis, Hunter (2010) pointed to the problem, which was originally highlighted by Budlender (2007), that the inclusion of simultaneous activities is important to ensure an accurate measure of unpaid work activities. They stated that the approaches in place are not sufficient for that and further research is required.

Ruuskanen (2004) criticised the scarce amount of literature on multitasking in time use studies. A current search on literature by the researcher showed that this situation has not significantly improved since 2004 and in-depth literature in that TUS field of research is still sparse. Most studies on multitasking in unpaid work focus on caring activities but disregard other household unpaid work activities.
An extension of the search area for literature by the researcher to include paid work in addition to unpaid work significantly increased the number of studies on multitasking but, depending on the field of research, was still limited. A similar result of the limited literature was also reported by Buser and Peter (2012), Kalenkoski

and Foster (2015), and Kirchberg et al. (2015). While in paid work "the fields of labour economics and industrial organization" provide a richer source of literature, it is very limited in specific areas; for example, "measure multitasking productivity in an experimental setting" (Kalenkoski & Foster, 2015, pp. 1848–1849).
By a further extension of the search area for literature, the researcher identified a large amount of literature on multitasking; for example, in areas of neuroscience and psychology. This is in line with Offer and Schneider (2011) and Spink et al. (2008), who stated that the main research on multitasking is not done in economics and time use research but in neuroscience and psychology.

3.3.3 Understanding Simultaneity and Multitasking

The research on simultaneous activities and multitasking covers wide fields of research. Therefore, in this section some interdisciplinary views should help to get a better understanding of multitasking. This interdisciplinary investigation is also a result of the scarcity of literature in the fields of time use or social studies on multitasking and is seen as an essential part for an in-depth understanding and the further treatment of multitasking in the valuation of unpaid household work.

3.3.3.1 Multitasking - An Interdisciplinary Investigation

The research fields of neuroscience and psychology try to evaluate the necessary brain functions and intellectual skills needed to allow multitasking (Offer & Schneider, 2011). Multitasking is seen as a complex cognitive procedure that requires many different steps involving various mental activities (Monsell & Driver, 2000). Burgess et al. (2008) stated that multitasking is essential for daily performance because without multitasking, "one would have to always finish one task (e.g. cooking the vegetables for a meal) before starting another (e.g. cooking other parts of the main meal)", which would not be very efficient (p. 243). However, Spink et al. (2008) saw multitasking "as a behavior that decreases efficiency and wastes time" (p. 105).

Research in neuroscience by Rogers and Monsell (1995) and Rubinstein et al. (2001) has confirmed that multitasking is not as efficient as most people think because people constantly need to switch between two activities which costs time, and those costs increase the more complex the activities are. Nevertheless, Lee and Taatgen (2002) stated that multitasking is like a skill that can be learned and improved, and Ruderman et al. (2002) found in their research that acquired multitasking skills at home can even be applied to paid market activities and can improve job performance.

Furthermore, research in neuroscience, which also investigated the cognitive ability of individuals, concluded that a human brain can only process a very limited number of tasks simultaneously (Pashler, 1994). Another neuroscience study by Dux et al. (2006) proved, using brain scanners, that the brain restricts task processing to only two simultaneous tasks.

Results of a study by Buser and Peter (2012) suggest that multitasking negatively impacts on performance compared to doing tasks sequentially. Due to the fact that their research was based on paid work and only covered cognitive but no physical tasks, results cannot be applied to unpaid work activities (Buser & Peter, 2012). However, Kalenkoski and Foster (2015) pointed out that it is almost always better to do multitasking than to spend half of the time on one activity and the other half on the second activity.

Rieger (2012) summarised that, according to dual task studies, the level of concentration is dependent on the complexity of the task. Brain performance experiments have shown that subjects doing two tasks may be able to achieve performance levels of more than 100 percent (Rieger, 2012). He stated that combined performance levels of 134% (90% for task A and 44% for task B) are possible. The downside of this higher performance is that it comes with a higher duration time to complete both tasks (Rieger, 2012). The main reason for this is that the individual is constantly changing between the two tasks, and this does cost time (Manhart, 2004; Rieger, 2012).
Furthermore, Rieger (2012) outlined that this is different when it comes to automatically performed tasks or routines. He named household chores as one of them. Those tasks need less cognitive controlling, less planning and lower attention and therefore can be more efficiently done with another activity than more complex tasks (Manhart, 2004; Offer & Schneider, 2011; Rieger, 2012).

Similar to Rieger (2012), Kalenkoski and Foster (2015) suggested that multitasking on household activities, depending on the attention that is required to perform them, may lead to a higher productivity compared to performing single tasks (Kalenkoski & Foster, 2015). Spink et al. (2008) distinguished between activities that require "active or passive attention" (p. 108). For example, active attention involves looking at street signs or the speedometer while driving a car, while passive attention is considered "listening to music while doing housework" (Spink et al., 2008, p. 108).

Not only does task switching cost time, but it also increases the risk of errors when compared to two activities done sequentially (Delbridge, 2000; Laxmisan et al., 2007; Monsell, 2003; Spink et al., 2008). According to Spink et al. (2008), the time of task switching consists of three steps: the "desire to task switch, task switch, and switching back to a previous task" (p. 95).

However, a distinction can be made between the ways in which simultaneous activities are performed. They can either be done one after the other, in a sequential order, also called *monochronic*, or parallel which is also referred to as *polychronic* (Floro & Miles, 2003; Zaiceva & Zimmermann, 2011).
Studies showed that men have a tendency to do activities monochronically (Floro & Miles, 2003; Lui et al., 2021), while women prefer polychronicity (Floro & Miles, 2003). A study by Kirchberg et al. (2015) on the paid work environment, which, unfortunately, does not provide gender-specific results, found that *monochronic* workers are more affected by multitasking than workers who prefer to work polychronically. Whether or not this statement also holds for unpaid work activities was not investigated by Kirchberg et al. (2015). Buser and Peter (2012) stated that further research in that area would be necessary.

3.3.3.2 Myth of Women being Better than Men at Multitasking

A general assumption in many societies is that women compared to men are better at multitasking. However, Buser and Peter (2012), Hirnstein et al. (2019), and Stoet et al. (2013) claimed that this general impression has not been scientifically proven. Depending on the focus of the investigation, existing studies contained mixed results on the multitasking abilities of men and women, ranging from women being better than men (Stoet et al., 2013), over findings without significant differences between both genders (Buser & Peter, 2012; Hirnstein et al., 2019), to men being better than women (Lui et al., 2021). It is believed that due to the sparse research studies in that particular research field, a clear recommendation is not possible (Hirnstein et al., 2019; Stoet et al., 2013). However, this makes the investigation of gender and multitasking important for this study.

3.3.4 Factors Impacting on Multitasking

Similar to the previous investigation of what factors influence the allocation of time, the key factors that directly impact on multitasking, with the main focus on unpaid household work, are presented, while factors influencing paid work or leisure activities are disregarded.
Floro and Miles (2003) analysed influencing factors on multitasking for up to three simultaneous activities. Their results indicated that the determinants of simultaneous activities are widespread across social, demographic and economic factors (Floro & Miles, 2003) but it is uncertain whether it is also affected by personal or individual skills and intrinsic motivation (Kenyon, 2010).
The seven key factors identified, similar to the allocation of time factors, are gender, age, children living in own household, level of employment, marital status, level of education and health, which are explained in more detail.

Research by Floro and Miles (2003) revealed, that gender is a significant factor impacting on multitasking but it is uncertain to what extent. Their findings indicated that women spent 158 minutes per day on multitasking while men spent less than half of that (67 minutes) on multitasking (Floro & Miles, 2003). This difference requires researchers to investigate multitasking on a gender basis.

Zaiceva and Zimmermann (2011) showed that age is not a significant driver of multitasking but it is still positively correlated to simultaneous household activities. However, a different result comes from Drago (2011), who stated that age has an impact on how many simultaneous activities are reported. His findings need to be treated with care, though, because he used ATUS data, which only include voluntarily reported simultaneous activities and therefore provide an incomplete picture.

Craig (2007) and Floro and Miles (2003), both using Australian TUS data from different years, pointed out that the presence of children in households increases the amount of unpaid work for primary and secondary activities and thus increases multitasking. The younger the children, the larger that effect (Craig, 2007). The conclusion that people with children have a tendency to do more multitasking was later confirmed by Zaiceva and Zimmermann (2011).

Research by Floro and Miles (2003) and Zaiceva and Zimmermann (2011) demonstrated that the level of employment also has an impact on multitasking, but it is uncertain to what extent.

Based on Zaiceva and Zimmermann (2011), married individuals are involved in more multitasking than non-married people. However, Destatis (2015) confirmed that the marital status influences the amount of time spent on multitasking, while single parents do more multitasking activities than married couples with children.

In their Australian study, Floro and Miles (2003) revealed a significant relationship between the level of education and multitasking. Kalenkoski and Foster (2008) suggested that a higher level of education may result in an increased skill to multitask. In line with this, a tendency for more multitasking was found among individuals with a better education while men generally tend to do less multitasking than women, but the level of education was claimed to be positively correlated with multitasking (Zaiceva & Zimmermann, 2011).

Endrayana Dharmowijoyo et al. (2021) identified general physical health as another factor to have an impact on the ability to multitask for some unpaid work activities; in their case, grocery shopping. While physical health seemed to have a positive impact on multitasking, mental health led to the opposite result (Endrayana Dharmowijoyo et al., 2021).

3.3.5 Treatment of Multitasking in the Valuation of Unpaid Household Work

Hawrylyshyn (1976) pointed out that a particular focus on the treatment of simultaneous activities is important. Quah (1989) stated in his paper on a comparison of 20 studies on household production that a correct treatment of simultaneous activities is important for future work. 14 years later Floro and Miles (2003), pointed out that the various forms of overlapping activities need further investigation. More than a decade later, the United Nations (2017) and the United Nations (2020) still claim that further work is required because no proper solution has been found. A missing consensus on appropriate or improved valuation methods in general was also criticised by Błaszczak-Przybycińska and Marszałek (2019) and Varjonen et al. (2014). Based on research by Kenyon (2010), Nordhaus (2006), and United Nations (2017), the following five main ways in which simultaneous activities are generally treated, when TUS diary data is used for the VoL, were identified and are discussed in more detail below.

1. Ignore simultaneous activities and only value the primary activity
2. Prioritise activities either by significance, duration or by most attention
3. Combine simultaneous activities into one joint activity
4. Ignore the 24-hours per day constraint by either adding the time spent on simultaneous activities to the primary activity, or by separating primary activities from simultaneous and value them individually
5. Split the time of simultaneous activities to be in line with the 24-hour time constraint

Kenyon (2010) concluded that those different procedures on how to treat multitasking in TUSs will rather lead to a subjective measure than a pure objective measure, because results and data collection will mostly be dependent on the research aim, the view and the perception of the researcher who runs and coordinates the survey.

3.3.5.1 Ignore Simultaneous Activities and only Value Primary Activities

Chadeau (1992) claimed that the most simplistic approach is to only value the primary activity at full time and completely ignore simultaneous activities, which is justified by the restriction of the theory of the allocation of time that there are only 24 hours in a single day to spare. This method is often applied in research studies due to its simplicity (United Nations, 2017).

In his microeconomic study, Quah (1987), for example, avoided simultaneous activities and only valued the primary activity. However, Floro and Miles (2003)

highlighted that the exclusion of simultaneous activities leads to an underestimation of unpaid work activities and the economic contribution of households. In line with this statement are Craig and Bittmann (2005), who showed that omitting secondary activities from the VoL will massively underestimate the true value of unpaid household work. One of the main reasons for this statement is that childcare is often performed as secondary activities, and thus not counted.
Suh and Folbre (2016) and Waring (2010) described the problems of valuing time spent on multitasking childcare activities. They support the view that the exclusion of multitasking or secondary activities in regard to childcare will not properly record the total amount of time spent on childcare and being available for care, and will therefore lead to an undervaluation of it. Nonetheless, counting it may cause double counts and thus needs to be carefully considered (Waring, 2010).
Ignoring simultaneous activities and valuing just the primary is still found to be a common way nowadays that is sometimes supplemented by keeping primary and simultaneous activities separate (United Nations, 2017).

3.3.5.2 Priority Declaration of Activities

Another option is that the multiple activities can be prioritised to distinguish between the primary, secondary and possible further simultaneous activities. While the United Nations (2005) clearly offered that the priority decision could be done either by the respondent or the statistical officers, this procedure was massively criticised by Waring (2010). She clearly stated that the statistical officers should not act as 'interpreters' and should leave this decision up to the respondents as they are the only legitimate experts on this (Waring, 2010). Nevertheless, the newer version of the guidelines for harmonising TUSs still include both options but softened the wording from a previous 'should' to a 'may' (United Nations, 2005, 2013).
It needs to be noted that this priority declaration can only be applied if the TUS collects that information from respondents. According to Kenyon (2010), the priority can either be determined by declaring the most significant activity as the primary activity or the activity to which respondents gave the most attention. An example of a priority setting is found in the work by Nordhaus (2006), who ranked simultaneous activities depending on their usefulness or importance. The useful or important activity is then classified as the main primary activity (Nordhaus, 2006).

3.3.5.3 Simultaneous Activities as a New Combined Activity

Ironmonger (2003) proposed solving the problem of simultaneous activities by recording them as so-called *joint activities*, which are a combination of the recorded primary and secondary activities. For example, the two activities *ironing* and *listening to the radio* would form the joint activity *ironing and listening to the radio.* The benefit of this combination is claimed that it allows for a correct treatment of simultaneous activities (Ironmonger, 2003). However, Ironmonger does not discuss potential downsides such as the increasing number of different joint activities as a result of a large variety of activity combinations which might make coding and data analysis extremely difficult, or impede the finding of appropriate wage rates that could be applied to those joint activities.
Ironmonger (2003) further claimed that joint activities could be considered as a two-dimensional measure of time use. According to Ironmonger (2003), his method would also solve the problem of some respondents who may not be able to clearly decide what their primary and what their secondary activity truly is; for example, someone watches TV while waiting for the food to heat up, both could be classified as the primary or secondary activity.
An additional advantage mentioned by Ironmonger (2003) is that his two-dimensional matrix can be created for women and men separately as well as both genders combined to allow a gender based analysis. With the two-dimensional measure, Ironmonger ignored that TUS diaries may include three or more simultaneous activities, and that their consideration would further increase the complexity of his method from a two- to a three- or even higher dimensional measure. In the case of three or more reported activities this does not work anymore, unless a cube or something of higher order would be used.

3.3.5.4 Ignoring the Constraint of 24-hours per Day

Stinson (1999) identified the time restriction of 24 hours, based on Becker's theory of the allocation of time, as the main reason causing the problem of dealing with simultaneous activities.
Nevertheless, another option to deal with simultaneous activities is to soften up the time constraint of 24 hours a day and treat the time spent on simultaneous activities additively to primary activities, allowing for more than 24 hours a day (Budlender & Brathaug, 2010). Research by Zaiceva and Zimmermann (2011) on the year 2000

TUS in the UK indicated that due to multitasking, some respondents were able to squeeze almost four additional hours into one day, resulting in a total amount of almost 28 hours in case no weighing of simultaneous activities is done (Zaiceva & Zimmermann, 2011). This step would cause consistency issues because it is not in line with Becker's theory of the allocation of time and the 24-hour constraint for each day.

As a compromise between the rejection of simultaneous activities on the one hand and ignoring the 24-hour constraint on the other, simultaneous activities may be analysed separately, one analysis for primary and another one for secondary activities. This is a common way, for example, to investigate caring activities that are regularly reported as secondary activities because parents often are available for care without actually doing physical care, as shown by studies from Bianchi (2000) and Kalenkoski et al. (2007, 2009).

3.3.5.5 Applying Splits for Time Spent on Simultaneous Activities

The time duration of a TUS diary time slot with multiple recorded activities may be split across those activities. While Ironmonger (2003) stated that using splits is not a proper solution to the problems of how to treat simultaneous activities in the valuation of unpaid work, a number of researchers – for example, Budlender and Brathaug (2010), De Vaus et al. (2003), Drago (2011), Holloway et al. (2002), Robinson (1969), Stinson (1999), Williams and Donath (1994), and Zaiceva and Zimmermann (2011) – are in favour of splitting the time duration on simultaneous activities.

However, a major problem is that there is no general agreement on appropriate splits. One solution pointed out by Stinson (1999) could be that TUS respondents are asked to assign weights to simultaneous activities for each timeslot, but this idea was not implemented by Stinson because it would significantly increase respondent burden.

Other research studies provided suggestions of what those splits might look like, but apparently many splits were either arbitrarily chosen or their calculation was not clearly specified in the publications. For example, De Vaus et al. (2003) included simultaneous activities but did not explain in their research paper how this was done.

A common method used by researchers is the application of an equal split of 50% of the time duration for the primary activity and 50% of the time duration for the secondary activity (Drago, 2011; Holloway et al., 2002; Robinson, 1969; Zaiceva & Zimmermann, 2011). This means that 30 minutes of two simultaneous activities A and B were coded to 15 min of primary activity A and 15 min of secondary activity B (Robinson, 1969). Unfortunately, Robinson did not provide a specific explanation of why this equal split assumption was made, leading to the assumption that the equal split may have been arbitrarily chosen.

In their work on valuing unpaid work in South Africa, Budlender and Brathaug (2010) included primary, secondary and even tertiary activities in their estimate. They applied an equal split of 50/50 for two activities and assigned one-third of the time duration to each of the three activities (Budlender & Brathaug, 2010). Again, a scientific justification for this choice was not found. Different from the above studies, Apps and Rees (2009) used a split of 60% of the time for the primary and 40% of the time for the secondary activity, without explaining how they made that choice.

In addition to the above-mentioned research studies that often applied arbitrary splits, some researchers investigated different methods to estimate splits for simultaneous activities. Stinson (1999), for example, suggested gaining the splits through the application of complex utility functions but, unfortunately, did not publish any splits in her paper.

A further method to calculate splits was used by Williams and Donath (1994), who estimated the parameters of a Cobb-Douglas production function for household production using data from the 1987 Australian TUS and allowed weighting time inputs from primary and secondary activities in their production function. Their results showed a split of 55% for the primary and 45% for the secondary activity, but they suggested that their result is within the confidence interval and hence believed an equal split of 50% for the primary and 50% for the secondary activity would also be justifiable (Williams & Donath, 1994). They further concluded that, in the case of more than two activities recorded in the TUS diary, those activities should be given a split of $1/n$ with n being the number of simultaneous activities, but did not supplement their statement with data (Williams & Donath, 1994). They acknowledged that their results should be treated with care due to the limitations of the research study and therefore they may not be valid for large samples and should not be used in a complete TUS.

Also, a production function was used by Cardia and Gomme (2018) to estimate childcare based on ATUS data for primary and secondary childcare. Their estimates revealed a similar result to that of Williams and Donath (1994), with a split of 54.92% for the primary and 45.08% for the secondary childcare time (Cardia & Gomme, 2018). Nevertheless, the results of their study should be treated carefully because of the long list of limitations. Those are, for example, that one-third of secondary childcare activities were not included and that they only focussed on children until they reached an age of 12 years and women.

3.3.6 Interim Conclusion on Multitasking

Based on the current state of literature and despite the problem regarding the treatment of simultaneous activities being known for decades, there is no satisfying approach available on how to best include simultaneous activities into the VoL Equation 2.1 to ensure proper estimates (Błaszczak-Przybycińska & Marszałek, 2019; Kenyon, 2010; United Nations, 2017). It is therefore recommended to investigate this further and find appropriate improvements (United Nations, 2017).
The literature suggests that using splits for simultaneous activities is one option that can solve the problem, but there is no agreement on the magnitude of those splits.
Most researchers tend to use equal or arbitrarily chosen splits for the VoL. Some researchers tried to estimate splits by using a production function approach, which is different to the VoL approach, but their results were of limited use due to numerous limitations around the production function, the data and the models they applied.
Literature confirms that new ways should be investigated to enhance the existing valuation procedures. Current knowledge on this issue was identified as being insufficient for the formulation of clear-cut recommendations and further work is required (United Nations, 2017, 2020).
To the knowledge of the author, no research study has looked at the magnitudes of splits for up to four simultaneous activities from the TUS and VoL side, and therefore this research thesis aims to add further knowledge to that field of research. The review of the literature also revealed that asking respondents on reporting splits has,

although suggested by Stinson (1999), not been investigated. Furthermore, gender differences on splits of multitasking and neuroscience information for the judgement of what individuals are capable of, regarding multitasking, have not been taken into account in previous studies on multitasking regarding the VoL.
While the previous part of this chapter focused on time use and multitasking, the next part focuses on the VoL approaches and their wage rates.

3.4 Value of Labour Approaches and their Wage Rates

The commonly used approaches for the valuation of unpaid household work consist of two steps. The first step is to identify the amount of time spent on unpaid work activities, while the second step applies a wage rate to the duration of those activities (Lowen & Sicilian, 2015). While the previous sections focused on the variable time, this section focuses on the wage variable w of the VoL Equation 2.1 (VoL $= t * w$) introduced in Chapter 2.

Ferrán (2010) highlighted that the value of unpaid household work can either be estimated on the micro- (household) or the macro-level (economy) and that the literature offers suitable approaches for both the micro- and macro-levels. In line with this, the two central approaches – the opportunity cost approach and the replacement cost approach – are introduced. It needs to be noted that a researcher's decision for one of those approaches always goes in line with correspondingly different results of the valuation (van de Ven & Zwijnenburg, 2016). Therefore, the choice of the approach needs to be carefully considered. First, the concept of the opportunity costs is introduced.

3.4.1 Opportunity Cost Approach

The opportunity cost approach assigns the hourly wage rate that an individual could have earned during his/her paid market work to the unpaid household work activities (Goodwin et al., 2008; United Nations, 2017). This means, if a paid market professional earns £30 per hour, all unpaid work activities would be valued at £30, while for a second paid market professional who only earns £10 per hour, that second person's unpaid work activities would only be valued at £10. If those two different people cook a dinner that takes them exactly one hour to prepare, and under the assumption that their produced meal is equivalent in quality, ingredients, amount, size, etc. the first person's dinner would be assigned a value of £30, while the second person's would only be worth £10, one-third of the other value. Equation 3.1 presents the opportunity cost approach based on Hawrylyshyn (1976).

$$\mathrm{VoL}^{\mathrm{OC}} = \sum_{i \in N} t_i \; w_i^{\mathrm{OC}} \tag{3.1}$$

where:

OC = indicates this is the VoL using the opportunity cost approach

t_i = time spent on unpaid work activities for each individual i

w_i^{OC} = opportunity cost wage for each individual i

i = individual of the population or sample N

N = set of all individuals in the population or sample

The opportunity cost approach arose from the marginal thinking of the microeconomic theory and can be linked to Becker's theory of the allocation of time (Becker, 1965; Goodwin et al., 2008). It is based on the assumption that an individual could potentially earn money in a paid market job but decides to spend some of that market time in unpaid work activities which leads to a forgone income (Goodwin et al., 2008).

The main advantage of the opportunity cost approach is that it is consistent with microeconomic theory and its concepts (Chadeau, 1985; Goldschmidt-Clermont, 2000). However, this advantage causes serious problems in case the opportunity cost approach is used within a macroeconomic environment (Chadeau, 1985). A review of the literature identified the following four central disadvantages.

Firstly, being a microeconomic approach, the opportunity cost approach is based on econometric models that focus on the household level and investigate individual household members' allocation of time and consumer behaviour (Goldschmidt-Clermont, 1993; Goldschmidt-Clermont, 2000). Decisions are based on utility with the aim to maximise that utility (Goldschmidt-Clermont, 1993). Those assumptions are connected to the microeconomic theory and therefore the opportunity cost approach works best in the microeconomics environment at the household level. Applying this approach to macroeconomics causes some serious, conceptual problems because individual household level decisions cannot straightforwardly – if at all – be applied to a country's population.

Secondly, the opportunity cost approach further conflicts with the SNA (Goldschmidt-Clermont, 1993). Landefeld and McCulla (2000) claimed that the opportunity cost approach "may lead to a serious inconsistency in the national accounts, as the value of a given activity would depend more on the earnings potential of the individual in the market than it would on the activity itself" (Landefeld & McCulla, 2000, pp. 295–296). This is also the view of Goldschmidt-Clermont (2000), and is later supported by Schreyer and Diewert (2014), who stated that one of the main problems of the opportunity cost approach is that the value of an activity is dependent on the individual and his/her wage rate and not on the task itself. As shown in the example above, all activities would be valued with the same wage rate, no matter if it is cooking, cleaning, painting or repair work (Schreyer & Diewert, 2014). But, on the other hand, this also means that the same lunch would be valued at a significantly higher price in case one individual earns the salary of a pilot and the other the salary of a hairdresser (Dong & An, 2015). Chadeau (1985) also mentioned that due to the differences in wage rates for men and women (the so-called gender wage gap), women may be disadvantaged by using the opportunity cost approach as they often are paid less per hour than men.
In case the opportunity cost approach would be used for the valuation of unpaid work, those conceptual problems need to be kept in mind and, according to Salamon et al. (2011), those conceptual issues were the main reason why most valuation of unpaid work is done by another concept, the replacement cost approach, which is introduced in the next section.

Thirdly, it is uncertain what wage rate should be applied to a person who is not working in a paid market job, either voluntarily or due to other circumstances, as those people do not have a market wage rate that can be applied (Bivens & Volker, 1986; Chadeau, 1985; Landefeld & McCulla, 2000; Sharpe & Abdel-Ghany, 1997). In those cases, wage rates would need to be estimated (Chari et al., 2015; Ferber & Birnbaum, 1980; Sousa-Poza et al., 2001) or, as proposed by Blades (2000), a country's average wage rate may be used as a suitable alternative.

Lastly, Graham and Green (1984) and Landefeld and McCulla (2000) claimed that using the opportunity cost approach may overestimate the value of unpaid household work and they brought up two reasons for this. The first one is that individuals tend to be more productive in paid work compared to unpaid work and thus using their individual wage rate would lead to an overvaluation of unpaid work (Graham & Green, 1984). The second reason is that some time for unpaid work is also connected with leisure time, and in case the full amount of time would be valued as working time, that would also lead to an overestimation of unpaid work (Landefeld & McCulla, 2000). For example, some people may classify activities like gardening, childcare or even maintenance work as a hobby or as activities they enjoy doing, and hence do not mind spending more time on them.

Despite the long list of problems, the opportunity cost approach was and is still applied in some macroeconomic valuations of unpaid household work. For example, Sharpe and Abdel-Ghany (1997) used it for their Canadian study, and Soupourmas and Ironmonger (2002) used it for their valuation of Australia's household economy from 1970 to 2000. But due to its conceptual issues, the opportunity cost approach is not widely accepted for the valuation of unpaid household work. Goldschmidt-Clermont (2000) disregarded the opportunity cost approach for the reason that it is a microeconomic approach underlying microeconomic theory assumptions, and she stated that applying this concept to a macroeconomic environment causes problems because those microeconomic assumptions may not be necessarily met within the macroeconomic framework. As a microeconomic concept, the opportunity cost approach should be used for research on the individual utility of household members (Varjonen et al., 2014), but the opportunity cost approach is, of all the options available in this field of research, claimed to be the least suitable approach for the valuation of unpaid work (Sharpe & Abdel-Ghany, 1997; Varjonen et al., 2014). Poissonnier and Roy (2017) disregarded the opportunity cost approach and claimed that disregarding it should be the standard procedure with this approach for the valuation of unpaid household work.

3.4.2 Replacement Cost Approach

The second approach for the VoL recommended by literature is the replacement cost approach, which sometimes is also called the market cost approach (Landefeld & McCulla, 2000). The replacement cost approach is defined as "valuing hours at the amount it would be necessary to pay someone to do the work" (Goodwin et al., 2008, p. 19). This means that the time spent on unpaid household work activities is valued at the wage rate at which a third person could be paid to do that activity. The underlying assumption of the replacement cost concept is that household members decide to do certain activities by themselves rather than buying them on the market, mainly to save household money (Statistics New Zealand, 2001).
Contrarily to the opportunity cost approach that uses one wage rate per individual, the replacement cost approach works with different wage rates that can be assigned to different activities.
Landefeld and McCulla (2000) highlighted that the most commonly used wage rates for the replacement cost approach are the housekeeper wage rate and specialist wage rates. Below, those two types of wage rates and associated problems are evaluated.

3.4.2.1 Replacement Cost Approach using the Housekeeper Wage Rate

It is assumed that a household hypothetically can hire a housekeeper from the market to do all unpaid work activities, and the average wage rate that would need to be paid to that housekeeper in the market is used to value all unpaid work activities done within the household (Chadeau, 1992; Dong & An, 2015; Hawrylyshyn, 1976). This method is also referred to as the global substitute or the generalist method (Chadeau, 1992; Dong & An, 2015). Equation 3.2 presents the VoL using the replacement cost approach and applying the housekeeper wage rate based on the work from Chadeau (1992), Hawrylyshyn (1976), and Quah (1989).

$$\mathrm{VoL}^{\mathrm{HK}} = \sum_{i \in N} \mathrm{t}_i \, \mathrm{w}^{\mathrm{H}} \tag{3.2}$$

where:

HK = indicates this is the VoL using the traditional approach and the housekeeper wage

t_i = time spent on unpaid work activities for each individual i

w^H = housekeeper wage

i = individual of the population or sample N

N = set of all individuals in the population or sample

A major advantage of the housekeeper wage is its simplicity (Eurostat, 2003; Varjonen & Niemi, 2000). Therefore, many countries used this approach in their valuations, which makes comparisons across countries a lot easier. For example, studies from Bridgman et al. (2012), Colman (1998), Landefeld and McCulla (2000), Uriel et al. (2005), Varjonen and Aalto (2006), and Varjonen et al. (2014) applied the housekeeper wage rate in their work.

In addition, Eurostat (2003), Goldschmidt-Clermont (1993), and Goldschmidt-Clermont (2000) highlighted that the housekeeper wage is the most suitable wage rate for the VoL because the working conditions of a housekeeper employed in the market and the productivity level of those workers are claimed to be very close to the ones in household work. This is in line with Varjonen and Niemi (2000), who indicated that the housekeeper wage rate best reflects the circumstances at home regarding the appliances used and the activities performed, including multitasking activities, and therefore, let assume an overall similar productivity level between housekeepers in the market and individuals performing the same tasks at home.
Furthermore, the level of skills required to perform those housekeeper tasks usually tends to be quite low, which is reflected in the housekeeper wage rate that is often lower than most other market wage rates (Chadeau, 1992). Therefore, researchers who are looking to apply a more conservative wage may want to use the housekeeper wage, because it might act as a lower boundary for the VoL (Bridgman et al., 2012; Chadeau, 1992; Landefeld & McCulla, 2000).

A more distinct view is shared by Bridgman et al. (2012), Dong and An (2015), and Landefeld and McCulla (2000), who argued that the VoL may be underestimated if a housekeeper wage rate is applied, because the wage rate applied is too low to reflect the appropriate VoL. However, a different view is presented by Varjonen and Niemi (2000), who claimed that the estimated VoL could either be too high or too low if the housekeeper wage rate is applied, but the correct VoL would

remain uncertain.
More general is the view of Lowen and Sicilian (2015), who stated that valuing all activities with the housekeeper wage rate "would result in poor estimates in most cases" (Lowen & Sicilian, 2015, p. 9). The reason for this is the application of a single wage for all activities, disregarding the skills required for each task (Carrasco & Serrano, 2011; Poissonnier & Roy, 2017). Therefore, Chadeau (1992) and Varjonen and Niemi (2000) assumed that certain activities – for example, repair work, planning and administrative household tasks, or health and education-related activities – require a different set of skills than a housekeeper, and thus may be done differently in various households (Chadeau, 1992; Varjonen & Niemi, 2000). For those activities, a housekeeper wage rate may not be appropriate to use.

Another problem of the housekeeper wage rate is that the availability of proper wage data for housekeepers is not widely given. The main reason for this is that many housekeepers are employed privately and hence information on their payment is either not available or not concise (Varjonen & Niemi, 2000). A way to work around this issue of not having access to a housekeeper wage rate is to use the wage rate of the closest paid market job that is associated with a variety of typical housekeeper tasks (Carrasco & Serrano, 2011; Dong & An, 2015; Goldschmidt-Clermont, 2000; Varjonen & Niemi, 2000).

3.4.2.2 Replacement Cost Approach using Specialist Wage Rates

Different to the replacement cost approach using the housekeeper wage rate, the application of specialist wage rates assumes that a household hypothetically hires a market specialist to perform those activities within the household that closely match their market profession, and value those activities with the specialists' wage rates (Chadeau, 1992; Dong & An, 2015; Hawrylyshyn, 1976). This means, for example, that for cooking activities the average market wage of a cook, and for painting activities the average market wage of a painter, is applied. In the literature, this method is also referred to as specialist substitute or function cost approach (Chadeau, 1992; Fitzgerald & Wicks, 1990). Equation 3.3 presents the VoL using the replacement cost approach and applying specialist wage rates, based on the work from Chadeau (1992), Hawrylyshyn (1976), and Quah (1989).

$$\text{VoL}^{\text{SP}} = \sum_{i \in N} \sum_{j \in D} \text{t}_{ij} \ \text{w}_j^{\text{S}} \tag{3.3}$$

where:

SP = indicates this is the VoL using the traditional approach and specialist wage rates

t_{ij} = time spent on unpaid work activity j for each individual i

w_j^{S} = specialist wage for activity j

i = individual of the population or sample N

N = set of all individuals in the population or sample

j = activity in set D

D = set of all relevant activities

While the housekeeper wage rate is assumed to result in a lower VoL, which does not accurately reflect the contribution by households towards the economy, applying the specialist wage rate is recommended by researchers as the more sophisticated wage rate (Poissonnier & Roy, 2017; United Nations, 2017).

Similar to the housekeeper wage rate, the application of specialist wage rates in the replacement cost approach also leads to some problems outlined as follows.

3.4.2.2.1 Specialist Wage Rates and the Productivity Problem

According to Gwartney et al. (2003), a generic definition of productivity is “the average output produced per worker during a specific time period” (p. 229). However, for unpaid household work and the VoL this definition cannot be fully applied because no data on the output variable exists as only the input side of the valuation is looked at. Although adjustments for different productivity levels in unpaid work are required, if specialist wage rates are applied, the literature does not offer a precise definition on the meaning of productivity in this particular field of research. While Becchetti et al. (2013) stated that the level of productivity is dependent on the intrinsic motivation and skills of each individual, the literature on productivity in unpaid work widely supports that the level is very individual. Further insights into dealing with this problem are provided in the following paragraphs.

One main problem of using specialist wages is the assignment of a variety of different market wages to non-market activities (Bivens & Volker, 1986). This is problematic because the differences between market work and household tasks in regard to productivity and machinery equipment are claimed to be huge (Budlender & Brathaug, 2010; Goldschmidt-Clermont, 1993). Goldschmidt-Clermont (1993) further pointed out that market wages are based on market outputs and the market environment, which is different to a household setting and its produced outputs. Applying those market specialist wages to non-market activities implicitly assumes that productivity in the market and household is equal (Chadeau, 1992). However, various studies have revealed that this is not necessarily the case and that this assumption may not hold up.

Bridgman (2016) stated that the productivity level in households is not measured by a survey and therefore no data on this is available. A suggestion to work around this lack of data availability could be to estimate productivity. Unfortunately, there is not a lot of recent research available in the area of household productivity, but existing studies by Bridgman (2016), Duernecker and Herrendorf (2018), and Fitzgerald et al. (1996) revealed that the productivity of a household is lower than the productivity of the market sector. A slightly different result was found by Fitzgerald and Wicks (1990), who compared productivity between firms and households. They asked local businesses that supply typical household outputs in a professional manner to report how long a typical employee would require to produce one commodity. A comparison with households allowed Fitzgerald and Wicks (1990) to calculate the average productivity of a household. Their results indicated that for some household activities – for example, cleaning and childcare activities – households can be even more productive than a firm (Fitzgerald & Wicks, 1990). However, their findings need to be treated with care because the sample was small and very regionally focused and hence may not be fully representative of an entire country (Fitzgerald & Wicks, 1990).

Although most researchers pointed out that the specialist wage rate tends to overestimate the valuation of unpaid household work because payment in the market is also connected to the productivity of a company or firm (Bridgman et al., 2012;

Goldschmidt-Clermont, 2000; Lowen & Sicilian, 2015; Poissonnier & Roy, 2017; Quah, 1989), there are different views shared by Fitzgerald and Wicks (1990) and Gørtz (2006). While Fitzgerald and Wicks (1990) reported that, depending on the productivity level of household members, the replacement cost approach using specialist wage rates can either under-, over- or correctly value unpaid household work, Gørtz (2006) claimed that the magnitude of the under- or overvaluation depends on the personal skills and how much "energy, effort and concentration" compared to a market professional is included in each task (p. 96). This supports the view of Dulaney et al. (1992), who stated that, depending on the activities performed and the skills of the individual, the value of unpaid work may either be under- or overestimated.

Although Poissonnier and Roy (2017) are amongst those researchers who suggested that the use of specialist wages may overestimate productivity of unpaid work tasks, they described two thoughts why this may only be marginal. The first thought was that the majority of unpaid work activities do not require very high skills to perform them, which may allow household members to achieve a similar productivity level. The second thought was about those activities that require higher skills; for example, maintenance work. In that case, the authors assume that individuals only perform those activities that they believe they can handle themselves (Poissonnier & Roy, 2017). Thus, only those activities would be performed that have a similar level to the market specialist. Further, Poissonnier and Roy (2017) stated that some unpaid work activities that may include a proportion of leisure, such as fishing, gardening or maintenance work, are presumably not done as efficiently as if done by a market specialist. To avoid an overestimation of productivity, Poissonnier and Roy (2017) recommended including only those unpaid household work activities that are undoubtedly agreed on within the literature to be productive and do not contain any elements of leisure.

3.4.2.2.2 Specialist Wage Rates and the Quality Problem

Similar to the productivity definition problem raised above, there is no precise definition available in literature for quality in unpaid household work and the VoL. The terminology *quality* has many facets and "has been subject to many interpretations and perspectives in our everyday life, in academia, as well as in industry and the public domain" (Martin et al., 2020, p. 1). Differences in the perception of the quality of a product, service, work or activity depend on the own experiences and skills of individuals (European Commission et al., 2009; Martin et al., 2020; Zhang, 2001). This circumstance makes it difficult to formulate a clear definition. Although adjustments for different quality levels in unpaid work are required, if specialist wage rates are applied, a precise definition is not available. Further insights into dealing with the quality issue are provided in the following paragraphs.

Another problem of using specialist wages are different levels of the quality of unpaid work feeding into the VoL. Gørtz (2006) pointed out that the "quality of the activity performed at home" is important (p. 96). Landefeld and McCulla (2000) and Bridgman et al. (2012) commented that the quality of a produced good or service is dependent on the skills of the worker producing it. This will not be reflected accordingly once the specialist wage rate is applied. They concluded that, compared to market work, the quality of a good or service in households is either lower, if the same time is used for production, or to achieve the same quality, more time needs to be devoted to produce the good or services.

According to Lowen and Sicilian (2015) market professionals compared to household members have a higher level of experience and routine in the tasks they perform during their work in the market and this experience might lead to a higher level of quality of their work. Based on ATUS data, they calculated that an average of just above 100 hours per year were spent on housekeeping tasks by men within the age group 15 to 35 years (Lowen & Sicilian, 2015). Assuming a professional housekeeper works 40 hours per week and with 20 working days of annual leave, this would result in 1920 working hours per year. To achieve the same experience level, the men would need to work approximately 20 years. For women, due to more time spent on such activities, this experience level is reached after 10 years (Lowen & Sicilian, 2015). For this reason, Lowen and Sicilian (2015) proposed that it is necessary to adjust market wages for this difference, which will also be reflected in significantly lower levels of quality. The significant differences in experience levels between men and women also shows the inequality between both genders as highlighted by Shelton (2006) and supports gender-based evaluations.

3.4.2.2.3 Assigning Specialist Wage Rates to Activities

A further problem with the specialist wage rates is the complexity of finding the correct wage rate for each activity (Lowen & Sicilian, 2015). For the purpose of matching the activities with an appropriate wage rate, the activities need to be grouped into mutually exclusive activity groups, and a corresponding wage rate for all those activity groups needs to be identified. This is complex, but the detailed effort is assumed to ensure a high quality of the valuation (van de Ven & Zwijnenburg, 2016).

3.4.2.2.4 Specialist Wage Rates and the Gender Wage Gap

Jankiewicz (2017) highlighted that researchers should not focus only on the difference between household and market differences but also should focus on gender differences between men and women. Gender plays an important role in time use analysis as men and women have different priorities (Gimenez-Nadal & Molina, 2020; Hunady et al., 2014). The application of market rates to households will implement the wage gap between men and women from paid work to unpaid work because market wages for women and men are often not equal (Chadeau, 1992). Opinions are diverging from using gender-based average wage rates for men and women for the valuation of unpaid work (Bridgman et al., 2012) over the use of two different mean wages, for men and women, rather than economy-wide mean wage rates (Budlender & Brathaug, 2010), to a warning for researchers not to use wage rates for women only (Ironmonger, 1996). The reason for this warning by Ironmonger is that the gender wage gap is still present to date (Bargain et al., 2019; Matteazzi & Scherer, 2021), and will underestimate the real contribution of women, because not all of the unpaid household work is done by women.

In addition to those two commonly applied wage rates explained above, there are further wage rates that were rarely applied in selected research studies but remained a niche.

3.4.2.3 Replacement Cost Approach and its Rarely Applied Wage Rates

Apart from the above two commonly applied wage rates, there are other wage rate options that are rarely applied with the replacement cost approach. Those are, for example, hybrid wage rates that consist of a mix of the housekeeper wage and specialist wage rates and were applied by De Vaus et al. (2003) and Trewin (2000) in their Australian studies, because they believed hybrid wages were the most suitable concept to reflect the Australian economy.

Other possible wage rates that were applied by researchers include a country's average wage (Hunter, 2010; Poissonnier & Roy, 2017), the median wage (Hunter, 2010; Statistics New Zealand, 2001), wage rates available through online platforms (Jokubauskaitė & Schneebaum, 2022) or the minimum wage (Poissonnier & Roy, 2017; van de Ven & Zwijnenburg, 2016). A study by Schäfer (2004) compared nine different wage concepts that could be applied with the replacement cost approach: net wage with and without absence from work, gross wage with employer contributions and a variety of the generalist housekeeper, specialised worker and average wages rates (Schäfer, 2004). This comparison revealed very different results of the VoL when various wage rates were used.

3.4.3 Evaluation of Opportunity and Replacement Cost Approaches

If one compares the opportunity cost with the replacement cost approach, James (1996) explained that from a theoretical perspective both approaches should provide a similar value of unpaid work, but according to the literature this is rarely the case. An in-depth analysis by James (1996) showed that the explanation for the difference may be due to the simple fact that individuals can influence *time* and *wage* within the opportunity cost approach, while it is only the variable *time* they can control within the replacement cost approach. Individual properties such as education, age and gender can impact on the personal wage rate of the opportunity cost approach but may not impact on the replacement cost wage rate in a similar way (James, 1996).

Which of the two approaches should be used is dependent on the purpose of the research. For example, Fischer (1994) stated that in legal economics the valuation of lost household services in case of death or injury prefers either the opportunity or the replacement cost approach depending on what side of the lawyers is looked at, and whether or not a high or low valuation is preferred. The plaintiff attorney usually favours the replacement cost approach, while the defence attorney prefers the opportunity cost approach (Fischer, 1994). Nevertheless, if the purpose of the valuation of unpaid work is related to the SNA and macroeconomics, the replacement cost approach is recommended as the better choice over the opportunity cost approach (James, 1996).

Goodwin et al. (2008) claimed that neither of the two approaches can be seen as the optimal choice for the VoL because they both have limitations and disadvantages. But they do have in common, with many other approaches used to compile the national accounts, that they are not perfect. Hence, Goodwin et al. (2008) recommended that it is better to include some value of household unpaid work in the national accounts rather than disregarding the VoL completely.

While Hawrylyshyn (1977) believed that both approaches are useful for the VoL, he highlighted that both come with conceptual problems. Kiker and de Oliveira (1990) went one step further and believed that, due to those conceptual problems, neither approach can be firmly anchored in the theory of the allocation of time. Kiker and de Oliveira (1990) stated that, under the assumption of an equal price, productivity and quality level of goods or services between households and the market, individuals would be indifferent between performing unpaid household work or buying the goods or services in the market, in other words they are indifferent between allocating their time to market or household work. To work around this, Schreyer and Diewert (2014) extended Becker's 1965 theory of the allocation of time in their research and included the replacement cost approach into their model to allow a theoretical justification of its suitability to value unpaid work. They found that usually the microeconomic concepts applied in Becker's theory would imply that the opportunity cost approach is the only possible option. However, their research has confirmed that for the valuation of household unpaid work activities the replacement cost approach is better than the opportunity cost approach (Schreyer & Diewert, 2014). Also supporting this view are Salamon et al. (2011), who recommended using the replacement cost approach for macro-level estimations and valuations as the currently most suitable method.
The National Research Council (2005) and van de Ven and Zwijnenburg (2016) proposed using the replacement cost approach and adjusting the specialist wages to account for different levels of quality and productivity because otherwise the VoL would be too high. Suh and Folbre (2016) promoted that it is better to have an adjustment, even if it is not perfect, than having no adjustment at all. Quality adjustments of specialist wage rates were supported by Dulaney et al. (1992), Goldschmidt-Clermont (1991), Lowen and Sicilian (2015), National Research Council (2005), United Nations (2017, 2020), and van de Ven and Zwijnenburg (2016),

while Lowen and Sicilian (2015), National Research Council (2005), United Nations (2020), and van de Ven and Zwijnenburg (2016) recommended productivity adjustments of those wages.
The following section summarises the main studies on quality and productivity adjustments for specialist wage rates.

3.5 Specialist Wage Rate Adjustments for Quality and Productivity

Above it was highlighted that the application of specialist wage rates with the replacement cost approach requires adjustments because assigning unadjusted market rates to the household and private environment is thought to provide an incorrect measure of the VoL. This section presents a review of existing literature regarding those adjustments for quality and productivity.

3.5.1 Quality Adjustments

A general view on quality adjustments is shared by the National Research Council (2005). It stated that adjustments are necessary to account for the differences between households and market enterprises, but highlighted that those differences can either be looked at from the input side or from the output side, although they are both interconnected. No matter what side is looked at, the quality is assumed to differ and that needs to be adjusted for (National Research Council, 2005).

First, research on quality adjustments focusing on the output side of unpaid household activities was done by Dulaney et al. (1992), Fitzgerald and Wicks (1990), and Goldschmidt-Clermont (1991). It needs to be noted that adjustments regarding the output side do not directly affect the specialist wage rates and therefore research findings concerning the output side need to be treated with care as they are not recommended to be used for the VoL. Goldschmidt-Clermont (1991) believed that prices of market goods and services may need adjustments because their quality may be different from the goods and services produced at home but did not provide magnitudes of those adjustments.
Fitzgerald and Wicks (1990) and Dulaney et al. (1992) also focused on the quality of the output produced by households. In their study, Fitzgerald and Wicks (1990)

found that the quality of most commodities produced by households is almost equal to alternative goods and services available on the market, but households may even achieve a higher quality for some commodities. Their results are based on self-reported quality differences by household members between market and household commodities. In addition, Dulaney et al. (1992) investigated whether there is a difference of output product quality, depending on whether goods or services are produced in the market or in a household, and surveyed 175 households. Respondents were asked for the five activity groups *cleaning*, *childcare*, *meal preparation*, *clothing care* and *do-it-yourself* to compare, from their personal view, the quality of a produced household output with the quality of a substitute available in the market using a percentage scale (Dulaney et al., 1992).
According to Dulaney et al. (1992) only the quality of do-it-yourself outputs from single households is on average 10% lower than that of a market substitute. For married couples and all households together the quality of home-produced output is estimated to be between 15% and 66% higher than in the market (Dulaney et al., 1992). They further highlighted that their results are appropriate within their research field of forensic economics but should be treated with care if they are applied to other economic fields, for example, the VoL, because the small sample size and the fact that respondents reported their subjective opinion may limit the validity of the results.

Second, research focusing on the input side of unpaid household work is presented as follows. A different level of effort or skills being applied to the labour time input may impact, for example, on the quality of the produced good or service (National Research Council, 2005). Therefore, the National Research Council (2005) recommended adjustments and provided a suggestion on how to consider them in the VoL, but did not use data to provide any calculations or magnitudes. They proposed adjusting the specialist wage rate w^{s} by a variable b to compensate for the quality differences to derive the adjusted wage $\mathrm{w}^{\mathrm{adj}}$ as shown in Equation 3.4.

$$\mathrm{w}^{\mathrm{adj}} = b\ \mathrm{w}^{\mathrm{s}} \tag{3.4}$$

They allowed the adjustment factor b ranging between 0 and 1 (National Research Council, 2005). With the restriction of $b \leq 1$ the authors of the study assumed that households cannot exceed the market wage rate (National Research Council, 2005).

Building on work from National Research Council (2005) were Landefeld et al. (2009), who investigated the possibility of using quality adjusted wage rates and how those impact on the classic valuation approaches of unpaid work. Based on ATUS and MTUS data, Landefeld et al. (2009) focused on household production accounts and not only on the input of labour. Their study compared the new quality adjustments for specialist wages with a variety of valuation approaches based on the housekeeper wage, unadjusted specialist wages, the minimum wage and even the opportunity cost approach (Landefeld et al., 2009).
They allowed 75% of the specialist wage rates ($b = 0.75$) as adjustments for cooking, cleaning, repair and gardening activities while other activities such as shopping, childcare, and travel remained unadjusted (Landefeld et al., 2009). They did not provide evidence of why they picked 75%, and only stated it was arbitrarily chosen (Landefeld et al., 2009). They further did not believe that adjustments of greater than 100% ($b > 1$) are necessary and hence discarded that option (Landefeld et al., 2009).

In their work, Schreyer and Diewert (2014) highlighted the fact that the use of specialist wage rates should be in line with an adequate adjustment for quality per hour of work due to lower skills and lower professionalism of individuals compared to one hour of work in the market. Although they mentioned that the application of such an adjustment to an existing model will be done by simply adding a variable to the wage rate, as proposed by the National Research Council (2005), say $b > 0$, the still unsolved problem is the identification of the magnitude of those adjustments (Schreyer & Diewert, 2014). Therefore, they avoided adjustments ($b = 1$) in their research (Schreyer & Diewert, 2014).

Varjonen et al. (2014) pointed out that some unpaid work activities were done on a regular basis while others were performed rarely. Maintenance work is one example that is done seldom compared to daily, routine activities such as washing. Therefore, they were not in favour of treating all household members as laypersons compared to paid workers because, depending on the type of activity and individual skills, they may be close or equal to professionals and may achieve a similar quality level. Varjonen et al. (2014) stated that further research is necessary but until a solution is found they decided to use unadjusted wage rates ($b = 1$).

Lowen and Sicilian (2015) also investigated quality adjusted specialist wages and claimed that it is very complicated to estimate the value of b because it is dependent on the activity and the person performing the task.

A different view was shared by Salamon et al. (2011), who believed that quality adjustments are not necessary at the macroeconomic level, because they assumed those adjustments could be averaged out on the macro level, but did not supplement that statement with data. Therefore, they also did not use any adjustments ($b = 1$) in their volunteering study (Salamon et al., 2011).

The United Nations (2017) recommended adjusting market wage rates for different levels of quality in all those cases where the quality of services produced by unpaid household activities differs from the quality of the services produced in the market. The decision should be based on the question "does the quality of the service produced match that which would be provided by a market equivalent service?" (United Nations, 2017, p. 28). They proposed an adjustment that reduces the wage rate, which implies that the option of a higher wage rate ($b > 1$) had already been discarded by them.

The review of the literature shows that there is still no agreement on what those quality adjustments should look like to enhance estimates of the valuation of unpaid work. Therefore, United Nations (2017) urged researchers "to experiment with wage adjustments until they have what can be considered as a sensible result, based on a set of reasonable and clear assumptions" (United Nations, 2017, p. 29). This is in line with the United Nations (2020) and van de Ven and Zwijnenburg (2016), who also pointed out that further research is required to find a suitable solution to this problem.

3.5.2 Productivity Adjustments

Although many researchers, as mentioned above, recommended the application of productivity adjustments if specialist wage rates are used in the VoL, the review of the literature identified only a few studies that investigated those adjustments beyond the usual recommendation, and dealt in depth with the subject matter. This may be the reason why suggestions on the magnitude of productivity adjustments are scarce.

A recommendation on specialist wage rate adjustments for productivity was found in the study of Blades (2000), who suggested that for some activities adjustments may be appropriate to reflect the lower productivity of households. Blades (2000) proposed using the housekeeper wage rate to value typical household chore activities, while specialist wage rates should be applied to activities that are usually carried out by market professionals. In the case of using specialist wages, Blades (2000) recommended an adjustment between 50% and 70% of the specialist wage rates, while he assumed that 50% would possibly be more accurate than 70% (Blades, 2000).
This means that if the variable c would reflect a productivity adjustment, similar to the quality adjustment shown in Equation 3.4, based on the recommendation by Blades (2000), the following values for c would be possible: $0.5 \leq c \leq 0.7$.
It needs to be highlighted that his proposed percentage rates are not supported by data and seem to be chosen arbitrarily without any particular proof or justification of how or why those rates were chosen. Blades (2000) simply justified his procedure by pointing at other areas of the SNA that applied arbitrary weights and adjustments if accurate data is not available. This problem is currently still an unsolved issue and needs further research.

Lowen and Sicilian (2015) recommended that productivity adjustments may be necessary because non-professionals compared to professionals may not be as skilled and may not have the same level of experience to perform certain tasks and thus may achieve a lower productivity level. The same opinion of recommending appropriate productivity adjustments is also shared by Fischer (1994), National Research Council (2005), and van de Ven and Zwijnenburg (2016). Unfortunately, they do not specify the magnitude of those adjustments and do not offer a suggestion on how they should be calculated. The United Nations (2020) stated that productivity differences are often neglected as if they would not exist for simplicity reasons. Salamon et al. (2011) highlighted, similar to the quality adjustment, that no "exact scale of any such adjustment" is available (p. 226). Therefore, further research is required.

3.5.3 Factors Impacting on the Quality and Productivity of Unpaid Household Work

The review of the literature in the previous sections on factors impacting on the allocation of time and multitasking revealed the seven demographics of gender, age, children living in own household, level of employment, marital status, level of education and health as main determinants.

In a similar way, it is hoped to identify the key factors that directly impact on the quality and productivity of unpaid household work, but it was noticed that there is hardly any literature on factors impacting on the productivity of unpaid work, but even less was found about the factors impacting on the quality of unpaid work. Some literature on the relationship between productivity and quality was identified for paid work, but as this covers a different field of research, those studies were disregarded. For the seven above-mentioned demographic factors, three studies worth mentioning were found for productivity covering age, health and education, but only one relevant study considered the demographic factor health and its impact on the quality of unpaid work. In her thesis, Gørtz (2006) reported that productivity will decline with the individual's age when they retire and their personal fitness or health level decreases. This is in line with a study by De Vaus et al. (2003), who stated that people aged 65 and older may have a reduced productivity level.
Based on research by Dollahite and Rommel (1993), it can further be assumed that a higher level of education may increase productivity.
De Vaus et al. (2003) argued that a bad health level may reduce productivity. This view is in line with Zhang et al. (2011), who focused their research on labour input and concluded that illness, sickness or bad health influences productivity in unpaid work. Due to a reduced health level, people work slower or require more breaks than usual which reduces the quantity of produced goods or services.
Zhang et al. (2011) further identified that a reduced level of health also reduces the quality of unpaid work because sick people make more mistakes or do not work as concentratedly as healthy individuals.

In addition to those three demographic factors, two studies were found that showed a direct influence of multitasking on both productivity and the quality of unpaid work. According to Zaiceva and Zimmermann (2011), multitasking may reduce productivity of unpaid household work. Similarly, Kalenkoski and Foster (2015) pointed out that multitasking has an impact on productivity but the exact effects need to be investigated further. An interesting finding by Bloemen and Stancanelli (2014) revealed that a high level of productivity and higher wages of women in paid work lead to a higher productivity in unpaid work activities. Furthermore, Zaiceva and Zimmermann (2011) also identified that multitasking may result in a lower quality of work.

Overall, the research on the impact of quality on unpaid household work is sparse and therefore, it may be interesting to investigate the determinants of quality of unpaid household work in relation to the demographics.

3.6 Summary of the Literature Review and Identification of the Research Gaps

This section summarises the review of the literature by identifying the gaps in research regarding the VoL. Also taken into account is the previous Section 3.3.6 on the 'interim conclusion and recommendation on multitasking', that summarised the problems regarding the consideration of multitasking.

According to the literature review, the replacement cost approach is identified as the dominating approach that is used to estimate the VoL. In its traditional form, it multiplies the time spent on activities with a suitable wage rate, typically the simple housekeeper wage rate or the more sophisticated specialist wage rate. However, the traditional approach of the VoL lacks some degree of accuracy which may be overcome by implementing various improvements to adjust for multitasking and wage-related issues, as previously outlined above. Without those improvements, the valuation is assumed to result in less accurate estimates. Moreover, the arbitrarily chosen splits and percentage rates for adjustments are not convincing and justify investigating this further.

Varjonen et al. (2014) summarised the main problem as follows: the research on the valuation of unpaid work done within the past decades only resulted in "a confusing spread of values, for example, in relation to GDP, which undermine the credibility and usability of the estimates" (Varjonen et al., 2014, p. 5).

The review confirmed that new ways should be investigated to enhance the existing valuation procedures, and this is where this research will pick up. Based on the literature review, four research gaps are identified.

3.6.1 Research Gap 1: Adding Multitasking to the VoL

The first gap is the exclusion of simultaneous activities from the valuation of unpaid household work as a result that, based on the current state of literature, there is no satisfying approach available on how to include simultaneous activities into the valuation of unpaid work to ensure proper estimates. It is therefore important to investigate this further and find a better treatment when estimating unpaid household work.

According to Budlender (2007) and Hunter (2010), the inclusion of simultaneous or multitasking activities into the VoL estimates is necessary to ensure accurate calculations. The necessity of including them has also been pointed out by Quah (1989). The review of the literature showed that there is currently still no agreement on how to best treat simultaneous activities (Błaszczak-Przybycińska & Marszałek, 2019; Ironmonger, 2003; Nordhaus, 2006; United Nations, 2017; Williams & Donath, 1994). Recommendations range from splitting time equally amongst activities (Drago, 2011; Williams & Donath, 1994; Zaiceva & Zimmermann, 2011) over the development of complex utility functions that supply necessary weights (Stinson, 1999) and modified household production functions (Kalenkoski & Foster, 2015) to activity combinations for simultaneous activities (Gershuny & Sullivan, 1998). Budlender and Brathaug (2010) included the time for simultaneous activities in addition to the main activity and thus allowed in their research for exceeding the daily time constraint of 24 hours.

Although some research on splitting the time spent on multiple activities has been done in the past, the splits used so far have either been chosen arbitrarily, or the weights were calculated using a different perspective; for example, a production function approach which is different to the VoL approach used in this thesis. Literature clearly confirms that new ways should be investigated to enhance the existing valuation procedures. It was further identified that current knowledge on the treatment of multitasking is insufficient for the formulation of clear-cut recommendations to policy makers and practitioners. The United Nations (2017, 2020) highlighted that further research is utterly required to properly include simultaneous activities and find suitable splits for multitasking.

3.6.2 Research Gap 2: Adjusting Wage Rates for Quality

The second gap identified is a missing adjustment for different levels of quality of unpaid work, if market wage rates of a specialist are assigned to value unpaid work activities performed by a household member. Without those adjustments, the valuation is assumed to result in less accurate estimates. A review of the literature showed that a necessity of those adjustments is supported by many researchers and organisations including the European Commission et al. (2009), Folbre (2015), Landefeld et al. (2009), National Research Council (2005), Poissonnier and Roy (2017), Schreyer and Diewert (2014), and Varjonen et al. (2014). Although this quality adjustment is recommended, the exact scale for such adjustments has not been established yet (Schreyer & Diewert, 2014).

Therefore, many prior studies either avoided adjustments or implemented arbitrary adjustments, often based on subjective assumptions which were less convincing as they are not supported by scientific data (Dulaney et al., 1992; Goldschmidt-Clermont, 1991; Lowen & Sicilian, 2015; National Research Council, 2005; United Nations, 2017, 2020; van de Ven & Zwijnenburg, 2016). This clearly demands the need for further improvements, in particular on the magnitude of the adjustments and their impact on the VoL.

3.6.3 Research Gap 3: Adjusting Wage Rates for Productivity

The third gap concerns a missing adjustment for differences in productivity between a household member and a specialist in the market. Similar to quality, it is assumed that a market professional achieves a different level of productivity than the average household person.

Blades (2000), Fischer (1994), Lowen and Sicilian (2015), National Research Council (2005), and van de Ven and Zwijnenburg (2016) recommended that productivity adjustments are necessary to account for these differences. They are also necessary to avoid an overestimation of the VoL (Lowen & Sicilian, 2015). Similar to the quality adjustment, the magnitude for those adjustments is uncertain (Salamon et al., 2011), and a consensus on appropriate adjustments has not been reached so far (United Nations, 2020). As a consequence, similar to the quality adjustments, arbitrary numbers were often applied or no adjustments at all considered. Hence, further research is required on finding the appropriate magnitudes of the productivity adjustment and investigate its implementation on the VoL.

3.6.4 Research Gap 4: Demographic Factors and their Impact on the Quality of Unpaid Household Work

The fourth gap was identified by a review of the literature regarding influencing factors of the quality of unpaid work. It was highlighted that seven demographic factors impact on the allocation of time and on multitasking. Some studies investigated the relationship between demographic factors and the productivity of unpaid work, but there was almost no research on demographic factors and their impact on the quality of unpaid work. Therefore, this research aims to fill that void.

3.7 Conceptual Framework and Research Steps

Following the identification of the research gaps, the conceptual framework and the research steps are presented.

3.7.1 Conceptual Framework

In line with Imenda (2014) and Kivunja (2018) the conceptual framework in Figure 3.2 describes the relationship between the main concepts and variables used in this research study.

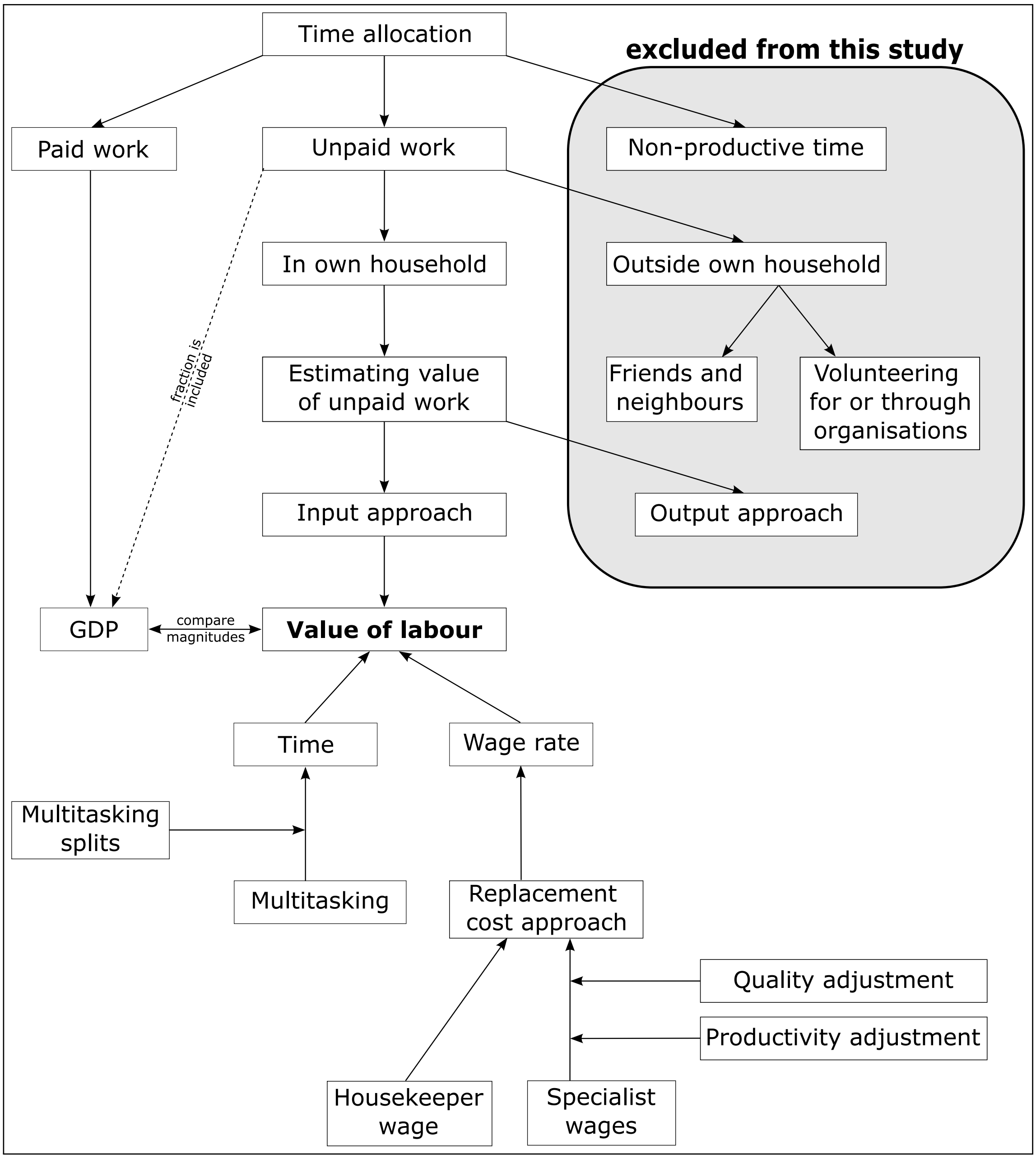


Figure 3.2: Conceptual framework

Source: The author

The review of the literature identified the theory of the allocation of time as the key theory applied in time use research and the VoL (Heckman, 2015; Ironmonger, 1995). According to Schäffer (2003) time is a scarce commodity that can neither be stored, saved nor extended. Each minute can only be used once. Therefore, it is essential for individuals to decide how to allocate their time in a suitable and efficient way – in other words to maximise personal utility (Gørtz, 2006; Juster & Stafford, 1991; Schäffer, 2003). Individuals must allocate their time of 24 hours per day to either paid work, unpaid work or non-productive time which includes, for example, leisure, resting, eating and sleeping, and therefore, is considered economically irrelevant time. This research focuses on unpaid work in own households, disregarding paid work and unpaid work outside the own household. The value of unpaid work in own households can be estimated either by an input or output based approach. In line with Folbre (2015) and United Nations (2017) this study applies an input based approach but only focuses on its VoL part, as illustrated in Figure 2.1.

The review of the literature identified that the VoL, in its simplest form, is calculated by multiplying the time spent on activities with a corresponding wage rate. In the case only one activity is performed, the duration time of that activity can be valued completely, but in the case of multiple activities done simultaneously, splits are required to allow for dividing up the time.

Regarding the wage rate, the literature favours the replacement cost approach rather than the opportunity cost approach. Following the United Nations (2017), two wage rate concepts, the housekeeper wage and specialist wage rates are recommended to be used when the replacement cost approach is applied. While the same housekeeper wage rate can be assigned to all unpaid household work activities, the specialist wage rates vary depending on the unpaid work activity performed. It is widely claimed in the literature that the housekeeper wage is low and thus, wage rate adjustments are believed to be unnecessary. Contrarily, the specialist wage rates are claimed to require adjustments allowing for differences in quality and productivity between market workers and households.

3.7.2 The Steps of this Research

Based on the conceptual framework, the above identified research gaps and in line with the research objectives and the research questions, the researcher aims to fill those gaps through the steps presented in Figure 3.3. Four steps concern the VoL approach and its modifications. Research gap number four, the demographic factors and their impact on the quality of unpaid household work, is investigated by a regression analysis.

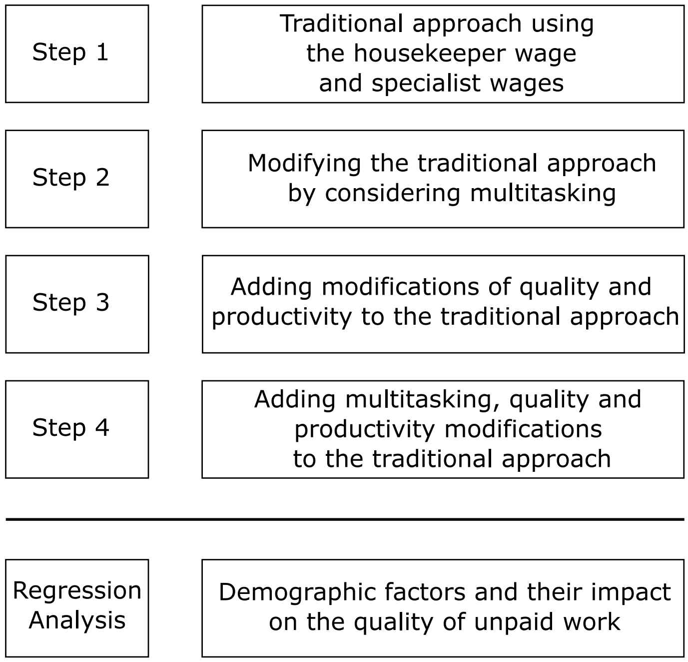


Figure 3.3: Research steps to answer the research questions

Source: The author

3.7.2.1 Step 1: Traditional Approach using the Housekeeper Wage and Specialist Wages

In the first step, the traditional approach will be evaluated, and the VoL will be calculated based on the housekeeper wage and the unadjusted specialist wage rates. Both results will later act as a benchmark for comparison with further modifications.

3.7.2.2 Step 2: Modifying the Traditional Approach by Considering Multitasking

The aim is to estimate splits (weights) that can be applied to the traditional approach using specialist wages, based on time input from the TUS and the evaluation of respondents' views on how they would rank and split multiple activities based on their personal experience.

This research will also investigate this by taking into consideration possible gender differences. It is further aimed to estimate splits not only for two simultaneous activities but also for multiple activities since more than two activities have not been looked at regarding the application of splits.

Furthermore, the magnitude of the step 2 adjustments and their impact on the VoL will be evaluated. The VoL results will be compared to the VoL using the traditional approach from step 1.

3.7.2.3 Step 3: Adding Modifications of Quality and Productivity to the Traditional Approach

The aim of the third step is to estimate weights that allow for adjusting the traditional approach using specialist wage rates for quality and productivity differences in the VoL. Furthermore, gender differences and the way in which this may influence the specialist wage rate will be taken into account and the magnitude of the adjustments will be identified. It further will be evaluated how the adjustments impact on the VoL and how this compares to the results of steps 1 and 2.

3.7.2.4 Step 4: Adding Multitasking, Quality and Productivity Modifications to the Traditional Approach

In a fourth step, the traditional approach using specialist wage rates is aimed to be modified to combine the inclusion of multitasking splits and the adjustments for quality and productivity in one single equation. A combination of adjustments for simultaneous activities and wage rates has, according to the literature review, not been done in the past. This modified approach should enhance the valuation of unpaid work estimates significantly as it combines the solution of two problems known to literature; the multitasking and the specialist wage adjustment. This can be seen as a significant original contribution to existing knowledge.

It will further be investigated how gender differences might impact on this modified approach. The magnitude of the adjustments and their impact on the VoL will be evaluated. In order to show the impact of the modifications, the VoL results will be compared to the results of the modifications with the traditional approach of step 1 and the results of steps 2 and 3.

3.7.2.5 Regression Analysis: Demographic Factors and their Impact on the Quality of Unpaid Household Work

It is further aimed to identify the relationship between selected demographic factors and their influence on the quality of unpaid work by using a regression analysis. This is hoped to also contribute to knowledge because research on this matter is sparse.

3.8 Chapter Conclusion

The original contribution to knowledge of this study is the modification of the dominating approach of the VoL by taking multitasking splits into consideration and allowing for the adjustment of quality and productivity in one valuation approach. This includes the identification of magnitudes of splits and adjustments as well as the evaluation of their impact on the VoL. According to the relevant literature, this has been sought for decades. It is further investigated how gender differences influence those adjustments and how quality is affected by selected demographics.

Based on the evaluation of all VoL results, the researcher aims to provide recommendations to policy makers and practitioners on the implementation of the splits and adjustments identified in the research and on how those improvements might be used to develop a harmonised approach useful to other countries and researchers.

Chapter 4

Research Methodology

4.1 Introduction to Chapter

Following the literature review, this chapter presents the research methodology that helps to answer the research questions outlined in Chapter 1. First, the research philosophy, the approaches to reasoning and the research design are explained. In a second step, primary and secondary data are described, the sampling procedures are outlined and data reliability and validity are investigated. The last part of this chapter covers data preparation as well as analysis and discusses research ethics.

4.2 Research Philosophy

Research philosophy is a "system of beliefs and assumptions about the development of knowledge" (Saunders et al., 2019, p. 130). The research philosophy distinguishes between the different philosophical traditions covering the range from *positivism* on one side to *interpretivism* on the other side (Blumberg et al., 2008). In between, the literature offers many variations of those key philosophical traditions (Saunders et al., 2019). According to Creswell (2014), variations are, for example, *post-positivism*, *constructivism* or *pragmatism*.

The philosophical traditions are sometimes referred to as *paradigms* which are defined as "a model or framework for observation and understanding, which shapes both what we see and how we understand it" (Babbie, 2011, p. 32), or as "a set of assumptions about the social world, and about what constitute proper techniques and topics for inquiring into that world; a set of basic beliefs, a worldview, a view of how science should be done" (Punch, 2005, p. 292).

Embedded in each philosophical tradition are the ontology, epistemology and axiology, which are explained below.

4.2.1 Ontology

Ontology is about what can exist in the world and what is the nature of reality (Bryman, 2008). The literature distinguishes between two extreme ontological positions: objectivism and subjectivism (Saunders et al., 2019).
Objectivism is based on natural science and its assumptions and therefore it is believed that the reality exists without the presence of individuals (Bryman, 2008). Contrarily, subjectivism is based on assumptions underlying the research fields of humanities and art (Saunders et al., 2019). The reality is created by individuals; it can only exist through those individuals, and therefore reality can be different for each person and also may constantly change (Bryman, 2008; Bryman & Bell, 2015).

4.2.2 Epistemology

Epistemology is about how knowledge is created and, how things are understood; it helps to answer the question of how we know what we know (Bryman, 2008; Bryman & Bell, 2015). Therefore, it can be referred to as the theory of knowledge (Bryman, 2008).

4.2.3 Axiology

Axiology is about what gives things value and how this may impact on the research process (Gonzalez, 2013). Researchers need to decide how much they want their own values to influence their results, as well as how the values of other individuals being part of the research will affect those results (Saunders et al., 2019). This means that research can, for example, be *value-free*, *value-driven* or *value-laden*, depending on the choice of the ontological and epistemological position, as shown in the philosophical traditions explained below (Gonzalez, 2013; Saunders et al., 2019).

4.2.4 Philosophical Traditions

Based on ontology, epistemology and axiology, the main philosophical traditions *positivism* and *interpretivism* are explained.

4.2.4.1 Positivism

Positivism is the oldest philosophical tradition that originates from natural science and is seeking *The Truth* (Babbie, 2011; Blumberg et al., 2008; Bryman & Bell, 2015). Bryman (2008) defines positivism as "an epistemological position that advocates the application of the methods of the natural sciences to the study of social reality and beyond" (p. 697). Research undertaken in this paradigm is objective, logically ordered, based on facts, typically quantitative and often based on deduction; it produces law-like statements that allow generalisations, the reality is external to the researcher and reality is seen as a constant (Babbie, 2011; Blaikie, 2010; Blumberg et al., 2008). The researcher tries not to influence the research, data and findings by taking a neutral position that is distant to the research and allows the research to be undertaken value-free (Blumberg et al., 2008; Bryman & Bell, 2015; Gonzalez, 2013).

4.2.4.2 Interpretivism

Interpretivism is a position contrary to positivism that follows a subjective perspective and is not based on the logic of natural science (Blaikie, 2010; Blumberg et al., 2008; Bryman & Bell, 2015). Bryman (2008) defines interpretivism as "an epistemological position that requires the social scientist to grasp the subjective meaning of social action" (p. 694). Thus, the social reality is created by the meanings of individuals, and those meanings can be studied and interpreted (Blaikie, 2010; Blumberg et al., 2008). Research undertaken in this paradigm does not seek representativeness, it is often qualitative, inductive and is looking for one of the many truths out there (Blaikie, 2010; Bryman & Bell, 2015). Contrarily to positivism, the researcher does not have a neutral position, is not distant to the research, influences the research by his/her own sets of skills, beliefs and values, which increases bias and therefore this research is considered value-laden (Blumberg et al., 2008; Holden & Lynch, 2004; Saunders et al., 2019).

4.2.5 Researcher's Philosophical Tradition

The researcher of this study adopts a positivist position, which is based on the theory of the allocation of time, micro- and macroeconomics as it is evident in the literature. Data in this research are collected and not observed; it is based on numbers and facts. The researcher uses equations, laws of mathematics and economics and allows for bias, errors and limitations. The researcher remains in the background, applies an objective approach and aims to reduce the influence of the researcher's beliefs and behaviour on the gathered information to a minimum to ensure a value-free research.

4.3 Research Approach to Reasoning

The next step in defining the research methodology deals with the approaches to theory development and reasoning (Saunders et al., 2019). The approach to reasoning is based on the philosophical tradition and the researcher's understanding of the connection between theory and data (Given, 2008). It explains how the relationship between various concepts or variables can be explained using existing theories (Given, 2008; Saunders & Lewis, 2018). The selection of the most suitable approach to reasoning applied in this research depends on finding the best way of connecting the theory of the allocation of time, micro- and macroeconomic theory with the data, approaches and adjustments used in this study. This section compares three different approaches to reasoning, *deduction*, *induction* and *abduction* (Given, 2008). Each approach uses a different set of logic which helps to answer the research questions (Blaikie, 2010).

4.3.1 Deduction

Deduction is a top-down approach "moving downward in levels of abstraction" (Punch, 2005, p. 290), from general to specific (Babbie, 2011; Sekaran & Bougie, 2010). Post-positivists often use a deductive approach to reasoning, starting with a theory and then collecting data that allow the researcher to confirm or reject that theory (Cooper & Schindler, 2014; Creswell, 2014; Imenda, 2014). Deduction, as stated by Given (2008), is the oldest approach to reasoning. It is dominant in natural sciences and often combined with quantitative research (Bryman & Bell, 2015; Given, 2008).

4.3.2 Induction

Induction is a bottom-up approach "moving upwards in levels of abstraction" (Punch, 2005, p. 292) from specific observations or phenomena to general conclusions or theory (Babbie, 2011; Cooper & Schindler, 2014; Sekaran & Bougie, 2010). It starts with observations and then the researcher tries to find patterns in those observations that allow for postulating a tentative hypothesis, which is then used to build a theory or a general proposition such as a broad statement (Bryman, 2008; Given, 2008). The problem of induction is that the final outcome of inductive reasoning may always be overturned by a contradictory case, such as finding one observation that disproves the theory or the general proposition (Given, 2008). In a nutshell, inductive reasoning is used for theory building from data (Given, 2008; Saunders & Lewis, 2018), and it is typically used in qualitative research (Given, 2008).

4.3.3 Abduction

Of those three approaches to reasoning, abduction is the most recently developed (Given, 2008). It combines deduction and induction in a way that the researcher works from theory to data and back to theory, or the other way around, multiple times (Saunders & Lewis, 2018). Abduction is seldom used compared to induction and deduction, and it is claimed to be most suitable for qualitative research (Given, 2008).

4.3.4 Researcher's Approach to Reasoning

For this study, the researcher adopts a deductive approach to reasoning due to the nature of the research questions, the positivist philosophical tradition and the underlying theory of the allocation of time, micro- and macroeconomic theory.

4.4 Research Design

In the literature, the terminology research design can have different meanings, ranging from a very broad to a very narrow definition (Punch, 2005). Common to all those meanings is the aim of finding the best way of linking the research questions with data (Bryman, 2008; Punch, 2005). Kothari and Garg (2019) describe the research design as a framework for how data is collected, measured and analysed. The choices made for the research design are based on the philosophical tradition and the design will act as a blueprint covering all stages of the research, starting from the research questions (Cooper & Schindler, 2014; Kothari & Garg, 2019; Punch, 2005). This blueprint allows the repeatability of a study in future research. According to Saunders et al. (2019), the research design determines the approach and type of the research design, the research strategy and the time horizon. Subsequently, those different parts of the design are outlined.

4.4.1 Approaches of Research Design

The literature provides three main approaches of a research design: quantitative, qualitative and a mixed methods approach (Creswell, 2014). He notes that those approaches should not be seen as antipodes of each other with strict boundaries because they are not as rigid as often presented and may have flowing transitions or overlaps during the research process (Creswell, 2014). According to Saunders et al. (2019), the decision on which is best applied for a particular research is based on the philosophical tradition.

4.4.1.1 Quantitative Approach

A quantitative research design investigates the relationship of variables by collecting, analysing and displaying data and then expressing the measurements of the phenomenon in numbers rather than in a narrative form (Babbie, 2011; Given, 2008). It aims for a precise measurement of a phenomenon (Cooper & Schindler, 2014) and the analysis of the data is usually done by statistical procedures (Creswell, 2014). Quantitative data is "data that can be described numerically in terms of objects, variables, and their values" (Hox & Boeije, 2005, p. 593). Quantitative research is mainly associated with a positivist philosophical tradition and a deductive approach to reasoning (Bryman & Bell, 2015; Creswell, 2014).

4.4.1.2 Qualitative Approach

The purpose of the qualitative research design is to gather non-numerical data and observations to discover and explore underlying meanings or patterns of relationships (Creswell, 2014; Given, 2008). It aims to use interpretivist techniques to get a detailed understanding of phenomena and creates meanings from words or images (Bryman, 2008; Cooper & Schindler, 2014). Qualitative data is "data involving understandings of the complexity, detail, and context of the research subject, often consisting of texts, such as interview transcripts and field notes, or audiovisual material" (Hox & Boeije, 2005, p. 593). Qualitative research is mainly associated with an interpretivist philosophical tradition, an inductive approach to reasoning, and is generally subjective (Bryman & Bell, 2015; Creswell, 2014).

4.4.1.3 Mixed Methods Approach

A mixed methods research design is a combination of the quantitative and the qualitative research designs (Creswell, 2014; Given, 2008). The combination can be done in two ways, either parallel or sequential (Kuckartz, 2014). In a parallel design the qualitative and the quantitative part of the study are carried out almost simultaneously while one of the two studies acts as the priority study (Kuckartz, 2014). In a sequential design the two studies are carried out in a row, starting either with quantitative or qualitative, where the results of the first study influence the second study (Kuckartz, 2014).

4.4.2 Types of Research Design

In addition to the approaches of the research design, the researcher also needs to be certain about the type of research design applied in a study. The literature distinguishes between three main types of design, *exploratory*, *descriptive* and *explanatory*, while the purpose of the research influences the choice of the type of research design (Babbie, 2011; Bhattacherjee, 2012; Cooper & Schindler, 2014).

4.4.2.1 Exploratory Research

The purpose of an exploratory research design is to explore a phenomenon or field of research that is new or unknown to the researcher, and where existing research cannot be used to answer the research questions (Babbie, 2011; Sekaran & Bougie, 2010). Typical research questions used for exploratory designs are *what* or *how* questions (Saunders et al., 2019). The aim is that the researcher can familiarise him/herself and then gain a better understanding of the phenomenon or problem (Babbie, 2011). The power of an exploratory design is its high flexibility, which allows for easy alternations to new situations (Saunders et al., 2019). The downside lays in its low representativeness due to typically small population and sample sizes (Babbie, 2011). A consequence of this is that exploratory designs only give an indication on how further research should be designed to get more meaningful answers to the research questions which normally cannot be completely answered by exploratory designs (Babbie, 2011). Therefore, this design is often used to decide whether a further in-depth investigation is feasible and worth proceeding by applying a more detailed design such as descriptive or explanatory (Babbie, 2011; Sekaran & Bougie, 2010).

4.4.2.2 Descriptive Research

Descriptive research designs are typical in social sciences and are used to describe observed phenomena or the behaviour and relationship of variables by collecting data and further analysing them (Babbie, 2011; Cooper & Schindler, 2014; Sekaran & Bougie, 2010). It is often used in management, business or economic research (Cooper & Schindler, 2014). It cannot be used to answer research questions starting with *why* (Cooper & Schindler, 2014), but can answer questions of *what*, *where*, *when*, *how* and *who* (Babbie, 2011; Cooper & Schindler, 2014). More specific is Blaikie (2010), who states that research questions starting with *what* need to be answered in a descriptive way. Situated between exploratory and explanatory designs, the descriptive design may be used as a preliminary stage of an explanatory or for the further development of an exploratory research design (Saunders et al., 2019). Hence, descriptive research builds on exploratory research.

4.4.2.3 Explanatory Research

An explanatory research design builds on a descriptive design by aiming to explain why a phenomenon or problem, for example from a descriptive study, can be observed or measured (Babbie, 2011; Cooper & Schindler, 2014). It is used to identify how variables are related in a causal way (Saunders et al., 2019). Therefore, typical research questions start with either *why* or *how* (Cooper & Schindler, 2014; Saunders et al., 2019).

4.4.3 Research Strategies

The literature offers a wide range of research strategies that can be grouped into typically qualitative and typically quantitative types (Creswell, 2014; Kumar, 2019). Below, the survey research strategy is explained as an example for a qualitative strategy, while the case study research strategy is presented as a qualitative strategy.

4.4.3.1 Survey Research

Survey research is a quantitative or numeric research strategy that is used to collect data on a sample of the population, typically by questionnaires, to allow inferences on responses given by respondents, using a quantitative and descriptive design (Creswell, 2014). It uses deductive reasoning and is often applied in business, management and economics to answer research questions starting with *what*, *where*, *how* and *who* in exploratory or descriptive designs (Saunders et al., 2019). The collection of data through surveys generally produces large amounts of data that need to be analysed, often by using a statistical software (Saunders et al., 2019). According to Hox and Boeije (2005), survey research is often applied to household samples. Running a survey for a sample is often claimed to be cheaper than asking the entire population but can achieve a similar level of representativeness if the response rate is high enough (Saunders et al., 2019). The downside is the large amount of front-matter work required for and during data collection, which often includes a pilot testing of the questionnaire (Saunders et al., 2019).

4.4.3.2 Case Study

Hox and Boeije (2005) state that "within a qualitative research design the data collection strategy typically involves collecting a large amount of data on a rather small, purposive sample, using techniques such as in-depth interviews, participant observation, or focus groups" (p. 593). Case study designs are typically used in qualitative research and investigate one single phenomenon on a very deep level basis (Bryman & Bell, 2015; Creswell, 2014). A case in this setting can be an individual of a group, sub-group, organisation or even a social system (Bryman, 2008; Hug & Poscheschnik, 2015). The advantage of a case study is to get an in-depth understanding of the case investigated, and therefore, this design is also suitable to be used in addition to surveys to investigate one particular finding (Hug & Poscheschnik, 2015).

4.4.4 Time Horizon on Data

Another important step of the research design is to determine the time horizon for the data used in this research. Saunders et al. (2019) distinguish between a cross-sectional and a longitudinal time horizon. Cross-sectional means that the research data is only collected at one point in time which does not necessarily have to be a specific day or week, but a reasonably short timeframe (Bryman & Bell, 2015; Cooper & Schindler, 2014; Sekaran & Bougie, 2010). This allows a snapshot of the phenomenon at a single point in time and therefore surveys are often a choice for cross-sectional data (Bryman, 2008; Cooper & Schindler, 2014). Longitudinal means that the data is collected at many different points of time to allow an investigation on how some variables change during that covered period of time (Bryman, 2008; Cooper & Schindler, 2014; Sekaran & Bougie, 2010).

4.4.5 Researcher's Approach to Research Design

Within this research study, the researcher applies a quantitative approach because the measurements of the phenomenon will be presented in numbers and not in a narrative form. In line with the quantitative approach and the nature of the research questions which ask *what* and *how* questions, a descriptive type of research design is used in this research. However, the boundaries between exploratory, descriptive and explanatory types are not always clear-cut. Thus, there may be small elements of exploratory and explanatory types included, but the dominant type applied is descriptive.

Based on the quantitative approach, the nature of the research questions, the deductive approach to reasoning and the aim to use a sample of a large population to achieve high representativeness, this research uses a survey research strategy and aims for a cross-sectional timeframe for data collection. The choice of the research design is in line with the majority of studies done in the field of research on time use and unpaid work, as outlined in the literature review chapter. Figure 4.1 summarises the researcher's choices made on the philosophical tradition, approach to reasoning and the research design.

Topics	**This research study**
Research philosophy	Positivism
Approach to reasoning	Deduction
Approach of research design	Quantitative
Type of research design	Descriptive
Research strategy	Survey research
Time horizon	Cross-sectional

Figure 4.1: Summary of researcher's choices

Source: The author

Based on those choices, the methods of data collection and data analysis, the techniques and procedures used to gather the data that is required and how it is analysed to answer the research questions are outlined below. Therefore, the methods of data collection applied in this thesis are introduced, before presenting the methods on how that data is analysed. Literature distinguishes between two types of data: primary and secondary (Ghauri & Gronhaug, 2005; Kothari & Garg, 2019; Zikmund et al., 2010). This research uses both types of data to answer the research questions. To maintain a logical structure within this chapter, the description of the secondary data is done first, before the primary data collection is outlined in detail.

4.5 Secondary Data

Secondary data is data that already exists because it has been collected by someone else in the past (Cooper & Schindler, 2014; Kothari & Garg, 2019). The main advantages of using secondary data are twofold: saving money and time, because it is often cheaper to access existing data than to collect it, and getting access usually takes less time than the entire collection process (Bryman & Bell, 2015; Cowton, 1998; Punch, 2005). The disadvantages are that the data usually does not fit other research studies because it was generally collected for a different purpose and within a different context (Cooper & Schindler, 2014; Hox & Boeije, 2005; Kothari & Garg, 2019). Another downside is the researcher's lack of control over how the data was originally collected (Cowton, 1998). It is therefore essential to treat secondary data carefully and allow time to get a deep understanding of any underlying assumptions before the data can be cleared and manipulated to make it fit the current research project (Cowton, 1998). In case this is not thoroughly looked at, there is the risk of misinterpreting existing data, which may lead to wrong results or wrong conclusions (Cowton, 1998). Another disadvantage is the anonymity of most secondary data, which does not allow going back to respondents asking for additional information (Johnston, 2014). Although suitable secondary data may exist, Kumar (2019) points out that accessing it is not automatically guaranteed, but even if it is granted, in some instances the desired level of detail may not be available. Therefore, he recommends clarifying the access of data at a very early stage of each research project.

This research uses two sets of secondary data: time data from the UKTUS and wage data from the ASHE. Both are explained in detail below.

4.5.1 Selection of the UK Time Use Survey Data

As outlined in the literature review chapter, TUS data are the key data for the valuation of unpaid work activities. This research focuses on the territory of the UK and its population and therefore applies TUS data from the UK. Prior to this selection, the researcher has investigated the ATUS and the German TUS data but had to neglect both because they do not provide the in-depth information of multiple activities required for this research. The presence of that information is essential for answering the research questions regarding multitasking of household activities. The UKTUS data offers up to four different activities, while the German TUS only collects two simultaneous activities (Destatis, 2015). Apart from secondary childcare activities, the ATUS does not collect other secondary activities (U.S. Bureau of Labor Statistics, 2021).

The following paragraphs provide an explanation of UKTUS data and background information on its methodology, including the illustration of the relevance of TUS activity codes applied in this research. Furthermore, the UKTUS data files, their coding, representativeness and quality are assessed, and the data cleaning steps done by the researcher are outlined in detail.

4.5.1.1 The UKTUS

Two large-scale TUSs were conducted in the UK. The first one was run in 2000 and 2001, and the second one was conducted between April 2014 and December 2015 (Morris et al., 2016). The recent TUS was initiated by the Centre for Time Use Research (CTUR) at Oxford University, while the data was collected through the National Centre for Social Research (NatCen) and the Northern Ireland Statistics and Research Agency (Morris et al., 2016). According to Sullivan and Gershuny (2021), the first edition of the 2014/2015 UKTUS data was published in 2017 and the latest revision was done in 2021. Both surveys aimed to investigate how people living in the UK spend their time, using diaries to record activities over a specified period of time (Morris et al., 2016). The data are stored in an anonymised form for research purposes at the UK Data Archive (Morris et al., 2016; Sullivan & Gershuny, 2021).

The ONS also started a pilot feasibility study on an Online-TUS in 2020, where respondents were asked to fill in an online diary and a questionnaire that covers demographic information (East et al., 2021). However, being only a feasibility study, it was decided not to use Online-TUS data in this research. In consequence, the 2014/2015 UKTUS offers the most suitable and most recent data. Therefore, that survey was selected for this study. Furthermore, its results were fully published and the complete data files, including a step of revision, were already incorporated by the time access to data sources was required by the researcher.

The option of using the 2000/2001 UKTUS was also considered to allow comparison of data over time. That option was discarded because in the 2014/2015 UKTUS methodology paper it was highlighted that the coding of primary and secondary activities had been handled differently in both surveys and therefore a comparison of primary and secondary activities is not recommended by the CTUR (2016). Based on the decision to use only the 2014/2015 UKTUS, the following parts of this thesis simply refer to it as UKTUS without providing the specific dates.

4.5.1.2 UKTUS Data Explained

The UKTUS is based on the 2008 version of the Harmonised European Time Use Survey (HETUS) guidelines provided by Eurostat (2009), a harmonised European framework that allows comparability of the collected TUS data with other countries. However, the HETUS guidelines needed to be customised to meet specific requirements of the UK government and academic users in the UK (Morris et al., 2016).

Based on the information provided in the UKTUS technical report published by Morris et al. (2016), the following characteristics of the UKTUS data are summarised. The eligibility criteria allowed all individuals from the age of 8 years living in a selected household to take part in the UKTUS. Each household had to fill in a household questionnaire that covered, for example, demographic information on the household and its members, living arrangements, income and consumption data. Each eligible individual also had to fill in two one-day diaries, an individual questionnaire and a one-week work and education time sheet. Before the UKTUS went into the field it was pilot tested in 139 households. The chosen sampling design for the UKTUS was a multi-stage stratified probability sampling design that ensured drawing a representative sample of the target population. The total sample size was 11,860 households. According to Morris et al. (2016), the UKTUS sample is representative of the UK population.

Completed household interviews were conducted with 9,388 eligible individuals in 4,238 households. This resulted in a total of 16,553 diary days. Each respondent had to fill in two diaries, one on a weekday and another one on the weekend, while both days were randomly selected. The 24-hour diary offered 144 timeslots of 10 minutes each to record activities. The average time of interviews was claimed to be 10 minutes for the household and 20 minutes for individual interviews, while the interview was also used to fill in missing information in the diary by asking the respondent to try and remember what they had done. Respondents were assured by NatCen that provided information is treated confidentially.

According to Morris et al. (2016), the responses of the questionnaires and diaries were later coded by specially trained personnel based on coding rules, queries logs, HETUS guidelines and other standard classifications; for example, the Standard Occupational Classification 2010 (SOC2010) published by the ONS (2010a, 2010b, 2010c), which is required for the coding of occupations of household members. The activities listed in the diary were coded using a pre-defined activity list that contained four-digit activity codes, applying a variety of special coding rules for primary and simultaneous activities (Morris et al., 2016). Regular testing and evaluating the entered data ensured accuracy and a high consistency of coded data (Morris et al., 2016).

Access to the UKTUS data was provided by the UK Data service (University of Essex, 2022) for registered scientific users. The UKTUS consists of six separate data files, as outlined in Table 4.1. Depending on the data file, a single case can have a different meaning and may represent a single person, a household, a diary day or a particular timeslot within a UKTUS diary.

Table 4.1: Overview of UKTUS data files

Data file name	Number of variables	Number of cases
uktus15_diary_ep_long	50	587,632
uktus15_diary_wide	2,335	16,533
uktus15_individual	603	11,421
uktus15_household	355	4,733
uktus15_dv_time_vars	367	16,533
uktus15_wksched	686	3,523

Source: The author's calculations based on UKTUS data (Sullivan & Gershuny, 2021)

The data files are explained in great detail in the UKTUS technical reports from the CTUR (2016) and Morris et al. (2016), and the detailed data catalogue provided by the University of Essex (2022). The data catalogue explains the variables of each of the six data files. All data files can be merged by creating unique identifiers, as described in the above-mentioned technical reports.

The first two files, the uktus15_diary_ep_long and the uktus15_diary_wide, both contain the same information and are easily transposable into the other file (CTUR, 2016). While in the file uktus15_diary_wide each case represents one day, covering 1440 minutes in 144 timeslots of 10 minutes, in the uktus15_diary_ep_long file each case represents an episode of a person-day (CTUR, 2016). As explained in the literature review, episodes consist of one or more timeslots and last as long as the set of the performed activities does not change. This shape of the file allows for investigating the time spent on activities by episode and for having an additional variable *eptime* that accounts for the time duration of each episode. For this reason, the uktus15_diary_wide file has more variables, while the uktus15_diary_wide has more cases.

For TUS research the uktus15_diary_ep_long is the preferred file because it groups all activities in four variables *whatdoing* and *WhatOth1*, *WhatOth2* and *WhatOth3*, representing the primary and up to three additional simultaneous activities performed during one episode (CTUR, 2016). This avoids having 144 variables per diary, which would significantly increase complexity when analysing the data.

The third data file uktus15_individual provides information gathered during the individual interviews and the fourth data file uktus15_household contains data collected during the household interviews. Neither supplies data on time duration

but contain, for example, demographic data on households and individuals (CTUR, 2016).
The remaining two data files are of no specific interest to this research because the file uktus15_dv_time_vars contains derived primary time use variables and uktus15_wksched includes data on paid working time (CTUR, 2016).
For this research, the focus is given to the three files uktus15_diary_ep_long, uktus15_individual and uktus15_household. Following the methodology report by CTUR (2016), those three data files are merged to allow all relevant variables to appear in one file. Further work on that merged file is explained in the data cleaning section below.

4.5.1.3 UKTUS Activity Codes used in this Study

The UKTUS used a total of 274 different four-digit activity codes for the coding of the variety of activities written down by respondents in the TUS diaries (Morris et al., 2016). Those 274 codes are grouped into 10 one-digit codes and 33 two-digit codes on the basis of the 2008 HETUS activity codes (Eurostat, 2009), the previous version of the current 2018 HETUS guidelines (Eurostat, 2019), as outlined by CTUR (2016) and Morris et al. (2016). Table 4.2 lists the 10 one-digit codes, a list of selected codes can be found in Appendix A, while the complete list of all 274 UKTUS activity codes is available in the CTUR (2016) report.

Table 4.2: UKTUS one-digit activity codes

One-digit code	**Description**
0	Personal care
1	Employment
2	Study
3	**Household and family care**
4	Volunteer work and meeting
5	Social life and entertainment
6	Sports and outdoor activities
7	Hobbies, games and computing
8	Mass media
9	Travel and unspecified time use

Source: CTUR (2016)

In line with the aim of this research and the research questions, this research focuses on unpaid household work activities. The relevant one-digit activity code covering those activities is 3, ‘household and family care’, as shown in Table 4.2. The one-digit-activity code 3 includes more than 60 different 4-digit-activity groups, as outlined by CTUR (2016), but only 31 of those codes were selected for this research. Those 31 activities are summarised in Table 4.3.

Table 4.3: UKTUS activity codes used in this research

Activity code	Lable of code
3	**HOUSEHOLD AND FAMILY CARE**
3000	Unspecified household and family care
31	**FOOD MANAGEMENT**
3100	Unspecified food management
3110	Food preparation and baking
3130	Dish washing
3140	Preserving
3190	Other specified food management
32	**HOUSEHOLD UPKEEP**
3200	Unspecified household upkeep
3210	Cleaning dwelling
3220	Cleaning yard
3230	Heating and water
3240	Arranging household goods and materials
3250	Disposal of waste
3290	Other or unspecified household upkeep
33	**MAKING AND CARE FOR TEXTILES**
3300	Unspecified making and care for textiles
3310	Laundry
3320	Ironing
3330	Handicraft and producing textiles
3390	Other specified making and care for textiles
34	**GARDENING AND PET CARE**
3410	Gardening
3420	Tending domestic animals
3430	Caring for pets
3440	Walking the dog
3490	Other specified gardening and pet care
35	**CONSTRUCTION AND REPAIRS**
3500	Unspecified construction and repairs
3510	House construction and renovation
3520	Repairs of dwelling
3530	Making repairing and maintaining equipment
3531	Woodcraft metalcraft sculpture and pottery
3539	Other specified making repairing and maintaining equipment
3540	Vehicle maintenance
3590	Other specified construction and repairs

Source: CTUR (2016)

Excluded from this research are the remaining 29 four-digit codes between 3600

and 3929. They cover the two-digit code 36 'shopping and related services' and the code 37 'household management', which includes online shopping as well as administrative work in the household, such as paying bills and banking. Code 38 covers different activities around 'childcare of own household members', such as child feeding, teaching, reading to or playing with the child, and accompanying children. The code 39 'help to an adult household member' mainly includes caring activities for the elderly such as accompanying adult household members to a doctor's appointment or caring for them, mainly due to sickness, injury or illness.
Also excluded from this study were activities covered by the one-digit-code 4 'volunteer work and meeting', which also concerns code 42 'informal help to other households'.
The decision to exclude these activities was based on the fact that the amount of data for including all those activities would exceed the limited resources of this study.

It further needs to be noted that the code 3000 'unspecified household and family care' in Table 4.3, although the name suggests otherwise, does not include caring activities for children or the elderly. By definition, code 3000 covers general household activities that were not further specified by respondents; for example, 'doing housework' or 'working outdoors' (Morris et al., 2016). Therefore, it was possible to include code 3000 in this research despite the exclusion of the above-mentioned 29 codes.

4.5.2 Quality of the UK Time Use Survey Data

In research studies, it is important that the data feeding into the data analysis achieves the highest quality standard possible to ensure accurate results as an outcome of the study.

4.5.2.1 Quality of Official Statistics and UK Data Service

According to Hox and Boeije (2005), official statistics are a great source of data and can be accessed through official data archives such as the UK Data Service (University of Essex, 2022) or the UK Government Web Archive (The National Archives, 2022). The advantage of accessing data through those official archives is that, in addition to the data, the researcher is supplied with detailed background information on the questionnaires and forms used, and methodologies of data collection, processing, coding, sampling, and bias allow a detailed understanding of the data (Hox & Boeije, 2005). This information is necessary to assess the quality of the secondary data (Hox & Boeije, 2005). This view is supported by Saunders et al. (2019), who state that data that are collected through the government or its departments are usually collected primarily for governmental use and therefore meet high quality standards. Based on this statement, and with the UKTUS being a governmental survey, it is assumed that it meets this high quality standard.

Although this already seems sufficient as an argument, the researcher used the methodology papers of CTUR (2016) and Morris et al. (2016), supplied with the UKTUS data, to verify the extent to which quality steps were undertaken prior to the publication of the data files. Furthermore, the methodology papers also provide suggestions and point out weaknesses that a researcher should consider when using the data for his/her own research purposes to maintain that high data quality level. The UKTUS methodology papers also focus on the coding of the data, which is an essential step to achieve a high quality level. For example, Kenyon (2010) mentions that the recording of simultaneous activities may cause issues during the coding process, if the beliefs of the respondent and the intentions of reporting simultaneous activities are different from the coder's view and the pre-defined coding methodology. Overriding responses may also mean overriding the respondent's beliefs, which may then bias the data (Kenyon, 2010). It is therefore necessary that the coding works similarly for all respondents and that each coder has an understanding of how the instructions and examples given to the respondent about filling in the diary may have influenced the reporting (Kenyon, 2010). Therefore, the United Nations (2013) recommend having ongoing quality controls during the entire coding process. The methodology paper by Morris et al. (2016) explains in detail how the coding process worked and how a high quality standard was also maintained during coding.

4.5.2.2 Confidentiality of UKTUS Data

Secondary data is usually made available in an anonymised form to ensure the confidentiality of respondents and their responses (Hox & Boeije, 2005). The UKTUS data is provided in an anonymised form. It is essential for researchers to understand the process of how the data was anonymised to ensure a high quality of the analysis of the manipulated data, particularly in those cases where data has been randomly altered (Hox & Boeije, 2005). The technical report of the UKTUS data by Morris et al. (2016) provides the necessary information to understand the coding and anonymisation steps undertaken by data processors and coders.

4.5.2.3 UKTUS Data Cleaning

Making the data fit this research, a thorough cleaning was necessary to ensure a high quality of the data feeding into the data analysis later on. Following Hox and Boeije (2005), this step also required identifying missing or unusual data entries and deciding how those values needed to be treated. Typical ways to deal with them are imputation or transformation of data based on the researcher's needs (Hox & Boeije, 2005). According to CTUR (2016), some missing data of the UKTUS had to be imputed and this was done based on available information from other household members.

Although the UKTUS data is claimed to have a very high quality level, the researcher did a thorough check of the data in line with the recommendations of the supplied methodology papers from the CTUR (2016), which gives very detailed descriptions about data cleaning options. Based on this, the researcher undertook the following steps to have a final dataset that can be used for further data analysis. The merged UKTUS data file contained 674 variables and 587,632 cases, a total of 396,063,968 values, which required further cleaning and shrinking because of the size. Variables that were of no interest to the researcher were deleted. The focus of this study is on individuals aged 18 years and older to be in line with the primary data introduced below. Therefore, cases from individuals younger than 18 years needed to be deleted, which reduced the number of cases. This reduction required a new balancing of the original weight $dia_w t_b$ that is necessary to balance the UKTUS sample to match the gender and age distribution of the population in the UK and allow having a representative sample of the population (Morris et al., 2016). Therefore, a new weight variable New_wgt was introduced to the UKTUS data. In addition, some manual coding was required to ensure a high quality and no missing data. This concerned a few cases where a third or fourth activity was reported while the second or third one was missing. Then the cleaned UKTUS data was prepared for analysis. Table 4.4 summarises the key variables from the UKTUS data that are later required for the VoL calculation.

Table 4.4: UKTUS data key variables

Variable name	**Description**
eptime	Episode duration in minutes
whatdoing	Primary activity coded
What_Oth1	Other activity 1 coded
What_Oth2	Other activity 2 coded
What_Oth3	Other activity 3 coded
New_wgt	Rebalanced weight after data cleaning
DMSex	Gender from household grid

Source: The author based on UKTUS data (Sullivan & Gershuny, 2021)

4.5.3 The Wage Data from Annual Survey of Hours and Earnings

In addition to UKTUS data, another secondary data source was used for this research. As outlined in Chapters 2 and 3, data on hourly wage rates for different occupations are required.

4.5.3.1 Introduction to ASHE

The ASHE collects data to estimate employees' earnings, hours worked and wage rates in the UK and allows breakdowns of this information by gender, age, full-time work and part-time work, industrial classification, occupational classification and geographical areas (ONS, 2016, 2018a). It further provides the data on an hourly, weekly and annual basis (ONS, 2018a). The ASHE publishes adult gross wage rates before any deductions such as taxes are made (ONS, 2017, 2018a).

Data have been published on an annual basis since 2004, with the reference date in April each year, and the ASHE replaced its predecessor the New Earnings Survey (ONS, 2018a). Compared to the New Earnings Survey, the ASHE has major improvements; for example, a higher coverage, it imputes for non-response and weights results (ONS, 2017). The target population covers all employee jobs in the UK, the sample consists of 180,000 employee jobs and it is based on a 1% sample frame from the UK's *HM Revenue and Customs Pay As You Earn* system (ONS, 2017, 2018a; Scottish Government, 2021). The ASHE data is weighted to the UK population and therefore it is claimed to be representative of the target population, the full UK employee population (ONS, 2018a).

The ASHE target population focuses on employed people, which means that self-employed or armed forces jobs are not covered in the survey data (ONS, 2018a). Due to the fact that the reference date is in April each year, the ASHE cannot pick up seasonal work that is typically not performed in April (ONS, 2018a). It further needs to be mentioned that there are no adjustments made in the ASHE to account for age, qualification or job experience differences (ONS, 2018a).
According to the ONS (2018a), the ASHE is unique and therefore the main and only available data source known to the author containing the information required for this research. The ONS states that ASHE data is suitable for academic research purposes in economics (ONS, 2018a).

4.5.3.2 Access to ASHE Data

The ASHE data can be accessed through the ONS website (ONS, 2021b). The published data is readily accessible and is provided in Excel tables that can be downloaded from the website without any further registration but must be used under the Open Government Licence for public sector information (The National Archives, 2014). It needs to be noted that the publicly accessible data is only available on an aggregated macro-level to be in line with confidentiality regulations and to assure that from published data on the ONS website no individual can be identified (ONS, 2018a). Micro-level data would have been accessible through the UK Data service but access to it is controlled and only provided in secure spaces (ONS, 2021a). This would require the user of the data to be based in the UK to apply for access and this was not possible due to the Covid-19 pandemic situation and the researcher residing outside the UK. Fortunately, this level of detail was not required for this study because the freely published ONS data was identified as being sufficient. This is because the researcher is not interested in individual earning or wage rates, but requires this information on an aggregated level only.

4.5.3.3 ASHE Data Explained

As mentioned above, the ONS publishes two ASHE datasets within each year; one provisional data file, usually in October, and a revised dataset that is published 12 months after the provisional release date (ONS, 2018a). Although revisions are quite small and claimed to be around 0.1 % (ONS, 2018a), the revised data file offers a higher quality. Therefore, revised data was aimed for.

The ASHE data offers a variety of different wage rates, of which the gross hourly wage was identified as the most suitable wage rate to be applied for this research, while all other wages of the ASHE were considered to be irrelevant. The choice of gross hourly wage rates is in line with the wage rate recommendations from Varjonen and Niemi (2000), who recommend using gross wage rates rather than net wages in the VoL. They justified their recommendation by stating that gross wage rates are the typical form of how surveys collect wage data, and it therefore better suits the SNA concepts than other wage rates (Varjonen & Niemi, 2000). Also in favour of using gross wage rates are Blades (2000), Budlender and Brathaug (2010), De Vaus et al. (2003), Poissonnier and Roy (2017), and Varjonen and Aalto (2006).

The ASHE data table provides almost 500 mean and median gross hourly wage rates and allows breakdowns for gender as well as for full-time and part-time workers. Each wage rate is assigned an individual occupation code, based on the previously mentioned SOC2010. The SOC2010 occupational codes are defined on a two-, three- and four-digit level and are assigned to one of the nine one-digit major groups of occupations (ONS, 2010a, 2018a). Table 4.5 lists those nine major groups.

Table 4.5: SOC2010 - Major groups

SOC2010 - Major groups
1 Managers, directors and senior officials
2 Professional occupations
3 Associate professional and technical occupations
4 Administrative and secretarial occupations
5 Skilled trades occupations
6 Caring, leisure and other service occupations
7 Sales and customer service occupations
8 Process, plant and machine operatives
9 Elementary occupations

Source: ONS (2010a)

No blueprint exists for the identification of the relevant SOC2010 codes. The researcher used the SOC2010 manuals provided by ONS (2010a, 2010b, 2010c) and an online coding tool for occupational codes from ONS (2022b) to identify the relevant codes for this research. This tool proved to be very helpful. The process was complicated and was done iteratively by excluding the occupational codes that were of no use. Although this was done under extreme caution, there may be a certain degree of subjectivity involved in the selection. Table 4.6 lists eleven selected SOC2010 codes most suitable for this study.

Table 4.6: Identified key SOC2010 codes

SOC 2010	Description
531	Construction and building trades
541	Textiles and garments trades
543	Food preparation and hospitality trades
613	Animal care and control services
614	Caring personal services
623	Housekeeping and related services
5113	Gardeners and landscape gardeners
5223	Metal working production and maintenance fitters
5231	Vehicle technicians, mechanics and electricians
5449	Other skilled trades n.e.c
6231	Housekeepers and related occupation

Source: ONS (2010a)

Some of the codes in Table 4.6 have 3 digits and are thus broader based, while others are 4-digit codes which are more specific in terms of the occupation. The reason for selecting a mix of 3- and 4-digit codes is twofold. First, for some 4-digit codes the wage data quality was not acceptable, because the sample did not provide a representative wage rate on the 4-digit level. In those cases, the higher order 3-digit code, offering a much better quality, was applied. Second, in some instances, the UKTUS activity code did not allow for establishing a direct link to a single 4-digit level SOC2010 code, because the 4-digit SOC2010 code is too specific. For example, the 3-digit SOC2010 code 531 'construction and building trades' covers seven different types of construction and building trades and includes the codes from 5311 to 5316 and 5319, the latter being a residual code. The code 5312 represents 'bricklayers and masons', code 5314 represents 'plumbers and heating and ventilating engineers' and 5315 includes 'carpenters and joiners'. Each of those 4-digit codes was too specific to match a UKTUS activity code and therefore the more generic 3-digit code 531 was used.

The SOC2010 code 6231 in Table 4.6 represents the housekeeper wage rate, which was introduced in the literature review as the second most useful wage rate, in addition to specialist wages, and which is also required for comparison of VoL results in the results and discussion chapters, but is not required for any of the improvements to the VoL calculation.

4.5.3.4 ASHE Data Quality

Similar to the UKTUS data, the ASHE data is collected and published by a governmental department. In line with the views of Hox and Boeije (2005) and Saunders et al. (2019), the quality of published governmental data is assumed to be high. According to the ONS (2018a), this high quality of the ASHE is based on data collected from a huge sample through the administrative Pay As You Earn system from employers and thus data is less biased by self-reported answers or proxy data compared to other surveys. Pay As You Earn is a system that allows employers to transfer the income tax of employees directly to the government. Similar to the UKTUS, the ASHE data comes with detailed methodology and quality information, allowing secondary data users to judge whether or not the quality of the data meets the researcher's needs.

The ONS provides their published ASHE wage data by supplementing colour codes that highlight four different quality levels of the data and allows users to assess the accuracy of each individual value (ONS, 2018a). Quality levels 1 and 2 mean that the estimates are considered precise or reasonably precise. Level 3 means that they are acceptable, while level 4 stands for unreliable estimates. Depending on the quality level, Table 4.7 describes the ranges, in which the true wage rate value might vary. For example, a reported £10 hourly wage rate with a quality level 2 means that the true rate could be between £8 and £12. Due to ranges of more than 20% for levels 3 and 4, it has been decided to only use quality level 1 and 2 wage rates.

Table 4.7: Quality of ASHE data

Quality level	Range +/-	Definition
1	<=10 %	Estimates are considered precise
2	>10% and <= 20%	Estimates are considered reasonably precise
3	>20 % and <= 40 %	Estimates are considered acceptable
4	> 40 %	Estimates are considered unreliable for practical purposes

Source: ONS (2018a, 2021b)

Nevertheless, ranges of quality levels 1 and 2 are still very large and, therefore, it was essential that the data and wage rates were assessed very thoroughly to justify a suitable data selection for this research study.

The most recent ASHE data was published in October 2021 based on provisional data. The 2020 data was revised along with the publication of the 2021 data but is recommended to be used with care due to affections from the Covid-19 pandemic situation (Athow, 2021; Scottish Government, 2021). This research does not focus on wage data of one particular year. It is more important that the data applied meets a high level of quality, with less bias, few outliers and should be as comprehensive and accurate as possible.

An in-depth analysis of the wage data for the six years from 2015 to 2020 was completed to identify the most reliable data. This analysis was necessary because some wage rates of certain years for the eleven SOC2010 codes listed in Table 4.6 were declared unreliable by the researcher due to the low quality level. The most robust wage data was identified as being the 5-year average data from 2015 to 2019 for men, women and both genders combined.

The ASHE publishes both mean and median wage rates for each SOC2010 code. The 5-year average could be calculated based on either of them. The researcher analysed and compared both the mean and median of the relevant wage rates. Although the ONS (2017) recommended using the median wage rates rather than mean wages, the in-depth analysis showed that, for all years investigated, the median had a lower quality than the mean if the quality criteria described in Table 4.7 were applied. It was therefore decided to use 5-year average data from 2015 to 2019, based on mean rather than median wage rates.

4.5.4 Matching UKTUS Codes to SOC2010 Codes

One critical step in this research is to match the SOC2010 codes identified in Table 4.6 to the corresponding UKTUS activity groups introduced in Table 4.3 above. The literature offers no clear-cut or straightforward way for how this is done best. Therefore, the matching process is also affected by some level of subjectivity because it is the researcher's decision on how this is done to best fit the research study. As a guideline, the researcher used the work from Poissonnier and Roy (2017), who presented in their appendix table a list of TUS activities and a corresponding occupation. Unfortunately, they did not supply SOC2010 or TUS codes in their paper but only the occupation and activity name. They linked 44 TUS activities with a corresponding occupation code, which was then linked to its gross hourly wage rate.

Further guidance was found in the research done by Egerton and Mullan (2008), who applied wage rates to unpaid work but also did not use SOC2010 codes, and work from Budlender and Brathaug (2010), who provided a list of linking activity codes with occupations without specifying the exact classifications used in their study. Linking ATUS activity groups with occupation codes was carried out by Lowen and Sicilian (2015), but their study is also based on a different classification. However, those guidelines were a great support in this matching task.

The researcher found that in most cases the matching process was straightforward because only one legitimate SOC2010 code could be applied to each UKTUS activity code. However, for some codes a mix of two or even more SOC2010 codes was necessary. This matching process was done rather intuitively and based on the researcher's choice and personal beliefs. Therefore, other researchers may have decided differently, because there are multiple views on how this can be done. Nevertheless, the researcher was guided by an approach from Statistics New Zealand (2001), which was applied in a different context but had a similar logic on splitting TUS activities on TUS codes. In addition, the SOC2010 coding tool from the ONS (2022b) was also used to confirm the best matching code for the activities. The appropriateness of the final matching was also discussed with an independent expert on SOC2010 codes to reduce possible errors to a minimum. This is hoped to ensure a high quality of this matching process.

Table 4.8 summarises the outcome of the matching process. Some of the UKTUS activity codes are residual categories and therefore no exact matching SOC2010 code could be identified. In those cases, for example, UKTUS activity code 3490, a mix of the two SOC2010 codes 5113 and 613, was applied. Two other mixed codes for residual activities were used for UKTUS codes 3590 and 3500. Table 4.8 is a central element of the VoL calculation.

Table 4.8: Matching UKTUS activity codes to SOC2010 codes

Activity code	Description	SOC 2010	Description
3000	Unspecified household and family care	614	Caring Personal Services
3100	Unspecified food management	623	Housekeeping and Related Services
3110	Food preparation and baking	543	Food Preparation and Hospitality Trades
3130	Dish washing	623	Housekeeping and Related Services
3140	Preserving	543	Food Preparation and Hospitality Trades
3190	Other specified food management	623	Housekeeping and Related Services
3200	Unspecified household upkeep	623	Housekeeping and Related Services
3210	Cleaning dwelling		
3220	Cleaning yard		
3230	Heating and water		
3240	Arranging household goods and materials		
3250	Disposal of waste		
3290	Other or unspecified household upkeep		
3300	Unspecified making and care for textiles	541	Textiles and Garments Trades
3310	Laundry	623	Housekeeping and Related Services
3320	Ironing		
3330	Handicraft and producing textiles	541	Textiles and Garments Trades
3390	Other specified making and care for textiles		
3410	Gardening	5113	Gardeners and landscape gardeners
3420	Tending domestic animals	613	Animal Care and Control Services
3430	Caring for pets		
3440	Walking the dog		
3490	Other specified gardening and pet care	mix (5113 and 613)	mix of Gardeners and landscape gardeners and Animal Care and Control Services
3500	Unspecified construction and repairs	mix (531, 5223, 5499, 5231)	mix of Construction and Building Trades, Metal working production and maintenance fitters, Vehicle technicians, mechanics and electricians and Other skilled trades n.e.c
3510	House construction and renovation	531	Construction and Building Trades
3520	Repairs of dwelling		
3530	Making repairing and maintaining equipment	5223	Metal working production and maintenance fitters
3531	Woodcraft metalcraft sculpture and pottery	5449	Other skilled trades n.e.c
3539	Other specified making repairing and maintaining equipment	5223	Metal working production and maintenance fitters
3540	Vehicle maintenance	5231	Vehicle technicians, mechanics and electricians
3590	Other specified construction and repairs	mix (531, 5223, 5499, 5231)	mix of Construction and Building Trades, Metal working production and maintenance fitters, Vehicle technicians, mechanics and electricians and Other skilled trades n.e.c

Source: The author's calculations based on ONS (2010a) and Sullivan and Gershuny (2021)

4.6 Primary Data

The secondary data introduced above do not provide all necessary information that is required to answer all the research questions. As outlined in the literature review, data on appropriate splits for simultaneous activities or information on weights to adjust wage rates for quality and productivity differences are not collected in the existing surveys. Also not covered is the data on factors that influence the quality of unpaid work. Therefore, this information needs to be collected by a questionnaire, particularly designed to answer this study's research questions.
Hence, in line with the chosen research design, a survey research strategy that uses a self-administered online questionnaire was applied to collect the primary data.

4.6.1 Questionnaire Design

The questionnaire design is key to collecting the primary data, and it is essential that the design is appropriate to measure what is intended to be measured. It is further important to respect the respondents and their answers provided in the questionnaire.
Designing a strong questionnaire may be achieved by considering the following guidelines based on work from Cooper and Schindler (2014) and Kothari and Garg (2019). The researcher should start with the revision of the research objectives and think about what types of questions may be suitable to ensure that the researcher collects the proper data to help answer the research questions (Cooper & Schindler, 2014). Based on this, a decision on the general form, structure and layout is required (Kothari & Garg, 2019), before developing the questions and including the content and wording (Cooper & Schindler, 2014). Then the drafted questionnaire is ready to be tested. It is suggested by Kothari and Garg (2019) that the draft questionnaire should be checked and revised multiple times to identify problems and remove errors. Even after the pretest or pilot phase, a revision or some re-editing may be required (Kothari & Garg, 2019). Each questionnaire should only be distributed along with clear instructions on what is expected from the respondents (Kothari & Garg, 2019). This long-developing process is necessary to ensure that the questionnaire meets the requirements of validity and reliability (Brace, 2013).
First, the purpose of the questionnaire is outlined.

4.6.1.1 Purpose of Questionnaire

The questionnaire has five parts, which were designed to collect data from respondents regarding unpaid household work.

The first part helped respondents to familiarise themselves with the topic by answering introductory questions.

In the second part, respondents were asked to provide their personal views on experiences with multitasking in general and, more specifically, about the impact of multitasking on selected UKTUS activities which were identified by an in-depth analysis of UKTUS data. In the central element of the multitasking section, respondents were asked to select an appropriate split for the situation of two, three or four simultaneous activities, based on their personal views. This information is essential to answer the research questions 2 and 3. Furthermore, collecting this data on splits for up to four simultaneous activities was completely new to this field of research. To the knowledge of the author, no questionnaire has investigated this detailed information and thus it can be claimed as original. Furthermore, respondents were asked about their personal views on how selected demographic factors, which were identified in Chapter 3, may impact on multitasking.

The third part covers the quality of unpaid household work and asks respondents for their personal experiences and opinions about how they would compare the quality they might achieve when performing unpaid work in seven typical household activity groups to the quality of a professional worker hired from the market. This is a completely new and original way of looking into this field of research. The responses will be used to estimate the necessary quality adjustments for the VoL, as identified in the literature review chapter. This information is a central element to answer research questions 2 and 3.
As highlighted in Chapter 3, data on the quality of unpaid work are not collected in TUSs. Therefore, the United Nations (2013) recommended to develop and implement new questions allowing for the collection of that data, while the design of those questions should be in line with TUS guidelines to easily allow their application in future TUSs. A central problem is the complexity to measure or calculate the quality of unpaid work. One reason is the lack of a unified definition of this particular

term as pointed out by Martin et al. (2020). Another reason is the different perception of quality, based on each individual's own experience and skills (European Commission et al., 2009; Martin et al., 2020; Zhang, 2001). This unique perception of the quality of unpaid work complicates the comparison of responses and may bias the data to a certain degree. Although this is not ideal, it needs to be accepted, because only the respondents themselves can judge their abilities properly, which is common practice in TUS research as outlined by Trübner (2019). Dulaney et al. (1992) faced a similar problem and applied a question that asked respondents to compare, from their personal view, the quality of a produced household output with the quality of a substitute available in the market using a percentage scale. Their question provided useful data and led to good results. Moreover, questions relying on the different perceptions of respondents are already successfully implemented in TUSs, for example, the question regarding the level of enjoyment of activities where each individual might have a different perception of enjoyment (Gershuny, 2013; Morris et al., 2016). Based on this information, the researcher has decided to follow the approach used by Dulaney et al. (1992).
Furthermore, in the third part of the questionnaire, respondents were asked how selected demographic factors may impact on the quality of unpaid work. This part was later used to compare with the results of the regression analysis, which is used to evaluate the impact of selected demographics on quality.

The fourth part of the questionnaire asked respondents how long they would require to complete tasks in seven typical household activity groups, compared to the time duration a market professional would require for the same tasks. This reflects the personal view of respondents in a self-ranking exercise for the same seven typical household unpaid work groups that were used in the quality section of the questionnaire. Using the time as an input factor into production by holding the output constant, the collected time duration is used to estimate productivity adjustments. This is also an original and unique way of looking into the productivity adjustment problem identified in the literature review. Those adjustments are the necessary part to estimate the productivity adjustments for the VoL and will help in answering research questions 2 and 3. In addition, respondents were asked to share their personal views on how selected demographic factors, which were identified in Chapter 3, may impact on the productivity of unpaid work.

The last part of the questionnaire covers demographic questions on the respondents.

The central parts two, three and four of the questionnaire are used to determine the multitasking splits and adjustments for quality and productivity required for the enhancement of the VoL approach. In addition, the demographic questions helped to validate the sample, helped with judging representativeness and were essential to perform gender-based analyses of the responses to answer research questions 2 and 3. Demographics were also applied in the regression analysis and helped to answer research question 4.
The questionnaire also included controlling questions, explained below, that were not directly planned to be used for estimating the VoL results or answering the research questions. They were used to determine whether the responses given made sense and were trustworthy, or whether they were randomly given and thus needed to be declared inconsistent. Those questions helped to exclude inappropriate answers and thus helped in increasing the quality of the questionnaire results.

4.6.1.2 Planning the Questionnaire

The initial idea was to distribute an online survey by email to a known group of experts from NSOs across the world. Unfortunately, this could not be done for two reasons. First, the collected data would represent opinions from various countries and therefore, it would have been difficult to justify applying those responses to the TUS data of just one country. Second, official queries to employees of NSOs would garner replies by stating the views of the organisation, rather than the personal views of the respondents. Moreover, official answers from NSOs need to be backed up by data that are collected by those NSOs. As identified in the literature review chapter, that data had not been collected by NSOs, otherwise a primary data collection would have been unnecessary. Thus, the chance of receiving valuable responses from NSOs was assumed to be low. Discussions with different employees of NSOs supported this view. Therefore, this option was discarded at a very early stage of this research.

The second idea was to hand out the questionnaire to randomly selected people in person, either on the street or in central places in various urban and rural areas of the UK over a few weeks in time. Due to travelling and meeting restrictions of the Covid-19 pandemic and an unforeseeable future on how those restrictions would be handled, this option had to be discarded in early 2021.

The researcher therefore decided to conduct a self-administered online survey. The distribution was done at a single point in time, aiming for cross-sectional data to be in line with the time horizon outlined in the research design section above. Kothari and Garg (2019) highlighted that it is important for the questionnaire to be simple to understand, be constructed with the minimum number of questions and that those questions should be designed in a logical order with an increasing difficulty. Furthermore, a professional appearance should be aimed for. In line with the recommendation from Kothari and Garg (2019), the questionnaire was accompanied by a short instruction on what was expected from the respondents as well as an outline of the research project to give respondents an understanding of how valuable and important their contribution was for this project, future research and policy makers.

4.6.1.3 Advantages and Disadvantages of Questionnaires

According to Kumar (2019), the main two advantages of using a questionnaire are the high rate of respondents' anonymity and its low costs compared to other methods. Lower costs not only touch the financial side but also include savings of time and manpower. Another advantage is that respondents can fill in the online questionnaires at a time convenient to them (Brace, 2013). The main disadvantages are typically a lower response rate compared to other methods (Kumar, 2019) and the missing contact between the respondents and the researcher or interviewer, which does not allow further clarifications of questions, if necessary (Brace, 2013; Kumar, 2019). To minimise the second disadvantage, the wording of the questions needs to be easy and understandable (Brace, 2013). Nevertheless, Brace (2013) claimed that there is no noticeable difference in terms of the strength of a self-completed questionnaire that is conducted online versus one that is paper-based.

4.6.1.4 Types of Questions

The central element of the questionnaire is its questions, and the choice of those questions is a key point in the development and design of a questionnaire. The literature offers a wide range of different types of questions, with each type following different purposes. The key types of questions are outlined below, starting with the difference between open-ended and closed questions.

4.6.1.4.1 Open-ended Questions

Open-ended questions do not provide a list of choices but require the participant to formulate a response to a question (Mitchell & Jolley, 2010; Sekaran & Bougie, 2010). This allows the respondent to share thoughts on a very deep level but also assumes that the respondent is able to express his thoughts in a proper answer (Kumar, 2019). Usually, the respondent can choose the wording, complexity and the length of the response, and that may differ between all respondents. Therefore, open-ended questions are complicated to analyse (Kumar, 2019). Kothari and Garg (2019) recommended that open-ended questions should be avoided in questionnaires, because they are harder to analyse than closed questions because the researcher has less control over the answers.

4.6.1.4.2 Closed Questions

Closed questions typically are pre-coded and thus limit respondents to selecting one or more answers from a pre-defined list of choices (Brace, 2013; Cooper & Schindler, 2014; Sekaran & Bougie, 2010). Questions that only allow two choices are called dichotomous questions (Brace, 2013). When pre-coding responses, it is important to formulate them as mutually exclusive and use a wording that is precise, meaningful and exhaustive (Brace, 2013). On one hand, the main advantages of closed questions are that responses are standardised and thus less difficult to analyse compared to open-ended questions (Bryman, 2008; Kumar, 2019). The wording of the questions, but in particular the answer choices listed in the questionnaire, can be designed based on the needs of the researcher to ensure that the researcher gets the required information (Kumar, 2019). This justifies the researcher's decision of using closed questions in the questionnaire. On the other hand, the disadvantages are that responses do not provide deep-level information, that pre-coded answers may lead to respondents ticking a box without thinking mentality, and that it may force respondents to choose an answer that does not reflect their honest opinion because of the limited number of choices (Kumar, 2019). Providing the response choices may also increase the investigator bias because the researcher only lists the responses he or she has thought of, which may not necessarily cover all possible options (Kumar, 2019).

4.6.1.4.3 Likert Scale Questions

Likert scales are one of the most common rating scales used in social research (Porst, 2009). They allow the respondent to respond to a question or statement by selecting one of the pre-defined points on a scale that best reflects the attitude of the respondent (Cooper & Schindler, 2014; Robson, 1993). A typical scale ranges between five to nine steps, while Kallus (2010) states the ideal amount is seven. The more options a respondent is given, the higher the complexity to answer appropriately in case respondents cannot clearly distinguish between two neighbouring graduations (Kallus, 2010).

Mitchell and Jolley (2010) see Likert scale questions as an extremely useful type of question in a questionnaire, and Brace (2013) states that Likert scale questions are great to be used in self-completed questionnaires. The fact that respondents are forced into giving an answer that may not even reflect their true opinion was seen as a disadvantage by Mitchell and Jolley (2010), but they mentioned that the option of having a *do not know* choice might help to overcome this issue. Brace (2013) reminds the researcher to think about the following two points when including Likert scale questions. Firstly, the direction from negative to positive or vice versa may impact on the responses, and secondly, there may be a tendency to either pick the central answer choice or answer in patterns.

4.6.1.4.4 Graphic scales

A different type of scale are graphic scales, which are "presented to the respondents visually so that they can select a position on it that best represents their desired response" (Brace, 2013, p. 69). One form of graphic scales is slider scales that allow the respondent to select one specific point of scale (Brace, 2013). The sliders can have two end-points but also may be constructed with a mid-point and it is up to the researcher to decide whether the responses are coded to intervals or used as given (Brace, 2013).

4.6.1.4.5 Dropdown, Control and Intimidating Questions

Dropdown questions are referred to by Brace (2013) as a very useful type because they collect a lot of information using only little space, which contrarily can lead to a serious problem if too many of them are used on one page. Kothari and Garg (2019) recommend including control questions that allow the researcher to assess the reliability of the responses given, and help with the justification if they make sense or were randomly selected. They further recommend excluding any sort of intimidating questions.

4.6.1.4.6 Do Not Know and Prefer Not to Say

Kothari and Garg (2019) recommend including choices for uncertainty by offering respondents the option to select *do not know* or *prefer not to say* as an answer choice, if applicable. However, those responses need to be treated with care (Brace, 2013). For some questions, for example sensitive questions on ethnicity, health or political orientation, it is essential to include a *do not know* or *prefer not to say* option because otherwise the risk of not responding at all to the question may increase significantly (Brace, 2013). The single *do not know* response can also be used as an indicator of questions that are not properly worded or not understood by respondents (Brace, 2013). While Kothari and Garg (2019) are in favour of using those responses regularly, a different view is given by Brace (2013), who claims that too many questions with a *do not know* option may lead respondents to just select this option as the easiest choice, which in consequence may increase the bias of responses.

4.6.1.4.7 Order of Questions and Layout

The question sequence is important to maintain the golden thread, and it is recommended to start with opening questions, followed by the essential questions to research while complex questions should be put at the end of the questionnaire (Kothari & Garg, 2019). In case the latter are not answered, the researcher has already collected a lot of data beforehand that may be useful (Kothari & Garg, 2019). Brace (2013) recommends beginning with general questions to allow a comfortable start into the topic and Mitchell and Jolley (2010) suggests putting demographic questions at the end of the questionnaire because they are often not directly related to the topic and may distract the respondent from the research purpose.
According to Kumar (2019), questions could be ordered either randomly or logically, using the research objectives as a guideline. The choice needs to be made by the researcher, but it is important to know that the chosen order of questions may cause a *question order bias* if a respondent's answer is affected by the previous question

and may have changed if the previous question had been asked later (Brace, 2013). According to Brace (2013), the layout and design of an online questionnaire must be chosen in such a way that it can be read, understood and answered easily by respondents using typical online devices; in other words, keeping it as easy as possible for the respondent.

4.6.1.4.8 The Wording of the Questions

Brace (2013) highlights that a questionnaire must not contain any type of errors. When designing an online questionnaire, the researcher needs to keep in mind that the respondent cannot ask for clarification if a question is not understood in terms of the wording. Therefore, the wording of questions must be chosen appropriately, and it needs to be as precise as possible (Kothari & Garg, 2019). The wording of the questions should also be as simple as possible and it is recommended to use everyday and not technical language (Kothari & Garg, 2019; Kumar, 2019).

4.6.1.4.9 Code Book

During the development process of the questionnaire, the researcher needs to define how to code responses to numeric data. For this purpose, Kumar (2019) and Cooper and Schindler (2014) recommend developing a code book for the coding of responses. Although some online questionnaire services offer automatic or pre-defined coding of collected data, the step of developing a code book still is seen as a requirement to ensure that coding is done as intended by the researcher.

4.6.2 Sampling

Sampling is defined as “the process of selecting items from the population so that the sample characteristics can be generalised to the population. Sampling involves both design choice and sample size decisions” (Sekaran & Bougie, 2010, p. 445). There are many reasons for using a sample rather than the total population, in particular for larger populations. Those are, for example, that data can be collected much faster and with reduced costs (Cooper & Schindler, 2014).
According to Sekaran and Bougie (2010) and Kothari and Garg (2019), it is important to identify the target population, the sample frame, the design of sampling applied and the sample size.

The population, or as Cooper and Schindler (2014) refer to it, the target population, is the group of individuals or elements that the researcher aims to investigate (Sekaran & Bougie, 2010) and aims to make inferences on (Scheaffer et al., 2012). In many cases, this group is too large to investigate each individual of it; only a subset (Sekaran & Bougie, 2010) or sample can be investigated (Punch, 2005). The aim is to select the sample in such a way that it represents the population (Cooper & Schindler, 2014) and allows for drawing conclusions from that sample to the population (Punch, 2005). The better the sample matches the characteristics of the population, the higher its representativeness is (Sekaran & Bougie, 2010).

4.6.2.1 Target Population

The target population for the collection of primary data was defined as individuals aged 18 years and older, living in private households in England, Wales, Scotland and Northern Ireland. Apart from the difference of the age groups, this is in line with secondary UKTUS data. Other than the primary data, the UKTUS data also covers people aged between 8 years and 17 years. This group has been excluded from the target population in primary data for three reasons. First, an ethical approval may have been required to collect primary data from children. Second, adults only were allowed to register with the online panel service used in this research. Third, ASHE data is also not available for that age group. Individuals younger than 18 years therefore were also excluded from the UKTUS, as explained in the secondary data section above, to keep all data consistent.

4.6.2.2 Sampling Frame

The sampling frame is a list of those individuals from the target population that have a chance of being selected for the sample (Cooper & Schindler, 2014; Kumar, 2019; Scheaffer et al., 2012). It should be aimed for that the sample frame is highly representative of the population (Kothari & Garg, 2019).
The sampling frame in this research includes individuals aged 18 years and over, living in the UK and registered with the SurveyMonkey online panel that allows participation in its questionnaires.

4.6.2.3 Sampling Technique

The literature offers many different sampling methods that can all be grouped to one of the two main types of sampling techniques: probability and non-probability sampling (Kothari & Garg, 2019; Kumar, 2019; Mitchell & Jolley, 2010; Punch, 2005).

4.6.2.3.1 Probability Sampling

Probability sampling, also referred to as chance, random or representative sampling, is a sampling design where individuals (or items) are selected randomly and have a known, non-zero probability of selection for the sample (Cooper & Schindler, 2014; Kothari & Garg, 2019; Punch, 2005; Sekaran & Bougie, 2010). According to Kumar (2019), the probability sampling design covers, for example, cluster sampling, simple and stratified random sampling. In cluster sampling, for example, the population is split into multiple clusters and a sample is drawn from each of those clusters (Cooper & Schindler, 2014). The advantage of probability sampling is that the selected sample is considered to be representative of the population (Cooper & Schindler, 2014; Kothari & Garg, 2019; Kumar, 2019). This can be used to infer from a sample to the target population (Cooper & Schindler, 2014). It is suggested that probability sampling can increase the external validity but typically reduces the internal validity of the research (Mitchell & Jolley, 2010).

4.6.2.3.2 Non-probability Sampling

Non-probability sampling is a design where the chance or probability of individuals (or items) being selected for the sample is uncertain or simply unknown (Cooper & Schindler, 2014; Sekaran & Bougie, 2010). Therefore, Cooper and Schindler (2014) stated that the selection process is “subjective” and “arbitrary” (p. 661). Non-probability sampling is usually associated with a higher bias than probability sampling but bias can be reduced if the sample is drawn accurately (Kothari & Garg, 2019). A non-probability design is often used by individual researchers or smaller studies where it is usually not feasible to generate proper probability samples (Kothari & Garg, 2019). The reason for this can either be fewer resources or limited access to crucial information that allows a probability sample. The main advantages of non-probability sampling are its low costs and speed (Kothari & Garg, 2019), while the disadvantage is that the sample usually is not representative of the population (Cooper & Schindler, 2014).

Common designs for non-probability sampling are convenience, purposive, quota and snowball sampling (Robson, 1993), which are shortly explained.

4.6.2.3.2.1 Convenience Sampling

Convenience sampling is a sampling technique that allows researchers to select those individuals from the population that are most convenient in terms of getting access to them, and form a sample based on this selection process (Cooper & Schindler, 2014; Sekaran & Bougie, 2010). The main advantages are that this technique is easy and cheap to apply (Cooper & Schindler, 2014). The downsides are its low reliability (Cooper & Schindler, 2014) and that the sample usually is not representative and does not allow generalisations (Mitchell & Jolley, 2010).

4.6.2.3.2.2 Purposive Sampling

Purposive sampling, also termed judgment sampling (Cooper & Schindler, 2014; Kumar, 2019), is a sampling technique that allows researchers to draw a sample based on their own judgement, experience or rational choice on who is appropriate to be part of the sample (Cooper & Schindler, 2014; Punch, 2005; Sekaran & Bougie, 2010). The researcher aims to find the most suitable individuals that provide the necessary information to find answers to the research questions (Kumar, 2019).

4.6.2.3.2.3 Quota Sampling

Quota sampling is a form of purposive sampling (Cooper & Schindler, 2014; Sekaran & Bougie, 2010) that draws the sample from groups that are identified based on predefined characteristics or quota that match the same quota in the population (Cooper & Schindler, 2014; Sekaran & Bougie, 2010). Typical characteristics used are, for example, gender (Kumar, 2019), age groups, ethnic groups or minorities (Mitchell & Jolley, 2010). In terms of the representativeness of the sample, quota sampling is superior to convenience sampling (Mitchell & Jolley, 2010).

4.6.2.3.2.4 Snowball Sampling

Snowball sampling is using networks to find respondents and is typical in qualitative research (Cooper & Schindler, 2014). The researcher selects a group of individuals as a starting point for the sample and then asks those individuals to identify further individuals who may become a part of the sample (Cooper & Schindler, 2014; Kumar, 2019). This step is done multiple times until the required sample size is reached or no further individuals are available (Kumar, 2019). Saunders et al. (2019) refer to snowball sampling as volunteer sampling because respondents freely choose to take part in a survey or fill in a questionnaire and, different from other sampling techniques, they were not chosen to take part (Saunders et al., 2019). Snowball sampling is often used when respondents are hard to find or not accessible (Cooper & Schindler, 2014).

4.6.2.3.3 Researcher's Choice of Sampling

Based on using a UK online panel, accessible through the online survey provider SurveyMonkey, this research applies a non-probability, purposive sampling method. Although the online panel has a very large size, there is not the same chance for all members of the population of being selected, because only registered individuals with the panel have a chance of selection. The sample was balanced for gender and age groups to avoid certain groups being overrepresented.

4.6.2.4 Sample Size

The sample size determines how large the sample is (Kothari & Garg, 2019; Kumar, 2019; Sekaran & Bougie, 2010). Depending on the size of the population, the minimum sample required can be calculated depending on the accepted sampling error of, for example, 5% or 1%, to ensure a confidence interval of 95% or 99% (Mitchell & Jolley, 2010). The lower the accepted sampling error, the larger the minimum sample (Scheaffer et al., 2012). For example, the minimum sample size for a population of 50,000 at the 95% confidence interval is 381 individuals, while 8,195 would be required at the 99% confidence level, according to Mitchell and Jolley (2010).
The exact size of the population in this study is not known. Based on Smith (2013) and Zikmund et al. (2010), the minimum sample size for large, unknown populations can be estimated by using the following equation:

$$\text{sample size} = \frac{z^2\,(p)\,(1-p)}{c^2} \tag{4.1}$$

where:

> z is the z-score of a confidence level (for example 1.96 for a 95% confidence interval)

p is the response distribution or population proportion, if unknown 0.5 is recommended

c is the confidence interval (for example 95%)

Applying the recommended values for the z-score of 1.96, a population proportion of 50% and a confidence interval of 95%, the sample size is:

$$\text{sample size} = \frac{1.96^2\,(0.5)\,(1-0.5)}{0.05^2} = 384.16 \tag{4.2}$$

A sample of 385 responses is required to achieve a confidence level of 95% and this is what this study aims for.

4.6.2.5 Errors and Biases

The researcher needs to be aware of the following four key errors and biases in terms of the sampling process (sampling and non-sampling errors) and responses provided by respondents (response and non-response bias).

Sampling errors occur because only a proportion and not the entire population is investigated, while non-sampling errors occur during the collection of data and its preparation (Bryman, 2008). It is aimed to keep both errors to a minimum. Kothari and Garg (2019) claim that a proper defined sample design may help to decrease non-sampling errors.

Response bias is caused by the respondent providing incorrect answers, for example, in questionnaires (Brace, 2013; Cooper & Schindler, 2014). There are many explanations why respondents provide wrong answers, and sometimes they are provided on purpose. A typical example is called social desirability bias. It occurs when respondents provide a wrong answer just to be in line with socially acceptable rules or cultural norms (Sekaran & Bougie, 2010), or to impress the interviewer or researcher (Brace, 2013). A typical example was given by Córdova Cazar (2016). Respondents were asked to state their level of enjoyment on a scale from 1 to 10 during childcare or cooking activities, and provided socially accepted answers rather than reporting their actual feelings (Córdova Cazar, 2016). The researcher is urged to minimise the response bias and needs to be aware of its impact on data accuracy (Brace, 2013). Social desirability bias can be massively reduced if the questionnaire is self-administered rather than done by an interviewer, and because online surveys usually offer a high level of anonymity, bias is considered to be even lower (Brace, 2013).

The non-response bias typically appears in surveys and happens due to respondents refusing to take part in the survey although they are part of the sample (Cooper & Schindler, 2014; Mitchell & Jolley, 2010). A high non-response rate can be problematic as it may lead to a reduced external validity of a survey (Mitchell & Jolley, 2010).

4.6.2.6 Questionnaire Distribution

According to Kumar (2019), questionnaires can be administered online, individually in public, or collectively to a larger group at the same time, for example at a conference. This research used a self-administered online questionnaire, as outlined in previous sections. While during a collective or public distribution the researcher is typically present during the survey and thus can explain the purpose of the research and provide instructions, this is different with online questionnaires. Therefore, a cover letter that explains the details and purpose of the questionnaire, as well as providing instructions or guidelines on how to fill in the survey, is essential for self-completed questionnaires (Brace, 2013).

While in the past two decades sending out questionnaires through emails got more and more popular, within the past few years digitalisation opened the door for new solutions, such as the growing interest in companies that pay respondents to fill in questionnaires (Kothari & Garg, 2019).
In particular, during the Covid-19 pandemic situations with lockdowns, travel restrictions, distancing rules and closed borders for months, digital data collection became necessary and convenient, or in some instances remained the only option to collect larger amounts of data. As mentioned above, the original research plan of interviewing people in different places around the UK to fill in the questionnaire was neither possible nor legally allowed for longer periods of time during the Covid-19 pandemic. Apart from the fact that planning was not possible, constant but rapid changes to rules and legislation made any planning of travelling, within and between countries, and being present for face-to-face talks almost impossible. It was there-

fore necessary to investigate other options, and search for acceptable alternatives. After a thorough investigation of problems, advantages and disadvantages concerning the quality of data, results, questionnaire design options, confidentiality, data security and data protection of various online questionnaire tools, a list of suitable options was evaluated. A comparison of the different online tools identified the online service provider SurveyMonkey (Momentive Inc., 2022) and its UK panel as the most suitable tool to administer the questionnaire. A panel can be used for both qualitative and quantitative research and its members already "have indicated a willingness to participate in research studies" (Cooper & Schindler, 2014, p. 662). SurveyMonkey offered the researcher the opportunity to design custom target groups from its UK panel, allowing for matching the target population required for a study. SurveyMonkey also highlighted on its web page (Momentive Inc., 2022) that it maintained a high data quality by regularly assessing and calibrating the panel by also assuring there were no fraudulent or duplicate respondents. It further claimed to monitor respondents' metadata to identify and exclude those respondents who rush through the questionnaires. SurveyMonkey ensures that panellists must meet certain response quality levels to remain in the panel (Momentive Inc., 2022). Nevertheless, the panel only includes respondents that voluntarily registered with SurveyMonkey, which was acknowledged as a downside. Furthermore, the researcher had no control over who filled in the questionnaire, because the distribution was done anonymously and no direct contact was made between the researcher and the respondents. However, it was hoped to achieve results that were more robust than administering the questionnaire elsewhere.

The questionnaire used in this research study consisted of 32 closed, scale and dropdown questions. The majority of the questions had to be specifically designed for this study, which offered new ways of collecting data, particularly on multitasking, quality and productivity, that had not been collected in any previous studies. Therefore, those questions needed to be designed from scratch to make them fit the research objectives, allowing for properly answering the research questions. In those instances that guidance was available in the literature, questions were adapted from earlier studies and were modified for this questionnaire. Furthermore, the questionnaire was designed in line with SurveyMonkey design guidelines to achieve a high response rate.
The following Table 4.9 provides an overview of the questions used in the question-

naire and presents their reason for inclusion and, the sources in literature or what inspired the researcher to develop those questions.

Table 4.9: List of questions

No	Question	Source from literature or reason for inclusion
1	Did you do any of the following activities in your own household without getting paid for within the past six months? Please tick all that apply.	This introductory question is a typical question asked in the individual questionnaire of TUSs, most typically as a part of the stylised questionnaire. It is based on suggestions from the United Nations (2005, 2013).
2	Do you see yourself as a specialist in one of the following activities because you either currently have or previously had a paid job in that area? Please tick all that apply.	This question is a further development of the previous question. It was developed by the author to introduce the respondent to the topic and to use it later for consistency and plausibility checks.
3	Multitasking means that you do multiple activities simultaneously within the same time period. Do you prefer to multitask or rather complete tasks one after the other?	This question was developed by the researcher based on the work from Floro and Miles (2003) who suggested that men are rather monochronic and women are rather polychronic in their nature.
4	How likely do you think multitasking is caused by time pressure?	This question was developed by the author. The idea is based on work from Floro and Miles (2003) and Zaiceva and Zimmermann (2011).
5	This question looks at how multitasking impacts on time duration of activities. Please look at the list of activities given below and think about the following situation. The listed activities are done together with a typical household chore activity. How likely do you think the listed activity will extend the time required to finish the household chore activity?	This question was developed by the researcher based on prior work from Buser and Peter (2012). The question serves the purpose of determining whether or not multitasking, compared to doing activities one after the other, may negatively impact on a respondent's performance. Further suggestions from Rieger (2012) and Spink et al. (2008) were also taken into account.
6	Think about a situation where two different activities of your choice are done simultaneously within a time period of 12 minutes. How would you split the 12 minutes on those two activities?	The three questions 6 to 8 are the key questions on multitasking in the questionnaire and had to be developed from scratch by the researcher. The necessity of splits is supported by Budlender and Brathaug (2010), De Vaus et al. (2003), Drago (2011), Holloway et al. (2002), Robinson (1969), Stinson (1999), Williams and Donath (1994), and Zaiceva and Zimmermann (2011). Stinson (1999) suggests that respondents could be asked to report appropriate splits. However, this has not been done to maintain a low level of respondent burden. United Nations (2013) encourage researchers to develop new questions that might be added to future TUSs.
7	Think about a situation where three different activities of your choice are done simultaneously within a time period of 12 minutes. How would you split the 12 minutes on those three activities?	
8	Think about a situation where four different activities of your choice are done simultaneously within a time period of 12 minutes. How would you split the 12 minutes on those four activities?	
9	How likely do you think the following factors have an impact on multitasking?	This new developed question is based on selected demographics from Craig (2007), Destatis (2015), Drago (2011), Endrayana Dharmowijoyo et al. (2021), Floro and Miles (2003), Kalenkoski and Foster (2008), Kenyon (2010), and Zaiceva and Zimmermann (2011).

10 - 16	For the following set of questions, try to compare yourself with a paid market professional for each unpaid household activity A) to G) listed below. Consider the professional worker achieves a quality level of 100 % for the completed tasks. If you would do the same work try to estimate the level of quality you would be able to achieve? Please select the quality using the sliders below for each of the seven activities listed. Note that sliding to the left means you achieve a lower quality than the expert, sliding to the right means you achieve a higher quality. A) Food preparation including cooking and baking B) Cleaning and waste disposal C) Laundry and ironing D) Gardening E) Pet and animal care including dog walking F) House renovation, construction, repair, maintenance G) Vehicle maintenance	This question was developed from scratch. However, the idea of asking respondents regarding quality is based on work from Dulaney et al. (1992) and Fitzgerald and Wicks (1990).
17	How likely do you think ... ... you tend to overestimate your skills when you are asked to compare yourself with a paid market professional? ... the quality of your work would improve in case you would receive a payment for the tasks you normally perform without pay? ... you work as productive in unpaid work activities as you would if you would get paid for it? ... doing two or more activities at the same time reduces the quality of your work? ... doing two or more activities at the same time reduces your productivity?	This transitional question was developed from scratch to allow a purposive split between the two blocks of questions about quality and productivity. It was predominantly developed for quality assurance and to allow plausibility checks of responses and answers. Ideas for this question were drawn from Dulaney et al. (1992), Poissonnier and Roy (2017), and United Nations (2017).
18 - 24	For the following set of questions, try to compare yourself with a paid market professional for each unpaid household activity A) to G) listed below. Consider the professional worker performs one typical task in each of the activity groups listed below and requires 60 minutes to complete each task. If you would do the same work try to estimate how many minutes you would require to complete the same task as the paid market professional? Please select the time using the sliders below for each of the seven activities listed. Note that sliding to the left means you need fewer minutes than the expert to complete the task (you work faster). Sliding to the right means you need more minutes than the expert (you work slower). A) Food preparation including cooking and baking B) Cleaning and waste disposal C) Laundry and ironing D) Gardening E) Pet and animal care including dog walking F) House renovation, construction, repair, maintenance G) Vehicle maintenance	This question needed to be developed by the researcher because the literature did not offer a guideline that the researcher could have used because this type of question has not been asked in previous studies. However, it follows the recommendation of United Nations (2013) by designing new questions to shed light on less explored areas.
25	How likely do you think the following factors impact on the quality of work and the time required to complete a task?	This is a new developed question based on selected demographics that were used in the above multitasking question number 9.
26	What is your age?	This is a typical demographic question in a TUS. The grouping of various age groups is based on the guidelines for harmonised TUSs by United Nations (2013, p. 94) as well as suggestions from Eurostat (2019), Gimenez-Nadal and Sevilla (2012), Morris et al. (2016), and UN Women (2021). The development also followed the recommendations of Brace (2013).

27	How many people of the following age groups live in your household including yourself?	This is a common question in TUSs to collect that type of demographic data, typically as part of the household questionnaire. The question is based on the work of Eurostat (2019), Morris et al. (2016), and UN Women (2021) and follows the recommendations on questionnaire development from Brace (2013).
28	What is your employment status?	This question is standard in TUSs and follows Morris et al. (2016) as well as Brace (2013).
29	What was your gender at birth?	Question 29 is a typical demographic question in a TUS. It is a requirement to allow any gender based analysis and hence it is a central question required for this thesis. It is based on Eurostat (2019), Morris et al. (2016), and UN Women (2021) and Brace (2013).
30	What is your marital status?	Similar to employment, this question is standard in TUSs and follows Morris et al. (2016) as well as Brace (2013).
31	What is your highest level of education or training completed?	This question is standard in TUSs and follows Morris et al. (2016) as well as Brace (2013).
32	How would you rate your current health status?	This question is in line with the general health question in the UKTUS and uses the same wording as Morris et al. (2016). In addition, the recommendations from Brace (2013) on how sensible questions should be asked in a questionnaire were also taken into account.

Source: The author

Unfortunately, a response rate cannot be calculated, because it is uncertain to how many potential respondents of the SurveyMonkey panel the questionnaire was distributed. This number is not provided by SurveyMonkey and also unknown to the researcher is the exact SurveyMonkey panel size. This is seen as a clear disadvantage and it may limit the explanatory power of results, but similar problems may occur even if other sampling designs, for example, snowball sampling, were applied. Thus, an unclear response rate is not a problem unique to the chosen method.

The questionnaire introduction supplied with the questionnaire was kept short and concise to be in line with the SurveyMonkey design regulations on its website (Momentive Inc., 2022). Questionnaire results could be downloaded in various formats for further analysis including CSV, SPSS and PDF files.
Before the main questionnaire was administered, it was pilot tested.

4.6.2.7 Piloting the Questionnaire

A pilot of the questionnaire, sometimes also referred to as a pretest (Kothari & Garg, 2019), is recommended to identify problems and errors prior to doing the main study (Brace, 2013; Kothari & Garg, 2019; Mitchell & Jolley, 2010). Those problems or errors can cover a wide range including, for example, misunderstandings in the wording of questions, errors in the answer choices, data collection and coding problems (Saunders et al., 2019). Depending on the dimension of changes required to correct identified errors, Passer (2014) recommends that another pilot study may be necessary to ensure that the changes made had improved the questionnaire. The results of the pilot may also help to judge the reliability and validity of the questionnaire (Brace, 2013; Saunders et al., 2019). According to Mitchell and Jolley (2010), the pilot is usually done with fewer participants than the full study. Usually a small number of respondents is sufficient, and Saunders et al. (2019) state that even the use of friends and families is better than no pilot testing at all.

The questionnaire testing included four steps.
First, a pretest covered a distribution in the US rather than the target region of the UK, allowing the researcher to get an awareness of whether respondents could understand the developed questions and were able to provide reasonable responses. The choice for the US rather than the UK was chosen because it was cheaper, more convenient, and also did not affect the target region of the UK. The researcher further used the opportunity of that pretest to evaluate whether the services offered by SurveyMonkey were suitable for this research, to get an understanding of the quality of results and the procedure of data collection, and to check whether the data were suitable for further analysis.
Second, the questionnaire used for the US pretest was also sent to a few experts on questionnaire design and who were familiar with the VoL topic, to get their views on it. The pretest questionnaire included, contrary to the pilot and main questionnaire, one open-ended question at the end to allow respondents to provide comments on problems they had faced when answering the questionnaire. Results were sent back anonymously using the SurveyMonkey distribution platform. A very high abortion rate of the pretest was found due to the high complexity of some questions. A few minor issues were identified, along with some very complex questions that needed modifications. The comments from respondents and experts provided in the open-ended question were helpful for redesigning and significantly improving the questionnaire, leading to a better layout, different order, easier wording and clearer understanding of the questions.
Third, the redesigned, pilot questionnaire was then administered to a small sample of 60 people from the target population in the UK via SurveyMonkey and resulted

in 51 completed questionnaires received back anonymously. The results had significantly improved compared to the pretest and the abortion rate also had dropped significantly.
Fourth, the pilot questionnaire was also sent to a few research experts via email, outside the SurveyMonkey distribution platform, with the result that no further modifications to the pilot questionnaire were necessary.

4.6.2.8 Administering the Main Questionnaire

The results of the pretest and the pilot allowed the researcher to administer the main questionnaire through SurveyMonkey using its UK panel, as outlined above. The distribution happened on one single day and the questionnaire was not sent out in multiple waves. It was aimed for a high-response rate to maintain a good level of representativeness of the sample, as suggested by Hox and Boeije (2005). In addition, the researcher also aimed for a high reliability and validity of the questionnaire and the collected data.
The main questionnaire is included in Appendix B.

4.6.3 Reliability and Validity

Measuring instruments need to be looked at in terms of their reliability and validity (Kothari & Garg, 2019). This is done for primary and secondary data individually. Reliability means that an applied measuring instrument will lead to consistent results if applied multiple times (Brace, 2013; Kothari & Garg, 2019; Kumar, 2019; Sekaran & Bougie, 2010).
The concept of validity helps to evaluate or assess how good an applied measuring instrument measures what it is supposed to measure (Cooper & Schindler, 2014; Kothari & Garg, 2019; Kumar, 2019; Punch, 2005). The literature offers various types of validity, but the main types discussed below are face validity, content validity and construct validity (Kothari & Garg, 2019; Kumar, 2019).
Reliability and validity are connected in the way that a measuring instrument may be considered reliable but fails to be valid, but if it is considered to be unreliable it is also invalid (Cooper & Schindler, 2014; Mitchell & Jolley, 2010). Nevertheless, it is suggested by Kothari and Garg (2019) to maintain a certain degree of practicability of the measuring instrument regarding the budget, convenience and interpretability.

4.6.3.1 Secondary Data Reliability

Prior to using secondary data, Kothari and Garg (2019) recommend evaluating its reliability, suitability and adequacy. This can be tested, for example, by answering a set of questions, as outlined by Kothari and Garg (2019) and Saunders and Lewis (2018), that cover: the purpose of the original study and who did it, when and how the data was collected, what type of data was collected, what methods were applied, whether the data was biased, and how suitable and adequate it is for the current research.

Both secondary data sources, the UKTUS and ASHE, were collected under the authority or supervision of a government department, the ONS. The UKTUS data were specifically collected for time use research and ASHE wage data to evaluate the hourly earnings of various professions in the UK. In this study that data is used for the same purpose it was originally collected for. Detailed methodology papers, supplied with the data files, allowed a thorough evaluation of the methods used to collect and clean the data, as well as assessing to what extent the data was biased. As Kothari and Garg (2019) state, the suitability and adequacy of data needs to be judged by the researcher. It is believed that both secondary data sets were the most suitable data that could be used to answer the research questions for this research. The ONS (2018a) explicitly claimed that ASHE data are very reliable, while such a specific statement for the UKTUS could not be identified. However, following Kumar (2019), who suggests that data published by governments typically are very reliable, the two secondary data sets were considered to be reliable, suitable and adequate for this research study.

4.6.3.2 Primary Data Reliability

Brace (2013) mentions that it is difficult to test a questionnaire directly for reliability, but points out that if the results of a questionnaire that was run twice within the exact same sample are consistent, reliability of the questionnaire can be assumed.

For the pilot and the main survey in the UK the exact same questionnaire was used, but it was not distributed to the exact same sample. However, a comparison of the results showed that the questionnaire in both cases collected the same information and delivered consistent results. Due to this finding, it can be assumed that the primary data is reliable, although the criterion of using the same sample, as mentioned by Brace (2013), was not met.

4.6.3.3 Secondary Data Validity

Similar to his comment on the reliability of governmental data, Kumar (2019) also states that data published by or through governments usually have a high level of validity. This is in line with the researcher's opinion and working experience. Therefore, further validity tests of secondary data were not performed.

4.6.3.4 Primary Data Validity

Brace (2013) offers a list of questions allowing researchers to evaluate a questionnaire's validity. The list aims to identify complicated questions, insufficient or overlapping answer choices and helps to check whether the responses are appropriate and useful to meet the objectives of the study. Hox and Boeije (2005) suggest that "questions must be carefully designed, evaluated, and tested" to assure a high validity of the questionnaire (p. 595). Further, Brace (2013) recommends pilot testing the questionnaire to identify errors and problems and thus increase its validity as a measuring instrument.

Content validity is a construct that evaluates whether the questions posed in a questionnaire lead to the best possible and valid results (Cooper & Schindler, 2014; Kothari & Garg, 2019). The researcher ensured this by using existing literature and previous questionnaires as a guideline, wherever possible. Content validity is considered to be good if there is a high representativeness, but it cannot be measured by statistical parameters (Kothari & Garg, 2019). Therefore, content validity may be judged by the researcher as it is considered to be an intuitive measure, but it also can be evaluated by other individuals or experts (Kothari & Garg, 2019).
Construct validity evaluates how well a questionnaire measures the constructs it is supposed to measure (Mitchell & Jolley, 2010).
Face validity can be assumed if a measuring instrument looks plausible to measure what it is designed to measure (Mitchell & Jolley, 2010; Sekaran & Bougie, 2010). According to Kumar (2019), face validity is simple to conduct by checking whether a connection between the question and research objectives can be identified.

All three types of validity were confirmed by pilot testing the questionnaire and evaluating its results, and thus, it is assumed that the primary data applied in this research meet the validity requirements.

4.7 Data Preparation and Analysis

Once the data are collected, the next step is the analysis of the primary and secondary data. Before conducting any analysis, the data needs to be prepared.

4.7.1 Data Preparation

Data preparation is a process that includes checking the responses given in the questionnaire for plausibility, ensuring that data entry is in line with the coding rules, editing and cleaning data and performing consistency checks (Cooper & Schindler, 2014; Kothari & Garg, 2019). In line with Kothari and Garg (2019), it is further necessary to find missing values, adjust the data accordingly to improve quality, assign weights to respondents, transform scales and modify responses by creating new variables.

The secondary data, as previously outlined, is used in the same context as it was originally collected for and showed a high quality according to its supplementary methodology papers (CTUR, 2016; Morris et al., 2016; ONS, 2018a). Therefore, data preparation work mainly focused on checking for consistency and missing values. The variables that were not required for this study were deleted from the data files.

Preparing the primary data for analysis was more complex. Although SurveyMonkey automatically precoded responses, it needed further work in terms of checking the coding and making it fit for data analysis. The coding rules were designed to be as close as possible to the UKTUS original coding to ensure a high level of consistency between primary and secondary data.

Additional rules needed to be defined on how to deal with non-responses, wrong responses or *do not know* or *prefer not to say* responses.

Cooper and Schindler (2014) pointed out that missing values need to be carefully investigated and a decision needs to be made on how to deal with them. According to Kothari and Garg (2019), missing values can be left out for analysis but the most common way is to impute those values. For this research, when possible, missing values were imputed by using iterative imputation techniques.

Kothari and Garg (2019) further stated that outliers are considered values that differ three times the standard deviation or more from the mean. Those needed to be identified and then the researcher had the options to a) keep the value as it is,

b) modify it or c) delete the value, as suggested by Kothari and Garg (2019). Any of those options would be justifiable and it was decided that this research study followed that exact order to retain those outliers that could be identified plausible, otherwise a possible modification was checked. If both options were claimed not suitable, the outliers were deleted.
Furthermore, the criteria for the identification of non-usable questionnaires also needed to be predefined by the researcher. Those questionnaires would be excluded and not coded. Any data entry was done directly into the primary and secondary data files. Once the data preparation was complete, the data were analysed as described below.

4.7.2 Data Analysis

The data analysis for both primary and secondary data starts with a presentation of descriptive statistics, such as frequency counts and mean values, as recommended by Cooper and Schindler (2014) and Kumar (2019), to have an overview and get an understanding of the data.
The central part of the data analysis will be the VoL and its modifications, as proposed in the different steps at the end of the literature review. Furthermore, inferential statistics, in particular regression analysis, were applied to determine the relationship between selected demographic variables and the quality of unpaid household work, following Cooper and Schindler (2014), Mitchell and Jolley (2010), and Punch (2005). The data analysis is done using SPSS and Microsoft Excel.

The VoL calculation is complex and to allow a reproduction of the results, SPSS-syntax, a unique programming language specific to SPSS, was used. The entire syntax consisted of more than 18,000 lines developed and written by the author and hence cannot be displayed in the appendix. One SPSS-syntax was required for each step of the VoL calculations plus additional ones for each gender-based analysis. Running the SPSS-syntax amounted to more than 16 hours, which is a result of the large data files and the lengths of the syntax.

4.8 Research Ethics

Research ethics is an important part of social sciences, where researchers usually focus on data that is collected from individuals (Eurostat, 2013). This research, and in particular the collection and use of primary data, was conducted in accordance with the University of Gloucestershire Handbook of Research Ethics 2022 (University of Gloucestershire, 2022) and under strict consideration of the German (researcher based), US (SurveyMonkey platform based) (SurveyMonkey, 2020) and UK General Data Protection Regulation (GDPR) law.
The researcher respects, and also will ensure this for the future, the principles of informed consent, anonymity, confidentiality and secure data storage.

The respondents in this research were individuals who either directly filled in a questionnaire (primary data) or individuals who had already filled in a questionnaire from a third party and only that published data was accessed by the researcher (secondary data). The distributor of secondary data ensured that its data came in an anonymised form that did not allow references to individuals. By accessing the data, the researcher further agreed to conform to current data protection laws.

The anonymity of respondents is ensured because SurveyMonkey provides the primary data to the researcher in an anonymised form which does not allow the receiver to trace back and identify respondents. All participants were registered users at SurveyMonkey and had specifically and voluntarily signed up with that online service provider to be able to fill in questionnaires and take part in surveys. All participants taking part in the questionnaire were required to be aged 18 years and over. Participation in the research was completely voluntary and participants had the opportunity to leave the research at any time. This was clearly communicated to participants in the instructions of the questionnaire. Children, teenagers or any people needing special care/treatment or living in any type of institutions were excluded from this research. Hence, a formal ethical approval was not required for this research project.

Primary and secondary data were stored by the researcher on a secured hard-drive that is password-protected. Access to the hard-drive was limited to the researcher only. Data that was generated using the services of SurveyMonkey was

stored, in addition to the researcher's hard-drive, on a SurveyMonkey server, according to their data protection, back-up and security guidelines (SurveyMonkey, 2020). SurveyMonkey ensures that any data deleted from the SurveyMonkey account will be deleted from its server back-ups within 90 days (SurveyMonkey, 2020).
Any data will only be published in an anonymised form, in line with data protection laws in the UK and Germany, so that no one is able to identify individuals or their responses given. In case research findings may be published in academic journals, books or conferences, the anonymity of respondents will always be protected. Furthermore, the data collected will only be used for research purposes and not for commercial use.

4.9 Limitations of Chosen Research Design

For this study, a research design was chosen that bests fits the researcher's need to answer the research questions. The design choices were supported by the literature, as outlined in this chapter, and were in line with the philosophical tradition of the researcher. Although carefully chosen, no research design is claimed to be perfect because they all have disadvantages and hence come with limitations. Those need to be kept in mind when presenting and discussing the results in the next chapters. The following main limitations to the design were identified.

- The sampling technique may not be ideal because a random sample would have been more accurate to ensure a high representativeness of the sample.
- The global panel from SurveyMonkey is claimed to be representative but due to the fact that only registered users have access to the panel, there may be room for discrepancies.
- This research study required decisions on many different steps of matching a variety of codes, which were, to some extent, subjective.
- The mean ASHE wage rates were used because they were found more robust, although the recommendation by the ONS suggested using median ASHE rates.

4.10 Chapter Conclusion

This chapter outlined the research methodology for this study. In line with the researcher's post-positivistic philosophical tradition and a deductive approach to reasoning, this research applied a quantitative, mainly descriptive research design, using a self-administered online questionnaire to collect primary data on a cross-sectional basis. In addition to primary data, secondary data from the UKTUS and the ASHE were used. Detailed information on secondary data was provided. Furthermore, the primary data collection, including questionnaire design, sampling, pilot testing and distribution of the main questionnaire, was explained. Primary and secondary data reliability and validity were evaluated and the process of data preparation and analysis outlined. The chapter concluded with a section on research ethics and a short presentation of potential research design limitations.

Chapter 5

Empirical Data Analysis and Model Building

5.1 Introduction to Chapter

This chapter presents the data analysis and results of the primary and secondary data described in the previous chapter and builds the models required for the VoL and the regression analysis. First, this chapter starts with the descriptive statistics of the secondary data and then describes the primary data to get an understanding of the composition of the data collected through the questionnaire. Next, the results of the questionnaire were evaluated in terms of reliability and validity. In addition, the activity groups used in the questionnaire were aligned with the UKTUS activity groups. Furthermore, the author's own approach is provided, using splits for multi-tasking and adjustments for quality and productivity that are stepwise included, in line with Figure 3.3. The different models for the VoL are built in a way to allow for an analysis by gender, and also allow the implementation of adjustments on a gender basis. This is required to evaluate how gender affects the VoL.

In the last part of this chapter inferential statistics are used, in the form of a regression analysis, to evaluate the impact of selected demographics on the quality of unpaid household work.

5.2 Secondary Data Results

The presentation of the secondary data results starts with the analysis of the ASHE wage data before the UKTUS data is described. The reason for this change in order, compared to the previous chapter, is that the results from the ASHE wage data can directly be implemented and combined with the explanation of the UKTUS results.

5.2.1 Data Analytics of ASHE Wage Data

As outlined in the methodology chapter, the ASHE wage rates of the 11 selected SOC2010 codes listed in Table 4.6, are based on the 5-year average data from 2015 to 2019 for men, women and both genders combined. The 5-year average was chosen in line with explanations outlined in the previous chapter, because some single-year wage rates were biased due to extreme outliers. The ASHE wage data were applied to SOC2010 codes, as can be seen in Table 5.1.

Table 5.1: SOC2010 and 5-year average ASHE wages

SOC2010	**Description**	**Both**	**Male**	**Female**
531	Construction and building trades	£ 12.81	£ 12.83	£ 11.24
541	Textiles and garments trades	£ 11.29	£ 12.00	£ 9.22
543	Food preparation and hospitality trades	£ 9.71	£ 9.88	£ 9.35
613	Animal care and control services	£ 9.64	£ 10.49	£ 9.33
614	Caring personal services	£ 9.97	£ 10.29	£ 9.89
623	Housekeeping and related services	£ 10.02	£ 10.42	£ 9.33
5113	Gardeners and landscape gardeners	£ 10.35	£ 10.31	£ 10.85
5223	Metal working production and maintenance fitters	£ 14.94	£ 14.99	£ 12.98
5231	Vehicle technicians, mechanics and electricians	£ 12.38	£ 12.40	£ 11.27
5449	Other skilled trades n.e.c	£ 12.93	£ 13.03	£ 12.45
6231	Housekeepers and related occupation	£ 9.07	£ 9.22	£ 9.03

Source: The author's calculations based on ASHE data and SOC2010

For each SOC2010 code the wage rates for men, women and for both genders combined are listed separately. All codes listed above, apart from code 6231, were used for the VoL estimates using specialist wage rates. The values for the specialist wage rates range between £9.22 (code 541) for women and £14.99 (code 5223) for men.

The code 6231 reflects the housekeeper wage rate that is only applied in the traditional valuation approach but is not part of any of the modification steps as outlined in the literature review. The housekeeper represents the lowest wage rate with £9.22 for men, £9.03 for women and £9.07 for both genders.

The hourly wage rates for men were higher than the ones for women and for both genders combined, apart from SOC2010 code 5113 ‘gardeners and landscape gardeners’. In that instance, with £10.85, the hourly wage for women is higher compared to £10.31 for men and £10.35 for both genders. The largest discrepancy between men and women was found for code 541 ‘textiles and garment trades’, where the hourly wage differed by £2.78 or, in other words, was 23.16% lower for women compared to men, clearly showing the gender wage gap existing for decades.

5.2.2 Data Analytics of UKTUS

The following part presents the analytics of the UKTUS data after it had been cleaned, as outlined in the previous chapter.
The cleaned UKTUS data file was reduced from a total of 674 variables to 22 numeric variables (18 scale and 4 nominal) and the variable names were changed from the original UKTUS terminology, as outlined in Table 4.4 of the previous chapter, to make them fit this study. Furthermore, the previously used variables *eptime* and *New_wgt* were combined into the new variable *eptimewgt*, which reflects the time duration in a weighted form, to be in line with the UKTUS methodology paper from Morris et al. (2016), which recommends using weighted time data. The six renamed key variables are listed in Table 5.2. The remaining 16 variables were kept for validation or identification purposes and included, for example, identifier variables.

Table 5.2: UKTUS key variables of cleaned secondary data file

Variable	**Description**
eptimewgt	Weighted episode duration in minutes
activity1	Primary activity code
activity2	Secondary activity code
activity3	Tertiary activity code
activity4	Quaternary activity code
DMSex	Gender from household grid

Source: The author based on UKTUS data (Sullivan & Gershuny, 2021)

The UKTUS sample consists of 7,145 individuals, of whom 3,277 (45.86%) are male and 3,868 (54.14%) are female. They completed a total of 14,283 diaries, while 6,551 (45.87%) of them were completed by men and 7,732 (54.13%) by women. This is summarised in Table 5.3.

Table 5.3: UKTUS sample – male/female ratio

	Individuals		**Diaries completed**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Male	3,277	45.86	6,551	45.87
Female	3,868	54.14	7,732	54.13
Total	7,145	100.0	14,283	100.0

Source: The author's calculations based on UKTUS data (Sullivan & Gershuny, 2021)

Based on the 14,283 diaries, the sample contains 520,318 cases and does not include any missing values. Each case reflects one episode which, as outlined in Chapter 4, represents the time duration of the same activities, before either a new activity starts, or the set of simultaneous activities changes. Episodes in the UKTUS consist of at least one 10-minute time slot, and thus could have a duration between 10 minutes and a maximum of one entire day, equalling 1440 minutes. Therefore, diaries can have different amounts of episodes per day. The mean duration of an episode is 39.5287 minutes with a standard deviation of 70.22198 minutes indicating that some episodes lasted quite long. A typical example of long-lasting episodes is sleeping. The total time spent on all episodes, the total of the variable *eptimewgt*, is 20,567,520 minutes which is equivalent to 342,792 hours for the 14,283 diaries, when all existing UKTUS activities are taken into account.

Table 5.4 contains the frequency count of episodes and the total minutes for the main activity (*activity1*) and for simultaneous activities (*activity2*, *activitiy3*, *activity4*), for all relevant UKTUS activity codes 3000 to 3590 investigated in this research. The frequency and time of all other codes, not used in this research, are summarised in the row *other codes*, while the row *no entry* contains the episodes where no simultaneous activities are recorded.

Table 5.4: Frequency count and time per UKTUS activity codes

	activity1		*activity2*		*activity3*		*activity4*	
UKTUS code	**Freq**	**Minutes**	**Freq**	**Minutes**	**Freq**	**Minutes**	**Freq**	**Minutes**
3000	2,506	95,040	163	4,510	*	160		
3100	17	310	*	70	*	*		
3110	30,200	574,150	4,304	59,230	290	4,220	20	300
3130	11,194	177,700	1,711	25,540	103	2,120	19	310
3140	52	1,420	12	160				
3190	12	130	14	210	*	*		
3200	437	13,660	73	1,470	*	140	*	30
3210	11,194	264,120	1,855	34,170	168	3,450	32	880
3220	299	9,640	34	1,220	*	*		
3230	341	6,980	126	1,590	*	140		
3240	5,675	105,280	1,062	16,370	65	1,280	*	180
3250	236	4,510	58	830				
3290	5,414	59,170	822	10,280	89	1,000	*	80
3300	22	620	*	140	*	180	*	*
3310	5,779	91,510	1,488	22,390	105	2,200	11	180
3320	2,329	66,000	285	7,130	12	540	*	80
3330	690	29,930	407	18,080	19	700		
3390	87	2,100	15	350	*	30		
3410	3,066	126,470	214	5,840	13	630		
3420	659	13,930	151	2,620	19	470	*	70
3430	3,148	48,060	1,718	24,120	218	3,530	22	370
3440	3,615	111,760	151	3,710	14	260	*	30
3490	123	2,800	31	390	*	40		
3500	159	7,450	*	170				
3510	126	5,550	*	120				
3520	1,115	52,870	35	1,050				
3530	125	4,910	11	400	*	*		
3531	55	3,810	*	40				
3539	331	10,210	52	1,350	*	320	*	20
3540	883	29,370	90	1,670	12	220		
3590	36	1,250						
Total unpaid	**89,925**	**1,920,710**	**14,909**	**245,220**	**1,164**	**21,670**	**130**	**2,540**
Percentage	**17.28**	**9.34**	**10.00**	**6.87**	**7.81**	**6.00**	**10.16**	**7.37**
Other codes	**430,393**	**18,646,810**	**134,192**	**3,322,440**	**13,741**	**339,780**	**1,149**	**31,930**
No entry	**0**	**0**	**371,217**	**16,999,860**	**505,413**	**20,206,070**	**519,039**	**20,533,050**
Total	**520,318**	**20,567,520**	**520,318**	**20,567,520**	**520,318**	**20,567,520**	**520,318**	**20,567,520**

* values ≤10

Source: The author's calculations based on UKTUS data (Sullivan & Gershuny, 2021)

For the first activity a frequency count of 89,925 episodes (17.28% of all episodes) were recorded or 1,920,710 minutes (9.34% of total minutes) were spent on relevant unpaid household work activities. The UKTUS activity code 3110 'food preparation and baking' includes the most episodes (30,200) and the highest minutes (574,150) of a single code. For the second activity, a total of 149,101 episodes were recorded, of which 14,909 (10.00%) were spent on relevant unpaid work and 134,192 on other activities. Secondary activity minutes accounted for 3,576,600 of which 245,220 (6.87%) were spent on secondary unpaid work and 3,322,440 minutes on other secondary activities. The numbers for the third and fourth activities are interpreted in the same way.

5.2.3 Matching UKTUS Activity Codes with ASHE Wage Rates

As outlined in the previous chapter, Table 4.8 provided the matching of UKTUS activity codes with SOC2010 codes. Using the wage rate data from Table 5.1 above, the activity code table was complemented with the hourly wage rates of market specialists. It needs to be noted again that the housekeeper wage rate is not included in those calculations, as explained in Chapter 4 and Section 5.2.1. The final matching is shown in Table 5.5.

Table 5.5: Matching UKTUS activity codes with ASHE hourly wage rates

UKTUS code	Description	Both	Male	Female
3000	Unspecified household and family care	£ 9.97	£ 10.29	£ 9.89
31	**FOOD MANAGEMENT**			
3100	Unspecified food management	£ 10.02	£ 10.42	£ 9.33
3110	Food preparation and baking	£ 9.71	£ 9.88	£ 9.35
3130	Dish washing	£ 10.02	£ 10.42	£ 9.33
3140	Preserving	£ 9.71	£ 9.88	£ 9.35
3190	Other specified food management	£ 10.02	£ 10.42	£ 9.33
32	**HOUSEHOLD UPKEEP**			
3200	Unspecified household upkeep	£ 10.02	£ 10.42	£ 9.33
3210	Cleaning dwelling	£ 10.02	£ 10.42	£ 9.33
3220	Cleaning yard	£ 10.02	£ 10.42	£ 9.33
3230	Heating and water	£ 10.02	£ 10.42	£ 9.33
3240	Arranging household goods and materials	£ 10.02	£ 10.42	£ 9.33
3250	Disposal of waste	£ 10.02	£ 10.42	£ 9.33
3290	Other or unspecified household upkeep	£ 10.02	£ 10.42	£ 9.33
33	**MAKING AND CARE FOR TEXTILES**			
3300	Unspecified making and care for textiles	£ 11.29	£ 12.00	£ 9.22
3310	Laundry	£ 10.02	£ 10.42	£ 9.33
3320	Ironing	£ 10.02	£ 10.42	£ 9.33
3330	Handicraft and producing textiles	£ 11.29	£ 12.00	£ 9.22
3390	Other specified making and care for textiles	£ 11.29	£ 12.00	£ 9.22
34	**GARDENING AND PET CARE**			
3410	Gardening	£ 10.35	£ 10.31	£ 10.85
3420	Tending domestic animals	£ 9.64	£ 10.49	£ 9.33
3430	Caring for pets	£ 9.64	£ 10.49	£ 9.33
3440	Walking the dog	£ 9.64	£ 10.49	£ 9.33
3490	Other specified gardening and pet care	£ 10.00	£ 10.40	£ 10.09
35	**CONSTRUCTION AND REPAIRS**			
3500	Unspecified construction and repairs	£ 13.27	£ 13.31	£ 11.99
3510	House construction and renovation	£ 12.81	£ 12.83	£ 11.24
3520	Repairs of dwelling	£ 12.81	£ 12.83	£ 11.24
3530	Making repairing and maintaining equipment	£ 14.94	£ 14.99	£ 12.98
3531	Woodcraft metalcraft sculpture and pottery	£ 12.93	£ 13.03	£ 12.45
3539	Other specified making repairing and maintaining equipment	£ 14.94	£ 14.99	£ 12.98
3540	Vehicle maintenance	£ 12.38	£ 12.40	£ 11.27
3590	Other specified construction and repairs	£ 13.27	£ 13.31	£ 11.99

Source: The author's calculations based on UKTUS, SOC2010 and ASHE data

Looking at all wage rates listed in the above table, they range between £9.22 and

£14.99. For both genders combined, the lowest wage was £9.64 for the codes 3420 'tending domestic animals', 3430 'caring for pets' and 3440 'walking the dog' while the highest was £14.94 for codes 3530 'making repairing and maintaining equipment' and 3539 'other specified making repairing and maintaining equipment'. For men, the lowest wage was £9.88 for the UKTUS activity codes 3110 'food preparation and baking' and 3140 'preserving', while the highest wage was £14.99 for codes 3530 and 3539. For women, the lowest wage was £9.22 for codes 3300 'unspecified making and care for textiles', 3330 'handicraft and producing textiles' and 3390 'other specified making and care for textiles' while the highest wage was £12.98 for codes 3530 and 3539.

Overall, the codes 3530 and 3539 had the highest wage rates for men, women and both genders combined.

For all UKTUS activity codes, apart from 3410 'gardening' and 3490 'other specified gardening and pet care', the wage rate for men was higher than the one for both genders combined, which again was higher than the wage rate for women. Gardening activities showed a different picture because it appeared that women got compensated more than men or both genders combined.

Attention needs to be given to activity code 3490, because for that UKTUS code, the male and female wage rate was higher than the combined wage rate. This is explained by the fact that the code 3490, as outlined in Table 4.8, consists of a mix of two different wage rates, which caused this slight difference.

5.3 Primary Data Results

Following the secondary data description, below are the results from the primary data that were collected by the self-administered online questionnaire.

A total of 442 questionnaires were returned, of which, after coding, re-coding, data cleaning, imputation of missing values and thorough plausibility and quality checking, 406 were useful and qualified for analysis within this research. The data cleaning was done in line with the steps outlined in the previous chapter, using SPSS-syntax to ensure the replicability of the cleaning process. The final primary data file contained 101 variables and 406 cases, one for each respondent. The median time to complete the questionnaire was 6 minutes and 18 seconds.

As mentioned in Chapter 4, the questionnaire consists of five parts: 1) introductory questions that allow respondents to familiarise themselves with the topic, 2) multitasking, 3) quality, 4) productivity and 5) demographics. Furthermore, a block of transitional questions clearly separates the quality part from the productivity part. Although being the last part of the questionnaire, the reporting of the primary data results starts with the descriptive statistics of the demographics. This way the distribution of the sample can be explained and an overview of who completed the questionnaire and who provided the data can be given.

5.3.1 Demographics Part of the Questionnaire

The questionnaire includes six questions on demographics and an additional one on health status. All seven questions in this part of the questionnaire allowed respondents to select one single answer of the choices provided. Following the recommendation from Brace (2013) to include a *do not know* or *prefer not to say* option to sensitive questions, this answer choice was added to the demographic and health questions. It was hoped to increase the acceptance for those questions and maintain a high response rate. For all seven questions that option choice was never selected. Therefore, this answer choice was excluded from the tables below.

5.3.1.1 Gender of Respondents

The majority of respondents were women. According to Table 5.6, 214 (52.7%) of the 406 individuals were women and 192 (47.3%) were men.

Table 5.6: Demographics on gender

	Frequency	**Percent**
Female	214	52.7
Male	192	47.3
Total	406	100

Source: The author

Respondents were asked to state their gender at birth to avoid any confusion, allowing respondents who are not clear on one choice at the moment of answering the question; gender at birth is very clear and without any doubt.

5.3.1.2 Age Distribution of Respondents

The age of respondents was collected by ticking one of six age groups that were provided in the questionnaire. To achieve a higher acceptance of this question, it was not asked for the actual year but a group choice was offered. The age groups between the ages of 18 and 65 were designed in 4 homogenous groups of 12 years. The groups of under 18 years and 66 years and older included a range of more than 12 years. Results are presented in Table 5.7.

Table 5.7: Age distribution of respondents

	Frequency	**Percent**
Under 18 years	0	0.0
18 - 29 years	68	16.7
30 - 41 years	81	20.0
42 - 53 years	96	23.6
54 - 65 years	83	20.4
66 years and over	78	19.2
Total	406	100

Source: The author

Respondents were required to be at least 18 years of age to register with SurveyMonkey and therefore, the age group of under 18 years was not selected once, as expected by the researcher. According to Table 5.7, the frequency of respondents in the main five age groups was almost evenly distributed at around 20%, with two small outliers for the age group 18 - 29 years with only 68 respondents (16.7%) and the age group 42-53 years, the largest group, of 96 respondents (23.6%).

5.3.1.3 Number of Household Members

Another question investigated the number of household members. The respondents were asked to state the number of adults, children under the age of 8 years, and those between 8 and 17 years living in the same household, including the respondent. Respondents were given the choice to select numbers from 0 to 5 as well as one category that represented the number of 6 or more people. Table 5.8 summarises the results of this question.

Table 5.8: Number of household members

	Adult		0-7 years		8-17 years	
Number	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
0	0	0.0	325	80.0	291	71.7
1	99	24.4	60	14.8	68	16.7
2	228	56.2	11	2.7	32	7.9
3	54	13.3	4	1.0	8	2.0
4	18	4.4	2	0.5	4	1.0
5	5	1.2	4	1.0	2	0.5
6+	2	0.5	0	0.0	1	0.2
Total	406	100	406	100	406	100

Source: The author

For example, 228 households (56.2%) consisted of 2 adults while only 2 households (0.5%) had 6 or more adults living together. One child younger than 8 years was present in 60 households (14.8%) while 4 children of the same age group were only present in 2 households (0.5%).

5.3.1.4 Employment Status of Respondents

Respondents were further asked to provide information on their current employment status. The employment situation of the respondents is summarised in Table 5.9. Respondents had the choice between 8 employment categories. The categories were in line with the ones used by Morris et al. (2016) for the UKTUS but were reduced from 11 to 8 categories because this research did not require that level of detail and hence some employment choices had been combined.

Table 5.9: Employment status of respondents

	Frequency	**Percent**
Self employed	25	6.2
In paid employment (full time)	149	36.7
In paid employment (part time)	59	14.5
Unemployed	49	12.1
Retired	91	22.4
Full-time student	7	1.7
Long-term sick	14	3.4
Something else	12	3.0
Total	406	100

Source: The author

From the 406 respondents in the sample, the majority of 208 (51.2%) were either in full-time or part-time employment, 25 respondents (6.2%) claimed they were self-employed and 12 (3.0%) ticked the answer 'something else'.

5.3.1.5 Marital Status of Respondents

Respondents were also asked to provide information on their marital status by selecting one of the 6 answer choices listed in Table 5.10. Similar to employment, the categories for marital status were in line with the UKTUS choices presented by Morris et al. (2016), but were reduced from 10 to 6 categories for the same reason, as mentioned above for employment.

Table 5.10: Marital status

	Frequency	**Percent**
Single, never married	124	30.5
Living with a partner, not married (cohabitating)	69	17.0
Married and partner lives in household	168	41.4
Married but separated	7	1.7
Divorced	30	7.4
Widowed	8	2.0
Total	406	100

Source: The author

Almost one-third of the respondents (124 or 30.5%) were single and had never been married. 175 respondents (43.1%) claimed to be married, while 69 respondents (17.0%) were living with a partner but had not been married, and 7 respondents (1.7 %) were separated.

5.3.1.6 Education Level of Respondents

Further, respondents were asked to state their highest level of education, using a list of 8 answer choices. The overview of the education levels is shown in Table 5.11 and provides a mix throughout all different types of education levels. The choices for the categories were adopted from Morris et al. (2016) to be in line with the ones used in the UKTUS. While the UKTUS offered 34 different categories, this level of detail was not required for this study and thus had been condensed to 8 categories.

Table 5.11: Education level

	Frequency	Percent
No qualification	5	1.2
Primary school	1	0.2
Secondary school up to 16 years	76	18.7
Higher or secondary or further education	97	23.9
Vocational and professional training, apprenticeship	70	17.2
University or college degree	118	29.1
Post-graduate degree	39	9.6
Total	406	100

Source: The author

Of the 406 respondents, 118 (29.1%) reported having a university or college degree as their highest level of education, which is the largest group. An additional 39 respondents (9.6%) stated that they had achieved a post-graduate degree. 5 respondents (1.2%) reported that they had no qualification and one respondent (0.2%) claimed primary school as the highest level of education.

5.3.1.7 Health Status of Respondents

The last question of the demographic section asked the respondents to indicate their own health status using a 5-point Likert scale ranging from 'very good' to 'very poor', as shown in Table 5.12. This 5-point Likert scale was in line with the general health question in the UKTUS that, according to Morris et al. (2016), had applied the same wording for the scale.

Table 5.12: Health status of respondents

	Frequency	Percent
Very good	58	14.3
Good	200	49.3
Fair	122	30.0
Poor	18	4.4
Very poor	8	2.0
Total	406	100

Source: The author

The health status reported by the respondents was at least 'fair' or better for 380 (93.6%) of the 406 respondents. 18 individuals (4.4%) considered their health as 'poor' and another 8 (2.0%) as 'very poor'.

5.3.2 Introductory Questions of the Questionnaire

The questionnaire started with two introductory questions that allowed the respondents to get used to the topic and helped them to quickly decide whether the topic was interesting enough to proceed with answering the questionnaire. Both questions were set up as multiple response questions, where respondents were allowed to tick more than one box in case it applied to them.

As pointed out several times above, this research focuses on the 31 UKTUS activity codes from 3000 to 3590, as listed in Table 5.5. Incorporating those 31 UKTUS activity codes into the questionnaire would not have been user-friendly. A more suitable option was to aggregate those 31 UKTUS activity codes into seven more user-friendly '*questionnaire activity groups*'. Those seven groups of unpaid work activities were 'food preparation including cooking and baking' (*food*), 'cleaning and waste disposal' (*cleaning*), 'laundry and ironing' (*laundry*), 'gardening' (*gardening*), 'pet and animal care including dog walking' (*pet*), 'house renovation, construction, repair, maintenance' (*renovation*) and 'vehicle maintenance' (*vehicle*). The wording was chosen in such a way as to allow respondents to allocate typical unpaid household work activities easily to one of the *questionnaire activity groups* and still maintain a clear-cut boundary to keep them mutually exclusive.
An in-depth explanation on how those *questionnaire activity groups* are connected with the 31 UKTUS activity groups is available in Section 5.5 (Matching Questionnaire Activity Groups with the UKTUS Activity Codes), after the descriptive analysis and the data reliability and validity analysis below.

The two introductory questions allowed the respondents to record for all those seven *questionnaire activity groups* in which of them they 1) have performed activities in their own household without getting paid for within the past six months, and 2) see themselves as a specialist because they currently have or had a paid job in that area. Multiple responses for both questions as well as the options of 'none of the activities' listed and 'do not know or prefer not to say' were possible.
No specific definition was given to the respondents stating what a specialist exactly means. It was up to the respondents to consider whether or not they see themselves as specialists. With no intention to use the results of those two questions for in-depth analysis, the character of a pure introductory question was maintained. It further

familiarised respondents with the necessary self-evaluation required to complete the questionnaire. The first question is a typical retrospective question adapted from the United Nations (2017) that is regularly applied in household questionnaires, while the second question was specifically developed for this questionnaire. The answers to both questions had been used for plausibility checks of other responses.

The results of the two introductory questions are illustrated in Figure 5.1 and, because multiple responses were possible, the total exceeds the number of 406 respondents.

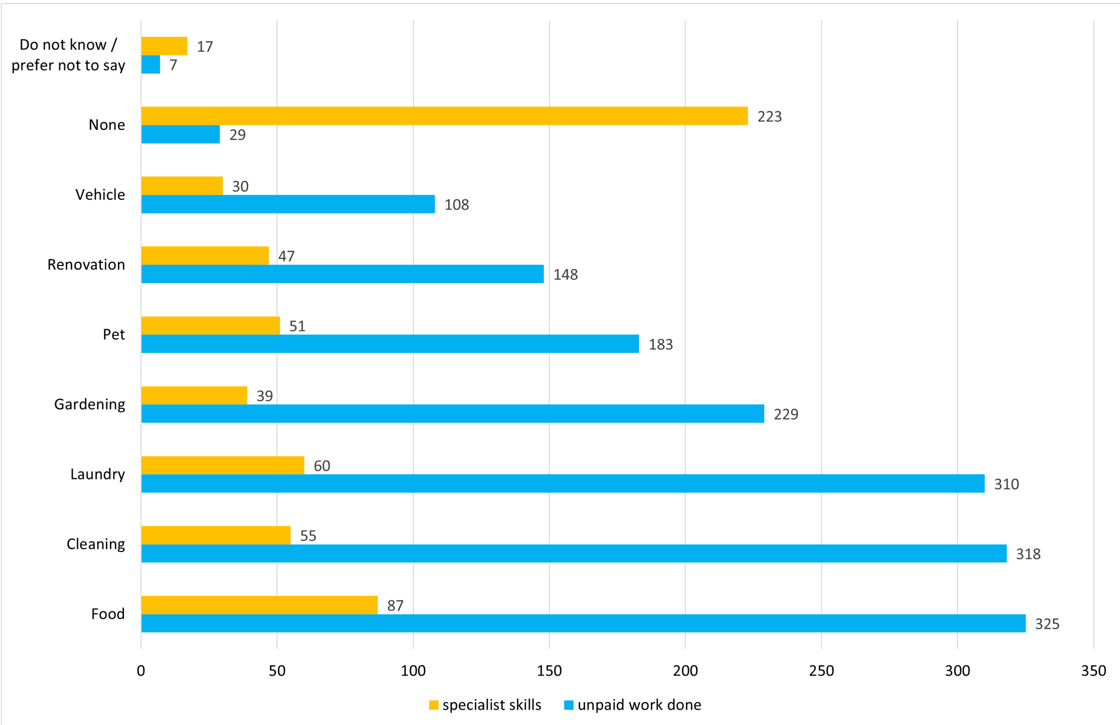


Figure 5.1: Respondents' unpaid work done in the past six months and specialist skills

Source: The author

Of the 406 respondents, only 29 (7.1%) reported they had not performed unpaid work within the last 6 months in any of the seven *questionnaire activity groups* listed, while 7 respondents (1.7%) preferred not to say or did not know.
325 respondents (80.0%) were engaged with 'food preparation', which was the highest selection, and closely followed by 'cleaning and waste disposal' with 318 responses (78.3%), and 'laundry and ironing' with 310 responses (76.4%). These activities can be referred to as the classical household chores. Next in line was 'gardening', with 229 responses (56.4%), and last was 'vehicle maintenance' done by 108 respondents

(26.6%).

Regarding the second question of whether the respondents view themselves as experts, 223 respondents (54.9%) did not see themselves as experts in any of the seven *questionnaire activity groups* and 17 respondents (4.2%) preferred not to say or did not know. The most experts were identified in the *questionnaire activity group* 'food preparation', with 87 respondents (21.4%), followed by 'cleaning and waste disposal', with 60 respondents (14.8%). The least number of experts were reported in the group 'vehicle maintenance', with 30 responses (7.4%).

5.3.3 Multitasking Part of the Questionnaire

The third part of the questionnaire covers the field of multitasking by investigating simultaneous activities. The answers to this part of the questionnaire were essential to answer the research questions 2 and 3. The literature review in Chapter 3 showed that research on multitasking in the unpaid work environment, in particular on how multitasking activities that are recorded in TUS diaries should be split accordingly, was scarce. In order to fill this gap in the literature and to investigate how the respondents perform multitasking activities, the researcher developed some pertinent questions for further analysis in this study.

5.3.3.1 Preference for Polychronic or Monochronic Use of Time

Respondents were asked whether they have a preference for multitasking (*polychronic*) or would rather do things one after the other (*monochronic*). This question is based on the work from Floro and Miles (2003), who claimed that men typically are monochronic and women polychronic, as stated in the literature review. The results of this question are presented in Table 5.13.

Table 5.13: Preference for multitasking or for one task after the other

	Both	Percent	Male	Percent	Female	Percent
Multitask (polychronic)	187	46.1	69	35.9	118	55.1
One task after other (monochronic)	205	50.5	117	60.9	88	41.1
Do not know/ prefer not to say	14	3.4	6	3.1	8	3.7
Total	406	100	192	100	214	100

Source: The author

Of the 406 respondents, 205 (50.5%) preferred to complete one task after the other, 187 (46.1%) preferred multitasking while 14 (3.4%) did not know or preferred not to answer. A breakdown by gender revealed that, of 192 men, 69 (35.9%) preferred multitasking, while the majority of the 214 women, 118 (55.1 %), also provided the same answer.

5.3.3.2 Time Pressure and Multitasking

A 5-point Likert scale from 'very likely' to 'very unlikely' was used to explore whether multitasking is caused by time pressure. Results are summarised in Table 5.14.

Table 5.14: Multitasking caused by time pressure

	Frequency	**Percent**
Very likely	129	31.8
Likely	197	48.5
Neither nor	59	14.5
Unlikely	15	3.7
Very unlikely	6	1.5
Total	406	100

Source: The author

For 326 respondents (80.3%) it was likely or very likely that time pressure causes multitasking. 59 respondents (14.5%) were undecided and 21 (5.2%) indicated that this cause and effect was unlikely or even very unlikely.

5.3.3.3 Impact of Multitasking on Performance

This question used a 5-point Likert scale from 'very likely' to 'very unlikely' to investigate how multitasking may impact on the time duration of activities. For the question, it was assumed that any of the three activities 'talking on the phone', 'socialising with family and friends' and 'listening to the radio' were done together with a typical chore household activity. Respondents were asked how likely they thought it was that the simultaneous activity would extend the time required to finish the household chore activity.

Those three activities were identified by the researcher from the UKTUS data as activities that are often reported with another activity. Because of their nature, it was believed that they needed at least some additional attention by the person performing them.

This question was developed by the researcher based on previous work from Buser and Peter (2012), who identified in their study that multitasking, compared to doing activities one after the other, may negatively impact on a respondent's performance.
The results of this question suggest that treating the time of one activity in exactly the same way as the time of two activities done simultaneously may not be appropriate, although it is standard practice in time use research not to make a distinction. The results for this question are presented in Figure 5.2.

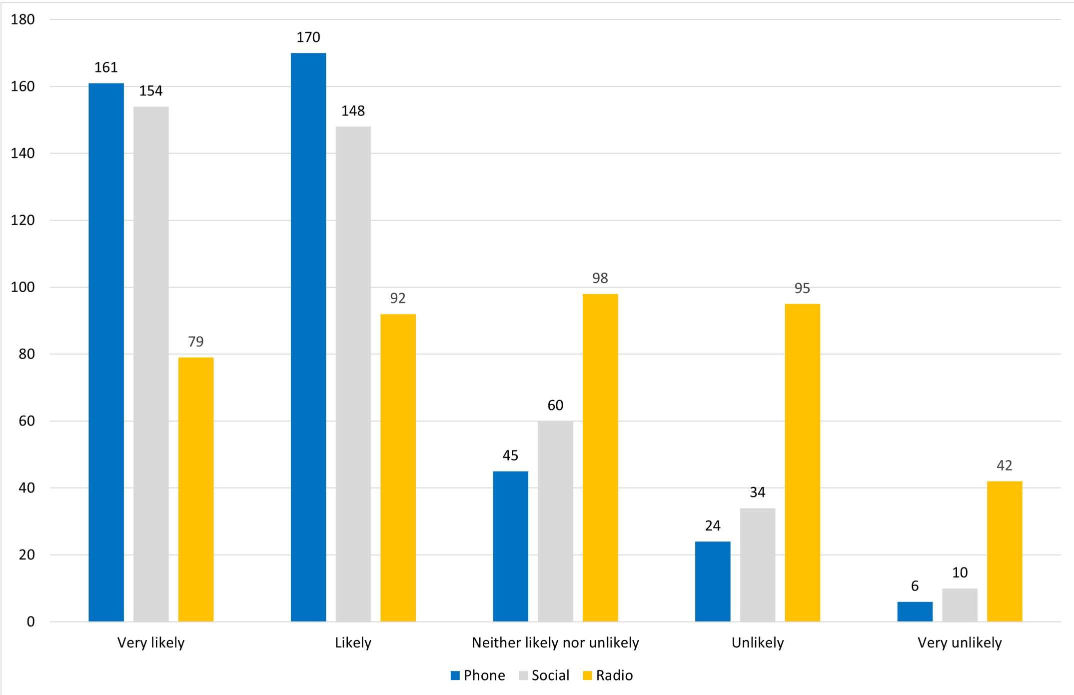


Figure 5.2: Impact of selected simultaneous activities on another unpaid work activity

Source: The author

Of the 406 respondents, 331 (81.5%) believed it was likely or very likely that a phone conversation done while doing another activity reduced the time spent on the other household activity. A total of 302 respondents (74.4%) also stated this for 'socialising with family or friends'. Contrarily, only 6 respondents (1.5%) reported it is very unlikely that the phone conversation, and only 10 respondents (2.5%) thought it is very unlikely that socialising impacts on a second activity.
However, the results are a bit different for the activity 'listening to the radio'. 171 respondents (42.1%) found it likely or very likely, 98 respondents (24.1%) were undecided and 137 respondents (33.7%) believed it was unlikely or very unlikely

that 'listening to the radio' impacts on a second household chore activity and the time spent on it.

5.3.3.4 Splits for Multitasking Activities

The key questions on multitasking were questions 6 to 8 in the questionnaire and had to be developed from scratch by the researcher. They are used to answer research questions 2 and 3. Respondents were asked their personal views on how they would split simultaneous activities for three different scenarios.

In the first scenario, they should think about a situation where two different activities of their choice were done simultaneously within a time period of 12 minutes. They should then decide, from a predefined list of choices, how they would split the 12 minutes on those two activities. In the second scenario, they were asked to do the same for three activities done simultaneously within a 12-minute time period, while in the third scenario they had to split four activities done simultaneously within a 12-minute timeslot. For each scenario, the respondents were provided with a list of choices for possible splits. In scenario 1, they had 6 options, scenario 2 offered 12 and scenario 3 provided 15 choices for the respondents. Only one choice could be selected in each scenario. The choices and results are presented in Table 5.15.

Table 5.15: Frequency count for the three multitasking scenarios

Scenario 1					
Activity 1	**Activity 2**			**Frequency**	**Percent**
6 min	**6 min**			232	57.14
7 min	**5 min**			69	17.00
8 min	**4 min**			69	17.00
9 min	**3 min**			19	4.68
10 min	**2 min**			12	2.96
11 min	**1 min**			5	1.23
Scenario 2					
Activity 1	**Activity 2**	**Activity 3**		**Frequency**	**Percent**
4 min	**4 min**	**4 min**		192	47.29
5 min	**4 min**	**3 min**		51	12.56
5 min	**5 min**	**2 min**		39	9.61
6 min	**3 min**	**3 min**		40	9.85
6 min	**4 min**	**2 min**		28	6.90
6 min	**5 min**	**1 min**		10	2.46
7 min	**3 min**	**2 min**		18	4.43
7 min	**4 min**	**1 min**		6	1.48
8 min	**2 min**	**2 min**		11	2.71
8 min	**3 min**	**1 min**		3	0.74
9 min	**2 min**	**1 min**		0	0.00
10 min	**1 min**	**1 min**		8	1.97
Scenario 3					
Activity 1	**Activity 2**	**Activity 3**	**Activity 4**	**Frequency**	**Percent**
3 min	**3 min**	**3 min**	**3 min**	194	47.78
4 min	**3 min**	**3 min**	**2 min**	36	8.87
4 min	**4 min**	**2 min**	**2 min**	40	9.85
4 min	**4 min**	**3 min**	**1 min**	27	6.65
5 min	**3 min**	**3 min**	**1 min**	13	3.20
5 min	**3 min**	**2 min**	**2 min**	29	7.14
5 min	**4 min**	**2 min**	**1 min**	16	3.94
5 min	**5 min**	**1 min**	**1 min**	9	2.22
6 min	**2 min**	**2 min**	**2 min**	10	2.46
6 min	**3 min**	**2 min**	**1 min**	7	1.72
6 min	**4 min**	**1 min**	**1 min**	3	0.74
7 min	**2 min**	**2 min**	**1 min**	6	1.48
7 min	**3 min**	**1 min**	**1 min**	6	1.48
8 min	**2 min**	**1 min**	**1 min**	2	0.49
9 min	**1 min**	**1 min**	**1 min**	8	1.97

N = 406 and total of 100.0 percent for each scenario

Source: The author

The implementation of a pre-defined list was done for two reasons. First, it was ensured that additional activities could not last longer than the main or primary activity. According to general TUS conventions, the activities are typically prioritised by their duration. This means that a primary activity should not have a longer duration than a secondary, because otherwise the order of primary and secondary would have to change. Second, a pre-defined list avoids misinterpretations and wrong calculations, and thus reduces invalid answers because respondents do not have to sum up the minutes to match the 12 minutes themselves.

Furthermore, the duration of 12 minutes rather than the UKTUS' 10-minute timeslot was chosen for the following two reasons. First, the 12 minutes allowed full-minute equal splits of time for all scenarios of 2, 3 and 4 activities. Second, 12 minutes allowed for a reasonable amount of pre-defined splits. The pretest in the US identified that too many choices (in that case, up to 24 choices were possible for a 20-minute timeslot) had confused respondents and had biased the pretest results.

The results in the above Table 5.15 indicate that, for example, 232 respondents (57.14%) chose an equal split of 6 minutes each for two activities. An equal split of 4 minutes for each of the three simultaneous activities in scenario 2 was reported by 192 respondents (47.29%). A similar result was shown for scenario 3, where 194 respondents (47.78 %) selected the option of an equal split of 3 minutes each for four simultaneous activities. For more than two activities done simultaneously, more than 50% of the sample opted for a non-equal split.

For each scenario and its corresponding number of activities, the mean minutes and mean splits were then calculated using the above-mentioned results. Table 5.16 reports the calculated results for men, women and both genders. Those splits are later applied to the multitasking activities in the calculation of the VoL and allow comparisons by gender also based on the primary data.

Table 5.16: Mean multitasking time and splits by gender

		Both		**Male**		**Female**	
		Min	**Split**	**Min**	**Split**	**Min**	**Split**
Scenario 1	**Activity 1**	6.83	0.5692	6.82	0.5681	6.84	0.5701
	Activity 2	5.17	0.4308	5.18	0.4319	5.16	0.4299
Scenario 2	**Activity 1**	5.04	0.4200	5.04	0.4197	5.04	0.4202
	Activity 2	3.86	0.3214	3.84	0.3199	3.87	0.3228
	Activity 3	3.10	0.2586	3.13	0.2604	3.08	0.2570
Scenario 3	**Activity 1**	3.99	0.3327	3.99	0.3325	4.00	0.3329
	Activity 2	3.17	0.2644	3.10	0.2587	3.23	0.2695
	Activity 3	2.60	0.2163	2.60	0.2166	2.59	0.2161
	Activity 4	2.24	0.1866	2.31	0.1923	2.18	0.1815

N = 406; N_{male}= 192; N_{female}=214

Source: The author

For example, in scenario 2, the mean time for activities 1 to 3 for both genders was 5.04 minutes, 3.86 minutes and 3.10 minutes with the corresponding splits of 0.42, 0.3214 and 0.2586, respectively. The splits for the primary activity of women were slightly higher than the ones for men in all three scenarios.

5.3.3.5 Factors Impacting on Multitasking

The last question of the multitasking part of the questionnaire focused on the factors that may impact on multitasking. A 5-point Likert scale from 'very likely' to 'very unlikely' was used to investigate how respondents rated the impact of demographic factors, also referred to as determinants, on multitasking. The literature review identified seven demographics influencing multitasking, from which six were investigated here: *health*, *age*, *gender*, *education*, *marital status* and *number of children living in a household*. It was hoped to also include *employment* in this question but due to the design limitations of the questionnaire, more than six factors could not be included. This question was predominantly added to the questionnaire to be able to justify the reliability and validity of responses, rather than using it for further analysis. The results are presented in Table 5.17.

Table 5.17: Demographic factors impacting on multitasking

	Health		**Age**		**Gender**		**Education**		**Marital**		**Children**	
	Freq.	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**
Very likely	118	29.1	121	29.8	74	18.2	27	6.7	30	7.4	121	29.8
Likely	176	43.3	177	43.6	102	25.1	101	24.9	77	19.0	153	37.7
Neither nor	77	19.0	70	17.2	101	24.9	140	34.5	135	33.3	80	19.7
Unlikely	26	6.4	32	7.9	69	17.0	92	22.7	78	19.2	25	6.2
Very unlikely	9	2.2	6	1.5	60	14.8	46	11.3	86	21.2	27	6.7
Total	406	100	406	100	406	100	406	100	406	100	406	100

Source: The author

For health and age almost a similar number of respondents said that their impact is likely or very likely on multitasking. This was 294 respondents (72.4%) for health and 298 respondents (73.4%) for age. While 176 respondents (43.3%) felt that gender also was likely or very likely to impact on multitasking, only 128 respondents (31.5%) felt the same for education. A likely or very likely impact on multitasking was assumed for marital status, with 107 respondents (26.4%). 274 respondents (67.5%) also thought that the number of children living in the household likely and very likely impacted on multitasking. Only 9 (2.2%) and 6 (1.5%) respondents, respectively, said that health and age had a very unlikely chance of impacting on multitasking. 60 people (14.8%) thought the same for gender, 86 (21.2%) for marital status, 46 (11.3%) for education and 27 (6.7%) for the number of children.

5.3.4 Quality of Unpaid Household Work Part of the Questionnaire

The next part of the questionnaire was designed to investigate the quality of unpaid household work, which is an essential part to answer research questions 2 to 4. Although this question was developed from scratch, the idea of asking respondents regarding quality is based on work from Dulaney et al. (1992) and Fitzgerald and Wicks (1990), as shown in the literature review. It has been pointed out in Section 4.6.1.1 that the responses provided to this question are based on the respondents' own perceptions, their life experience and personal judgement. Therefore, the responses may be subject to bias because each individual might have a different perception of their own quality. However, research by Dulaney et al. (1992) has shown that a similar type of question allowed for the collection of appropriate data. Based on their successful experience, meaningful results and due to the lack of other options to obtain the required quality data, it has been decided to follow the approach of Dulaney et al. (1992).

In line with the introductory questions, the following seven *questionnaire activity groups* were presented to the respondents: A) Food preparation including cooking and baking (*food*), B) Cleaning and waste disposal (*cleaning*), C) Laundry and ironing (*laundry*), D) Gardening (*gardening*), E) Pet and animal care including dog walking (*pet*), F) House renovation, construction, repair, maintenance (*renovation*), and G) Vehicle maintenance (*vehicle*).

The respondents were asked to select a typical unpaid work activity of their choice for each group A) to G) and compare themselves with a paid market professional. They should consider that a professional worker achieves a quality level of 100% for the completed tasks in each group, and should try to estimate the level of quality they would be able to achieve if they performed the same task. A slider in the questionnaire assisted the respondents, allowing them to select any value between 1% and 200%. Thus, the respondents could rank themselves with a quality that is up to twice as high as the one achieved by a professional, or almost no quality at all, if they believed their quality level was close to only 1%, since they would not be good at that activity.

All cases of reporting quality levels of less than 10% were checked regarding their validity, and only those cases where values seemed plausible were kept. Several analyses were done by the researcher to ensure a high data quality. Those analyses included options of recoding lower quality level reportings and investigating the suitability of applying median quality levels rather than the mean levels. While none of those additional analyses had improved the results, the responses were kept in their original form without any recoding or modifications. The responses were used to calculate mean quality adjustments (weights) for each of the seven *questionnaire activity groups*, as described in Table 5.18. The adjustments are presented in percentage rates on a gender basis for men, women and both genders combined. Those weights are later applied to the specialist wage rates for the calculation of the VoL and to allow comparisons by gender also based on the primary data.

Table 5.18: Quality adjustments (weights) by gender as percentage rates

Variable	**Both**	**Male**	**Female**
Quality_food	92.49	84.02	100.08
Quality_cleaning	99.72	93.49	105.31
Quality_laundry	96.15	88.97	102.59
Quality_gardening	80.41	82.95	78.14
Quality_pet	90.14	85.86	93.97
Quality_renovation	67.85	72.58	63.61
Quality_vehicle	58.69	65.34	52.71

Source: The author

The highest quality level for men, women and both genders appeared for the *questionnaire activity group* ‘cleaning and waste disposal’. While for both genders a mean quality level of 99.72% was reported, men’s quality level was 93.49% and women’s was 105.31% and thus above the quality level of the specialist. The lowest quality level with 58.69% for both genders, 65.34% for men and 52.71% for women was associated with ‘vehicle maintenance’.

5.3.5 Transitional Questions

The two questionnaire parts for quality and productivity were purposely separated by a block of five Likert scale questions. This was hoped to ensure that respondents did not mix up the quality and productivity answers. A scale from ‘very likely’ to ‘very unlikely’ was used to find answers on how likely

1) respondents tend to overestimate their own skills?

2) a payment for unpaid work activities would change the quality level?

3) a payment for unpaid work activities would change the level of productivity?

4) multitasking would reduce respondents' quality level?

5) multitasking would reduce respondents' productivity level?

The answers to these questions were intended to be used for quality assurance and plausibility checks. However, Table 5.19 reveals an interesting result for the first question on overestimating own skills.

Table 5.19: Tendency of respondents overestimating their own skills

	Both	**Percent**	**Men**	**Percent**	**Women**	**Percent**
Very likely	23	5.7	15	7.8	8	3.7
Likely	116	28.6	59	30.7	57	26.6
Neither nor	102	25.1	40	20.8	62	29.0
Unlikely	120	29.6	56	29.2	64	29.9
Very unlikely	45	11.1	22	11.5	23	10.8
Total	406	100	192	100	214	100

Source: The author

23 of the respondents (5.7%) thought it was very likely that they tend to overestimate themselves, while 45 (11.1%) thought the opposite way. Disregarding *neither nor* responses, there was almost no difference between the responses for likely with 116 (28.6%) and unlikely with 120 (29.6%). Overall, almost 1 in 3 respondents tends to overestimate their skills. A further breakdown by gender shows a larger difference for the answers likely and very likely between men and women.

Table 5.20 illustrates the frequency count and percentages of the remaining four transitional questions.

Table 5.20: Possible impact of multitasking or payment on quality and productivity

	Multitasking impact on quality		Multitasking impact on productivity		Payment impact on quality		Payment impact on productivity	
	Freq.	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**
Very likely	53	13.1	50	12.3	50	12.3	60	14.8
Likely	142	35.0	156	38.4	136	33.5	135	33.3
Neither nor	131	32.3	120	29.6	127	31.3	135	33.3
Unlikely	64	15.8	67	16.5	69	17.0	65	16.0
Very unlikely	16	3.9	13	3.2	24	5.9	11	2.7
Total	406	100	406	100	406	100	406	100

Source: The author

Apart from being very useful for quality assurance and plausibility checks, the answers revealed that respondents more likely thought that multitasking may reduce productivity than quality.

5.3.6 Productivity of Unpaid Household Work Part of the Questionnaire

Prior literature as well as the author's pretest questionnaire in the US indicated that the direct measurement of productivity of unpaid work activities is very complicated, because productivity is a variable that most people are not able to make meaningful comparisons with. Therefore, a solution had to be found to work around this problem, using a more suitable variable that respondents in general are more familiar with than productivity. This variable was *time.*

The choice for measuring time instead of productivity, and asking respondents to report the time spent on activities rather than directly asking how they would rank their productivity, was a result of the researcher's US pretest of the questionnaire. That pretest had shown that it was impossible to get plausible responses on how many units a person could produce compared to a specialist or market professional.

According to Gwartney et al. (2003), productivity is calculated by the following Equation 5.1

$$\text{productivity} = \frac{\text{output}}{\text{input}} \tag{5.1}$$

If the output is held constant at a certain production limit (for example, one task completed), and if the assumption is made that, apart from time, no other input factors are considered, time spent on the activity is the only factor that influences productivity, as clearly visible in Equation 5.2.

$$\text{productivity} = \frac{\text{1 task completed}}{\text{time}} \tag{5.2}$$

If the variable time increases, productivity will decrease, and vice versa. Therefore, productivity can be estimated from the input time. This is a new way of estimating productivity in the field of unpaid household work.

Similar to the quality part of the questionnaire, this part about productivity is essential to answer research questions 2 and 3 and used the same seven *questionnaire activity groups* applied in the quality part: A) *food*, B) *cleaning*, C) *laundry*, D) *gardening*, E) *pet*, F) *renovation*, and G) *vehicle*.
Respondents were asked to select a typical unpaid household activity of their choice for each group A) to G) and compare themselves with a paid market professional. They were asked to assume that the professional worker requires 60 minutes to complete each of those tasks. Respondents should estimate how many minutes they would require to complete the same task as the paid market professional. A slider in the questionnaire assisted the respondents, allowing them to select any value between 1 minute and 120 minutes.
There was no guideline in literature that the researcher could have used because this type of question has not been asked in previous studies and thus had to be developed by the researcher. As outlined in the literature review, similar types of ideas have been looked at in the past where other researchers tried to adjust for productivity but this was done in a different manner. The method used in this study is a different, completely new and original approach into the investigation of productivity adjustments. It certainly comes with limitations but also follows the recommendation of the United Nations (2017), which urged researchers to investigate new ideas “until they have what can be considered as a sensible result, based on a set of reasonable and clear assumptions" (p. 29).

Similar to the quality question, the results of this question were also thoroughly analysed to ensure a high data quality. A recoding of reported values of lower than 15, 20 and 30 minutes was investigated, because 30 minutes and less were seen as possibly unrealistic responses. Technically, a response of 120 minutes means that the respondent takes twice as long as the professional to complete a task, while 30 minutes would mean they were twice as fast. In addition to recoding options, imputation methods were investigated, median times were compared to mean times and the exclusions of possibly unrealistic values were also analysed for all cases within the sample reporting a time of less than 30 minutes. Neither a recoding nor an imputation significantly increased the quality of the data, but in some instances caused other implausible results. Median and mean times also did not differ significantly and it was therefore decided to use the mean time for men, women and both genders combined as reported for each of the seven *questionnaire activity groups*. Using mean time is further in line with using mean multitasking splits and mean quality adjustments. From all options looked at, the way chosen by the researcher offers the most robust estimates for productivity in this research.

However, one further step was required to derive productivity results from the collected time data. Based on Equation 5.2 and the assumption of an output of 1 unit, the time was used to calculate the productivity levels. Assuming that the professional achieved a productivity level of 100% (60 minutes), the calculated productivity adjustments (weights) for each of the seven *questionnaire activity groups* are shown as percentage rates in Table 5.21 for men, women and both genders. Those productivity adjustments are later applied to specialist wages to estimate the VoL and further allow for having gender comparisons based on the primary data.

Table 5.21: Productivity adjustments (weights) by gender as percentage rates

Variable	**Both**	**Male**	**Female**
Productivity_food	80.09	77.86	82.09
Productivity_cleaning	91.23	90.31	92.06
Productivity_laundry	89.29	84.05	94.00
Productivity_gardening	83.48	79.97	86.64
Productivity_pet	98.44	95.76	100.85
Productivity_renovation	73.38	67.82	78.36
Productivity_vehicle	77.33	68.68	85.09

Source: The author

The productivity ranges from as low as 67.82% for men in the activity group *renovation* to 100.85% for women for the activity group *pet*. For all seven *questionnaire activity groups* the productivity of women was higher than that of men. This was a rather unexpected finding.

5.3.7 Factors Impacting on Quality and Productivity

The last question of the productivity section focuses on the factors of unpaid household work that may impact on the quality and the time required to complete tasks. This question can be used for the discussion of results concerning research question 4.

A 5-point Likert scale from 'very likely' to 'very unlikely' was used to investigate views of the respondents on how likely six selected demographic factors may impact on the quality of unpaid work and on the time to complete unpaid household work tasks. In line with the demographic factors question on multitasking, *health*, *age*, *gender*, *education*, *marital status* and *number of children living in a household* were the selected demographic factors. Similar to the multitasking question, the design limitations of the questionnaire made it impossible to include *employment* as an additional factor. The results for the factors that may impact on quality are presented in Table 5.22.

Table 5.22: Demographic factors impacting on the quality of unpaid household work

	Health		**Age**		**Gender**		**Education**		**Marital**		**Children**	
	Freq.	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**
Very likely	136	33.5	83	20.4	34	8.4	25	6.2	21	5.2	91	22.4
Likely	195	48.0	197	48.5	69	17.0	97	23.9	49	12.1	162	39.9
Neither nor	60	14.8	86	21.2	171	42.1	152	37.4	152	37.4	93	22.9
Unlikely	13	3.2	32	7.9	77	19.0	89	21.9	108	26.6	28	6.9
Very unlikely	2	0.5	8	2.0	55	13.5	43	10.6	76	18.7	32	7.9
Total	406	100	406	100	406	100	406	100	406	100	406	100

Source: The author

Of the 6 factors, 331 respondents (81.5%) thought that health is the most likely factor to impact on the quality of unpaid household work. Also considered likely or very likely to impact on the quality was the age of people, reported by 280 respondents (68.5%), and the number of children living in the household, reported by 253 respondents (62.3%). The least impact factor was marital status, where 184 respondents (45.3%) said it was either unlikely or very unlikely to impact. Neither gender nor education give a clear indication of whether they affect quality or not, since many respondents reported that they were undecided.

The second part of this question looks at the same demographic factors and their impact on time to complete a task. Results are summarised in Table 5.23.

Table 5.23: Demographic factors impacting on the completion of one task

	Health		Age		Gender		Education		Marital		Children	
	Freq.	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**
Very likely	157	38.7	103	25.4	33	8.1	27	6.7	21	5.2	110	27.1
Likely	178	43.8	197	48.5	94	23.2	90	22.2	64	15.8	164	40.4
Neither nor	62	15.3	82	20.2	177	43.6	163	40.1	165	40.6	83	20.4
Unlikely	8	2.0	23	5.7	63	15.5	86	21.2	84	20.7	24	5.9
Very unlikely	1	0.2	1	0.2	39	9.6	40	9.9	72	17.7	25	6.2
Total	406	100	406	100	406	100	406	100	406	100	406	100

Source: The author

Of the 6 factors, 335 respondents (82.5%) thought that health was the most likely factor to impact on the time to complete a task and thus indirectly may impact on productivity. The variables age, reported by 300 respondents (73.9%), and the number of children living in the household, reported by 274 respondents (67.5%), are also suggested to be important factors. Marital status had the least impact, as 156 respondents (38.4%) reported it was either unlikely or very unlikely to impact on their completion of a task. For both demographic factors, gender and education, there were no clear indications whether they impact on the time needed for completing a task or not.

5.4 Primary Data Reliability and Validity Analysis

The reliability and validity of the primary data were tested, as explained in Chapter 4. According to Brace (2013), a questionnaire can be assumed to be reliable if it was run twice within the exact sample and with consistent results. The pilot questionnaire was identical to the main questionnaire because there were no changes required to it after testing was complete, but the sample, as outlined in Chapter 4, was not identical for the two questionnaires. However, the same panel was used for the pilot and the main questionnaire to draw the sample. Although this is not exactly what Brace (2013) suggested, it nevertheless seemed appropriate to compare the results of the pilot and main questionnaire. The analysis of both samples revealed that the results are consistent and thus the questionnaire and its results are assumed to be reliable.

Also in line with the remarks on testing validity in Chapter 4, the content validity of a questionnaire can be assumed if the questions posed in a questionnaire lead to the best possible and valid results (Cooper & Schindler, 2014; Kothari & Garg, 2019). In line with Brace (2013), a pilot was run and, prior to that pilot, another pretest was done, including seeking the views of experts. All of this allowed for identifying and eliminating errors and problems prior to sending out the questionnaire, which, it is assumed, increased its validity.

The pilot, the pretest and the views of experts established a strong connection between the questions posed in the questionnaire and the research questions. The pilot study and a rigorous pretesting allowed a high construct and face validity, which is in line with the recommendations made by Mitchell and Jolley (2010), as outlined in Chapter 4.

5.5 Matching Questionnaire Activity Groups with the UKTUS Activity Codes

One novel approach of this study is to utilise the primary quality and productivity data for estimating the VoL. As mentioned in Section 5.3.2 above, primary data was collected in a user-friendly way by seven *questionnaire activity groups*. These seven groups need to be connected to the 31 UKTUS activity codes in such a way as to allow a consistent link between the primary and secondary data for the VoL calculation. Without this matching, the primary data quality adjustments (Table 5.18) and productivity adjustments (Table 5.21) cannot be applied to the UKTUS data. Therefore, this connection step is essential for the calculation of the quality and productivity adjustments for each UKTUS activity code, that will feed into the VoL estimates. This procedure follows a similar matching process used by Statistics New Zealand (2001). Table 5.24 explains the connection for the seven *questionnaire activity groups*.

Table 5.24: Matching questionnaire activity groups with UKTUS activity codes

Questionnaire activity groups	**UKTUS activity codes**
Food preparation including cooking and baking	3100, 3110, 3130, 3140, 3190, (20% for 3000)
Cleaning and waste disposal	3200, 3210, 3220, 3230, 3240, 3250, 3290, (20% for 3000)
Laundry and ironing	3300, 3310, 3320, 3330, 3390, (20% for 3000)
Gardening	3410, (50% for 3490), (10% for 3000)
Pet and animal care including dog walking	3420, 3430, 3440, (50% for 3490), (10% for 3000)
House renovation, construction, repair and maintenance	(80% for 3500), 3510, 3520, 3530, 3531, 3539, (80% for 3590), (15% for 3000)
Vehicle maintenance	3540, (20% for 3500), (20% for 3590), (5% for 3000)

Source: The author

Table 5.24 describes, for example, that the quality and productivity values for 'food preparation including cooking and baking' will be applied to the UKTUS codes 3100, 3110, 3130, 3140, 3190 without any further adjustment, but only 20% of the quality or productivity adjustment will feed into code 3000. The UKTUS code 3000 is a residual activity code that covers a variety of different activities. Rather than applying this code to one specific *questionnaire activity group*, it has been split across all seven activity groups using different percentages, based on the work from Statistics New Zealand (2001). A similar procedure was done with other residual UKTUS codes; for example, code 3500.

A better visualisation of this connection is provided in Table 5.25, which presents the transposed view of the matching between the UKTUS and the *questionnaire activity groups*. The table includes a short terminology form of the seven *questionnaire activity groups* (food, clean, laun, gard, pet, reno, vehi) to reduce space in the table. It is important to note that each row in Table 5.25 represents percentage splits and sums to 1.

Table 5.25: Matching UKTUS codes with questionnaire activity groups

UKTUS code	**Description**	**food**	**clean**	**laun**	**gard**	**pet**	**reno**	**vehi**
3000	Unspecified household and family care	.2	.2	.2	.1	.1	.15	.05
3100	Unspecified food management	1						
3110	Food preparation and baking	1						
3130	Dish washing	1						
3140	Preserving	1						
3190	Other specified food management	1						
3200	Unspecified household upkeep		1					
3210	Cleaning dwelling		1					
3220	Cleaning yard		1					
3230	Heating and water		1					
3240	Arranging household goods and materials		1					
3250	Disposal of waste		1					
3290	Other or unspecified household upkeep		1					
3300	Unspecified making and care for textiles			1				
3310	Laundry			1				
3320	Ironing			1				
3330	Handicraft and producing textiles			1				
3390	Other specified making and care for textiles			1				
3410	Gardening				1			
3420	Tending domestic animals					1		
3430	Caring for pets					1		
3440	Walking the dog					1		
3490	Other specified gardening and pet care				.5	.5		
3500	Unspecified construction and repairs						.8	.2
3510	House construction and renovation						1	
3520	Repairs of dwelling						1	
3530	Making repairing and maintaining equipment						1	
3531	Woodcraft metalcraft sculpture and pottery						1	
3539	Other spec. making rep. and maint. equipment						1	
3540	Vehicle maintenance							1
3590	Other specified construction and repairs						.8	.2

Note: While rows sum to 1, this is not the case for the columns.

Source: The author

From Table 5.25 it can be seen, for example, that UKTUS code 3000 is assigned 20% of the quality or productivity adjustments from the three activity groups *food*, *cleaning* and *laundry*, 10% from *gardening* and *pet*, 15% from *renovation* and 5% from *vehicle*. The code 3140 'preserving' was assigned the full quality and productivity adjustment of *food*. Similarly, the UKTUS code 3410 'gardening' is also assigned the full quality or productivity weights of the *questionnaire activity group* '*gardening*'. However, the quality or productivity levels for UKTUS code 3490 'Other specified gardening and pet care' are calculated by using 50% of the *questionnaire activity group* '*gardening*' and 50% of the activity group *pet*.

Table 5.25 was used to calculate the productivity and quality adjustments that were implemented in the different VoL calculations, as outlined below.

With the presentation of the above table, all primary and secondary data required for calculating the VoL are explained. Therefore, the next step is to introduce the novel models that are developed by modifying the traditional approach in various steps, as shown in the literature review.

5.6 Model Building for the VoL Calculations

Based on Figure 3.3, the following Figure 5.3 outlines the four steps required to develop the equations and modifications for the VoL calculation. The results of the VoL calculations are provided in the next chapter, the results chapter.

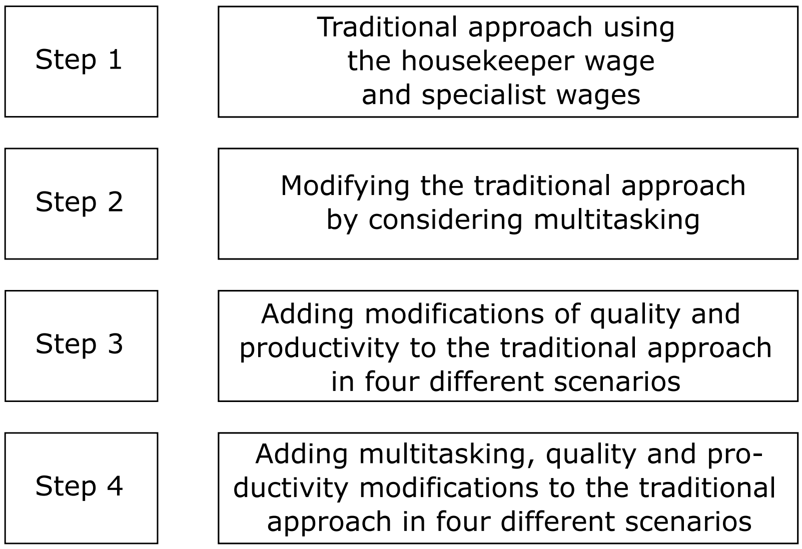


Figure 5.3: Model building steps

Source: The author

5.6.1 Step 1 - Using the Traditional Approach

The first step involves using the traditional approach, which is based on the replacement cost approach explained in Chapter 3, to calculate the VoL. The traditional approach considers and values only one activity, the primary activity, and disregards any other activities done simultaneously by allocating the entire time of a UKTUS episode to the primary activity. As outlined in the literature review chapter, the traditional approach can apply a variety of different wage rates – for example, the minimum wage rate or net wage rates – but most commonly uses two wage rates; the housekeeper wage rate and the specialist wage rate. Although both commonly used wage rates were used in this research study, the housekeeper wage was not part of the modifications. The reasons for this choice as well as the way they were applied are explained next.

5.6.1.1 Traditional Approach using the Housekeeper Wage

The housekeeper wage rate is represented by the SOC2010 code 6231 'housekeepers and related occupations' as can be seen in Table 5.1 above. Due to its overall presence in most VoL calculations and its simplicity, it was decided to include the housekeeper wage, solely for comparison reasons, at some relevant points in this research study. As pointed out in the literature review, adjustments to the housekeeper wage rate, due to the nature of applying a constant wage rate for all activities, are not recommended. Therefore, all the modifications in this study are based on the traditional approach using specialist wage rates.

The VoL using the housekeeper wage is calculated according to Equation 5.3. There is one housekeeper wage rate that is applied to all primary activities. Compared to the traditional equation presented in Chapter 3 (Equation 3.2), a gender index k was added here to allow for separate calculations for men, women and both genders combined.

$$\mathrm{VoL}^{\mathrm{TH}} = \sum_{i \in N} \mathrm{t}_{ik} \, \mathrm{w}_k^{\mathrm{H}} \qquad \forall \;\; k \in K \tag{5.3}$$

where:

TH = indicates using the traditional approach and the housekeeper wage

t = time spent on activities

w^{H} = housekeeper wage

i = individual of the sample N

N = set of all individuals in the sample

k = gender of set K

K = set of gender options {male, female, both genders}

The $\mathrm{VoL}^{\mathrm{TH}}$ is calculated by multiplying the time in hours spent on primary activities of the 31 UKTUS activity codes from 3000 to 3590 by the housekeeper wage rate. This was done for the entire sample and also by gender.

5.6.1.2 Traditional Approach using the Specialist Wages

The specialist wage rate is the wage of a professional worker in the market, which is applied to similar unpaid work activities, as outlined in Table 5.1 above. Other than the housekeeper wage that is consistently used to value all activities with a single wage rate, the specialist wage can be different for each activity. As discussed in the literature review, specialist wage rates have not been applied as often as the housekeeper wage but lay the foundation for this research and the required modifications. All modifications used in this study were applied to the traditional approach using specialist wage rates, as suggested in Chapter 3.
Similar to the housekeeper wage, the traditional approach using specialist wages values just one activity, the primary activity, and disregards any other activities done simultaneously. Based on Equation 3.3 in Chapter 3, Equation 5.4 presents the traditional approach using specialist wages, which has also been updated by a gender index k, allowing for a gender-based VoL calculation.

$$\mathrm{VoL}^{\mathrm{TS}} = \sum_{i \in N} \sum_{j \in D} \mathrm{t}_{ijk} \; \mathrm{w}^{\mathrm{S}}_{jk} \qquad \forall \;\; k \in K \tag{5.4}$$

where:

TS = indicates using the traditional approach and specialist wage rates

t = time spent on activities

w^{S} = specialist wage

i = individual of the sample N

N = set of all individuals in the sample

j= activity of UKTUS code of set D

D = set of all relevant UKTUS activity codes

k = gender of set K

K = set of gender options {male, female, both genders}

The VoL$^{\mathrm{TS}}$ is calculated by multiplying the time in hours spent on primary activities of the selected 31 UKTUS activity codes from 3000 to 3590 by those specialist wage rates that were associated with the relevant activity codes, according to Table 5.5. This was done for all respondents in the sample.

5.6.2 Step 2 - Modifying the Traditional Approach by Considering Multitasking

Following the conceptual framework in Chapter 3 and the steps outlined in Figure 5.3, the first modification of the traditional approach investigates how the VoL changes if not only the primary activity is used for the valuation, but all recorded activities. In this study up to four simultaneous activities of the UKTUS are included.
Based on the traditional approach using specialist wages, Equation 5.4 was updated by a new variable α that reflects the splitting of time spent on multitasking activities as shown in Equation 5.5.

$$\mathrm{VoL}^{\mathrm{M}} = \sum_{i \in N} \sum_{j \in D} \mathrm{t}_{ijku_v} \ \alpha_{iku_v} \ \mathrm{w}^{\mathrm{S}}_{jk} \qquad \forall \ \ k \in K, \ u \in U, \ v \in V \tag{5.5}$$

where:

M = indicates step 2 considering multitasking

t = time spent on activities

w^{S} = specialist wage

α = split of simultaneous activity

i = individual of the sample N

N = set of all individuals in the sample

j= activity of UKTUS code of set D

D = set of all relevant UKTUS activity codes

k = gender of set K

K = {male, female, both genders}

u = number of simultaneous activities of set U

U = set of total number of simultaneous activities

v = number of split applied to u

V = set of total number of splits for simultaneous activities

The variable α is dependent on two factors, represented by index u and index v. The index u indicates the number of the activity an individual has reported within one episode. This could be the primary, secondary, tertiary or quaternary activity based on the UKTUS sample. The index v indicates how many multitasking activities were recorded within one episode. Both indices are required to identify the correct value of α. For example, a secondary activity would be assigned a different split if there are only two simultaneous activities compared to a recording of four. Based on this modification, the VoL^{M} of the sample was calculated for the 31 UKTUS activity codes for primary, secondary, tertiary and quaternary activities using specialist wage rates. The multitasking splits were adopted from Table 5.16 and the VoL was estimated for men, women and both genders combined.

5.6.3 Step 3 - Adding Modifications of Quality and Productivity to the Traditional Approach

In line with the conceptual framework in Chapter 3 and Figure 5.3, step 3 involves adjustments of the specialist wage rate for quality and productivity differences. This step modifies the traditional approach using specialist wage rates (Equation 5.4) and thus, focuses on the primary activity only. Contrarily to step 2, step 3 completely disregards simultaneous activities, but they are again accounted for in step 4.
Four scenarios are considered for the quality and productivity adjustments.

- Scenario 3.1: Variable β adjusting for quality (see Equation 5.6)
- Scenario 3.2: Variable γ adjusting for productivity (see Equation 5.7)
- Scenario 3.3: Average of both quality (β) and productivity (γ) adjustments are applied (see Equation 5.8)
- Scenario 3.4: The product of quality (β) and productivity (γ) adjustments are applied (see Equation 5.9)

5.6.3.1 Scenario 3.1

In the first scenario, the traditional approach is updated by adding the new variable β that accounts for different levels of the quality of unpaid work. This modification changes Equation 5.4 to Equation 5.6.

$$\mathrm{VoL^Q} = \sum_{i\in N}\sum_{j\in D} \mathrm{t}_{ijk}\ \mathrm{w}^{\mathrm{S}}_{jk}\ \beta_{ijk} \qquad \forall\ k \in K \tag{5.6}$$

where:

Q = indicates step 3 adjusting for quality

t = time spent on activities

$\mathrm{w^S}$ = specialist wage

β = weight for quality adjustment

i = individual of the sample N

N = set of all individuals in the sample

j= activity of UKTUS code of set D

D = set of all relevant UKTUS activity codes

k = gender of set K

K = {male, female, both genders}

5.6.3.2 Scenario 3.2

In a similar way to the previous scenario, the traditional approach was updated by adding the new variable γ to Equation 5.4. γ accounts for different levels of the productivity of unpaid work. This modification is shown in Equation 5.7.

$$\mathrm{VoL^P} = \sum_{i\in N}\sum_{j\in D} \mathrm{t}_{ijk}\ \mathrm{w}^{\mathrm{S}}_{jk}\ \gamma_{ijk} \qquad \forall\ k \in K \tag{5.7}$$

where:

P = indicates step 3 adjusting for productivity

t = time spent on activities

w^S = specialist wage

γ = weight for productivity adjustment

i = individual of the sample N

N = set of all individuals in the sample

j= activity of TUS code of set D

D = set of all TUS activity codes

k = gender of set K

K = {male, female, both genders}

5.6.3.3 Scenario 3.3

In addition to the application of a single adjustment either for quality or productivity, a combination of both adjustments is suggested. In scenario 3 the average of the quality and productivity adjustment was added as a modification to Equation 5.4 and is presented by Equation 5.8.

$$\mathrm{VoL}^{\mathrm{QPA}} = \sum_{i \in N} \sum_{j \in D} \mathrm{t}_{ijk} \;\; \mathrm{w}^{\mathrm{S}}_{jk} \, (\frac{\beta_{ijk} + \gamma_{ijk}}{2}) \qquad \forall \;\; k \in K \tag{5.8}$$

where:

QPA = indicates step 3 adjusting for the average of quality and productivity

t = time spent on activities

w^S = specialist wage

β = weight for quality adjustment

γ = weight for productivity adjustment

i = individual of the sample N

N = set of all individuals in the sample

j= activity of UKTUS code of set D

D = set of all relevant UKTUS activity codes

k = gender of set K

K = {male, female, both genders}

5.6.3.4 Scenario 3.4

A different combination of both adjustments was suggested in scenario 3.4. The modification added the product of the quality and productivity adjustment to the traditional Equation 5.4. The changes are reflected in Equation 5.9.

$$\mathrm{VoL}^{\mathrm{QPX}} = \sum_{i \in N} \sum_{j \in D} \mathrm{t}_{ijk} \;\; \mathrm{w}^{\mathrm{S}}_{jk} \, \beta_{ijk} \, \gamma_{ijk} \qquad \forall \;\; k \in K \tag{5.9}$$

where:

QPX = indicates step 3 adjusting for product of quality and productivity

t = time spent on activities

w^{S} = specialist wage

β = weight for quality adjustment

γ = weight for productivity adjustment

i = individual of the sample N

N = set of all individuals in the sample

j= activity of UKTUS code of set D

D = set of all relevant UKTUS activity codes

k = gender of set K

K = {male, female, both genders}

The VoL calculations of step 3 are done individually for each of the four scenarios (3.1 to 3.4). The time on hours spent for all 31 UKTUS activity codes was multiplied by the corresponding specialist wage rates (Table 5.5) and taking into account the suggested adjustments for quality and productivity, as described above. Also taken into account were gender-based estimates of the VoL.

5.6.4 Step 4 - Adding Multitasking, Quality and Productivity Modifications to the Traditional Approach

Following the steps outlined in the conceptual framework in Chapter 3 and Figure 5.3, this step involves modifying the traditional approach using specialist wage rates (Equation 5.4) by including splits for multitasking in line with step 2, and adjustments for quality, productivity or a combination of both, similar to step 3. Therefore, step 4 combines the modifications of steps 2 and 3 in a novel approach. Similar to step 3, step 4 also considers the four scenarios for the quality and productivity adjustment, but also includes multitasking.

5.6.4.1 Scenario 4.1

The first scenario adds the variable α for multitasking splits and β for quality adjustments to the traditional approach as shown in Equation 5.10.

$$\mathrm{VoL}^{\mathrm{MQ}} = \sum_{i \in N} \sum_{j \in D} \mathrm{t}_{ijku_v}\ \alpha_{iku_v}\ \mathrm{w}^{\mathrm{S}}_{jk}\ \beta_{ijk} \qquad \forall\ \ k \in K,\ u \in U,\ v \in V \tag{5.10}$$

where:

MQ = indicates step 4 considering multitasking and adjusting for quality

t = time spent on activities

w^{S} = specialist wage

α = split of simultaneous activity

β = weight for quality adjustment

i = individual of the sample N

N = set of all individuals in the sample

j= activity of UKTUS code of set D

D = set of all relevant UKTUS activity codes

k = gender of set K

K = {male, female, both genders}

u = number of simultaneous activities of set U

U = set of total number of simultaneous activities

v = number of split applied to u

V = set of total number of splits for simultaneous activities

5.6.4.2 Scenario 4.2

The modifications in this scenario are shown in Equation 5.11 and consider the splits for multitasking activities α and the adjustment for productivity γ.

$$\mathrm{VoL}^{\mathrm{MP}} = \sum_{i \in N} \sum_{j \in D} \mathrm{t}_{ijku_v}\ \alpha_{iku_v}\ \mathrm{w}^{\mathrm{S}}_{jk}\ \gamma_{ijk} \qquad \forall\ \ k \in K,\ u \in U,\ v \in V \tag{5.11}$$

where:

MP = indicates step 4 considering multitasking and adjusting for productivity

t = time spent on activities

w^{S} = specialist wage

α = split of simultaneous activity

γ = weight for productivity adjustment

i = individual of the sample N

N = set of all individuals in the sample

j= activity of UKTUS code of set D

D = set of all relevant UKTUS activity codes

k = gender of set K

K = {male, female, both genders}

u = number of simultaneous activities of set U

U = set of total number of simultaneous activities

v = number of split applied to u

V = set of total number of splits for simultaneous activities

5.6.4.3 Scenario 4.3

The third scenario added the multitasking adjustment α and the average of the quality (β) and productivity (γ) adjustment to the traditional approach, as shown in Equation 5.12.

$$\mathrm{VoL}^{\mathrm{MQPA}} = \sum_{i \in N} \sum_{j \in D} \mathrm{t}_{ijku_v}\, \alpha_{iku_v}\, \mathrm{w}^{\mathrm{S}}_{jk}\, (\frac{\beta_{ijk} + \gamma_{ijk}}{2}) \qquad \forall\ k \in K,\ u \in U,\ v \in V \quad (5.12)$$

where:

MQPX = indicates step 4 considering multitasking and adjusting for the average of quality and productivity

t = time spent on activities

w^{S} = specialist wage

α = split of simultaneous activity

β = weight for quality adjustment

γ = weight for productivity adjustment

i = individual of the sample N

N = set of all individuals in the sample

j= activity of UKTUS code of set D

D = set of all relevant UKTUS activity codes

k = gender of set K

K = {male, female, both genders}

u = number of simultaneous activities of set U

U = set of total number of simultaneous activities

v = number of split applied to u

V = set of total number of splits for simultaneous activities

5.6.4.4 Scenario 4.4

The fourth scenario applied the multitasking adjustment α and the product of the adjustment for quality (β) and productivity (γ) to the traditional approach. The changes are presented in Equation 5.13.

$$\mathrm{VoL}^{\mathrm{MQPX}} = \sum_{i \in N} \sum_{j \in D} \mathrm{t}_{ijku_v}\ \alpha_{iku_v}\ \mathrm{w}^{\mathrm{S}}_{jk}\ \beta_{ijk}\ \gamma_{ijk} \qquad \forall\ \ k \in K,\ u \in U,\ v \in V \quad (5.13)$$

where:

MQPX = indicates step 4 considering multitasking and adjusting for product of quality and productivity

t = time spent on activities

w^{S} = specialist wage

α = split of simultaneous activity

β = weight for quality adjustment

γ = weight for productivity adjustment

i = individual of the sample N

N = set of all individuals in the sample

j= activity of UKTUS code of set D

D = set of all relevant UKTUS activity codes

k = gender of set K

K = {male, female, both genders}

u = number of simultaneous activities of set U

U = set of total number of simultaneous activities

v = number of split applied to u

V = set of total number of splits for simultaneous activities

For each of the four scenarios (4.1 to 4.4), the VoL was calculated for the relevant 31 UKTUS activity codes. The time spent on primary, secondary, tertiary and quaternary activities was split in line with Table 5.16 and multiplied with the suitable specialist wage rates that were adjusted for quality, productivity or both of them, as described above. The VoL was estimated for men, women and both genders combined to allow gender-based comparisons.

Here, it is worth pointing out that this research offers two different perspectives for gender-based comparisons; one is based on secondary data and another one is based on primary data. The first perspective only applies the splits and adjustments of both genders to the secondary data. This concerns the majority of the VoL calculations in this research. The second perspective applies the primary data splits and weights for men and women to the secondary data. This allows for further investigating the extent to which gender-based splits and adjustments impact on the VoL estimates, and those results are presented separately at the end of the results section in Chapter 6.

In the next section, the regression model building is explained. It aims to analyse whether selected demographics of the respondents may impact on the quality of their unpaid household work.

5.7 Regression Model Building

In line with the literature review and the methodology chapter, a regression analysis was done to answer the fourth research question. Multiple linear Ordinary Least Squares (OLS) regression analysis was used to evaluate whether selected demographics affect the quality of unpaid household work for any of the seven *questionnaire activity groups* outlined above: *food*, *cleaning*, *laundry*, *gardening*, *pet*, *renovation* and *vehicle.*

Differing from the VoL model that uses both primary and secondary data, the regression analysis only focuses on the primary data of quality, as reported in Table 5.18, and data on demographics of the respondents, presented in Tables 5.6 to 5.12. The primary data on productivity and multitasking were excluded from the regression and the reason for that choice is explained as follows. The primary data collection on multitasking was specifically designed to answer research questions 2 and 3. Due to the nature of that data, it could not be applied as a dependent variable in a regression in a meaningful way. A similar argument applies to the primary data on productivity. The productivity data obtained are based on the time duration to complete one task. Thus, the productivity of respondents was not directly measured but calculated. It is uncertain to what extent this calculation process would influence the regression results and therefore, it was decided to exclude the productivity data from the regression.

As a consequence, it was decided to only use the quality data as the dependent variable in the regression analysis.

5.7.1 Identification of Regression Variables

According to Backhaus et al. (2016) and Pardoe (2006), the first step of a regression analysis is building the regression model and defining the variables. The decision of choosing an OLS regression was made in line with the literature that recommends using a multiple linear regression analysis in case the dependent variable – in this case the quality of unpaid work – is a continuous variable and at least two predictor variables are applied to investigate the relationship between the dependent and independent variable (Zikmund et al., 2010). Other than the dependent variable, the independent variables in a multiple regression do not have be continuous and can also be categorical (von Eye & Schuster, 1998).

The literature review of this study revealed that little research has been done on how demographics may impact on the quality of unpaid household work. However, research on demographics that might influence multitasking or the allocation of time regarding unpaid work was done in the past. In those areas, the review of the literature identified seven main demographics: *age*, *children living in own household*, *employment*, *gender*, *marital status*, *education* and *health*.

It is assumed that those seven demographics may also impact on the quality of unpaid household work and thus were selected as the independent variables for this regression.

This decision was made despite the fact that the questionnaire offers data on two additional demographics, the 'number of adults living in household' and the 'number of children aged 8-17 years living in household' as shown in Table 5.8. Nevertheless, it was decided to exclude those two demographics from the regression analysis for the following two reasons. First is the lack of supporting literature on those additional demographics. Second is the uncertainty of the extent to which the responses on those two demographics are biased, because, compared to all other responses on demographics, the number of values that had to be imputed or recoded was much higher. To rule out the possibility that those two demographics may distort the regression results, they were excluded.

For the regression, this leaves the seven demographic variables *age, gender, marital status, education, number of children aged 0-7 years, employment* and *health* as the independent variables. Those seven independent variables are either nominal or ordinal (categorical) data and therefore, as suggested by Field (2009), Frost (2019), Urban and Mayerl (2006), and von Eye and Schuster (1998), need to be dummy coded before they can be applied to a regression model. It should be noted that those variables are also referred to as binary or dichotomous and due to their characteristics, they take on a special role in regression models, which must be taken into account accordingly (Cohen & Cohen, 1983; Hair et al., 2003; Moosbrugger, 2002).

5.7.2 Binary Coding of Regression Variables

Field (2009) stated that multiple dummy variables can be used in a multiple regression model and according to Urban and Mayerl (2006) categorical data with k categories need to be coded to $k - 1$ dummy variables. However, over-fitting a model with too many variables may produce misleading results and therefore should be avoided. For the seven demographic variables *age, gender, marital status, education, number of children aged 0-7 years, employment, health* with a total of $k = 41$ categories, dummy coding would have resulted in $41 - 7 = 34$ independent variables. It is recommended that for each variable of the regression model the sample should at least contain 10 to 15 and, depending on the source of literature, even up to 50 cases (Babyak, 2004; Harrell et al., 1996; Harrell, 2015). However, studies showed that the lower boundary of 10 might be too low for a multiple regression. Assuming that 15 cases per dependent variable provide robust results, based on the $N = 406$ cases of the primary data sample, the number of variables in this study should not exceed 27 ($406/15 = 27.07$), otherwise it may reduce the power of the regression model.

Another problem of creating dummy variables for each category is the increasing complexity when it comes to the interpretation of the regression results. For each variable, a reference group needs to be chosen and this reference group will later

be the basis for any interpretation (Field, 2009; Schendera, 2008). If this reference group is inappropriately chosen or only represents a small marginal group, it can considerably reduce the significance of the result (Backhaus et al., 2016; Frost, 2019; Schendera, 2008). This problem can be avoided by grouping categories of one variable into more meaningful groups (Frost, 2019; Schendera, 2008; von Eye & Schuster, 1998). It therefore has been decided to recode each of the seven demographic variables into a binary variable.
The decision on how to divide the categories of each variable into two parts was adapted from the literature review and the studies on factors impacting on the time allocation and multitasking as no further guidance was available from previous research studies.

Using binary variables as the only independent variables in a regression would also allow researchers to perform an analysis of variance, but according to Cohen and Cohen (1983), Pedhazur and Kerlinger (1982), and Schendera (2008) a regression analysis is considered equivalent and may also be superior in some cases. Using the superior option, this study applies a regression analysis.

5.7.2.1 Variable *age*

Based on the six age categories collected through the questionnaire, the variable *age* was binary coded to the variable *ageB* where the value of 1 was assigned to respondents 65 years and younger while the age group of 66 years and older was assigned the value of 0. In the literature review it was identified that the age of people tends to have an impact on unpaid work, and in particular people younger than 65 years spent less time on unpaid work than older people (De Vaus et al., 2003). This justifies the choice for the group.

$$ageB = \begin{cases} 1, & \text{if respondent is 65 years or younger (n=328)} \\ 0, & \text{if respondent is 66 years and older (n=78)} \end{cases} \tag{5.14}$$

5.7.2.2 Variable *number of children aged 0-7 years*

This variable was binary coded to *childB* where the value 1 represents the households with at least one child aged 7 years or younger living in the household; if no children of that age group live in the household, that group was assigned the value of 0. In the literature review it was identified that the number and the young age of children living in the own household increase the amount of unpaid work (Bloemen & Stancanelli, 2014; Destatis, 2015).

$$childB = \begin{cases} 1, & \text{if children of 0-7 years live in household (n=81)} \\ 0, & \text{if no children of 0-7 years live in household (n=325)} \end{cases} \tag{5.15}$$

5.7.2.3 Variable *employment*

For the binary variable *employmentB* respondents were split into two groups. One covers all respondents who claimed to be employed, which is assigned the value of 1. The other group, covering those who responded they were not employed, was assigned the value of 0. The latter group includes unemployed but also retired people, students, long-term sick people and those who responded 'something else'. This split is based on the literature review which revealed that employment of people impacts on the allocation of work (Shelton & John, 1996).

$$employmentB = \begin{cases} 1, & \text{if respondent is employed (n=233)} \\ 0, & \text{if respondent is not employed (n=173)} \end{cases} \tag{5.16}$$

5.7.2.4 Variable *gender*

For the binary variable *genderB* the value 1 represents men while women were assigned the value of 0. This variable was already coded dichotomous but was recoded to be in line and consistent with the other binary variables and general conventions.

$$genderB = \begin{cases} 1, & \text{if gender is male (n=192)} \\ 0, & \text{if gender is female (n=214)} \end{cases} \tag{5.17}$$

5.7.2.5 Variable *marital status*

The primary data results of the variable *marital status* were split into respondents who live with a partner (assigned the value of 1) and those who live without a partner (value of 0). The new binary variable is termed *maritalB*. The literature review identified that the marital status impacts on time allocation and multitasking (Bloemen & Stancanelli, 2014; Destatis, 2015). This impact is supposed to be different between people living alone and couples.

$$maritalB = \begin{cases} 1, & \text{if respondent is living with partner (n=237)} \\ 0, & \text{if respondent is not living with partner (n=169)} \end{cases} \tag{5.18}$$

5.7.2.6 Variable *education*

For the new binary variable *educatB* respondents who claimed to hold a university, college or post-graduate degree were included in the higher education category with a value of 1, while all other education levels were coded 0. This choice was made based on prior studies showing that higher education tends to have an impact on unpaid work (Bloemen & Stancanelli, 2014; Guryan et al., 2008; Ruuskanen, 2004; Shelton & John, 1996).

$$educatB = \begin{cases} 1, & \text{if education level is a university, college degree or higher (n=157)} \\ 0, & \text{if education is lower then a university or college degree (n=249)} \end{cases} \tag{5.19}$$

5.7.2.7 Variable *health*

In this study, all respondents who reported a health status of either 'good' or 'very good' were given the value of 1 and the other three health categories 'fair', 'poor' and 'very poor' were assigned the value of 0. The new binary variable is *healthB*. According to the literature review a good level of individual health impacts on the time spent on unpaid work (Gimenez-Nadal & Molina, 2015; Podor & Halliday, 2012).

$$healthB = \begin{cases} 1, & \text{if health is good or very good (n=258)} \\ 0, & \text{if health is fair, poor or very poor (n=148)} \end{cases} \tag{5.20}$$

5.7.3 Regression Model Equation

The definition of the variables leads to the following regression equation:

$$\begin{aligned} Y_i = b_0 + b_1\ ageB_i + b_2\ childB_i + b_3\ employB_i + b_4\ genderB_i\ + \\ b_5\ maritalB_i + b_6\ educatB_i + b_7\ healthB_i + \epsilon \end{aligned} \tag{5.21}$$

where i represents one of the seven *questionnaire activity groups* investigated.

It needs to be noted that due to the scarcity of studies on how demographics may impact on the quality of unpaid household work, a prediction of the expected outcome of the regression results could not be determined for all seven regressions in a plausible way without making arbitrary assumptions. Therefore, it was decided to interpret the regression results as they are, without comparing them to any expectations on the outcome. The results of the regression analysis are presented and discussed in the next chapter.

5.8 Chapter Conclusion

This chapter establishes a link between the methodology chapter and the following results chapter of the VoL calculation and the regression analysis by presenting detailed explanations of the primary and secondary data. It was further explained in detail how the sets of data were connected to make them fit for this research. This connection and the traditional approach of the VoL calculation provided the basis for developing the novel models of the VoL, which were explained step by step.

Furthermore, the model for the regression analysis was built to test whether the seven selected independent demographic variables could predict the quality of unpaid household work for the seven *questionnaire activity groups*.

The results of the VoL calculations by applying the traditional and modified approaches as well as the regression results are presented in the next chapter.

Chapter 6

Results of the Valuation of Labour, the Regression and Discussion of Key Findings

6.1 Introduction to Chapter

This chapter presents the VoL results of the models outlined in the four steps of the previous chapter, and provides comparison tables to show the differences between the modifications and the traditional model of the VoL. A regression analysis investigating the relationship between selected demographics and the quality of unpaid work is also presented. Furthermore, the key findings are discussed.

6.2 Preliminary Explanation of Reporting the Results

Prior to presenting the VoL results in a variety of different tables, and due to the massive amount of data introduced, it is necessary that this section provides an overview on how the results should be read and understood. Furthermore, it explains the terminologies used, which apply to all the tables in the Sections 6.3 to 6.6.

The VoL calculations of the traditional and modified approaches were done using the UKTUS data for time spent on the 31 selected UKTUS activity codes. Rather than presenting results on all 31 activities individually, they were grouped according to their 2-digit UKTUS activity codes, already described in Table 5.5 of the previous chapter. Those 2-digit codes were 30 'unspecified household and family care', 31 'food management', 32 'household upkeep', 33 'making and care for textiles', 34 'gardening and pet care', and 35 'construction and repairs'.

Wage data for the VoL calculations came from the ASHE, while the primary data provided the splits for multitasking and the adjustments for quality and productivity.

The VoL results reported in Sections 6.3 to 6.6 are presented for men, women and both genders combined, to allow gender-based comparisons. Secondary data from the UKTUS and ASHE was included in the VoL calculations by gender, while the primary data that was applied for the splits of multitasking and the adjustments of quality and productivity had not been separated and investigated by gender. As already mentioned in the previous chapter, whether or not primary data on a gender basis did have an impact on the VoL results was investigated separately in Section 6.8.

To allow a better understanding of the results, again it needs to be pointed out that the UKTUS sample consisted of 14,283 diary entries, as shown in Table 5.3. The result tables in Sections 6.3 to 6.6 present the VoL as a total monetary number for the entire sample of the 14,283 diaries, as well as the total VoL for men, based on their 6,551 diaries, and for women, based on their 7,732 diaries. Dividing the VoL estimates by the number of diaries from men, women and the total of both gender provides monetary values on a per-person basis. Those values reflect the average daily contribution of a single person of the target population to the economy and are reported in the 'person' column of the tables in Sections 6.3 to 6.6.

Multiplying those daily average values with the number of adults living in the UK, and by the 365 days of a year, provides the total annual VoL of the adult UK population. This annual number could then be compared with the UK's annual GDP, presented in Chapter 2, to evaluate the contribution of the selected unpaid household work activities to the economy.

However, an economy-wide VoL number is not of importance to this research because its purpose is not estimating or calculating the size of the UK economy. Rather, the focus of this study is on the VoL of unpaid household work, its calculation and the difference of the modifications compared to the traditional approach. Nevertheless,

indicative comparisons on an economy-wide level were found to be suitable at some stages of the discussion of the results and might also be a supportive element when answering research questions 3 and 5. In those instances, the VoL for the adult UK population was presented additionally. This mainly appeared in the discussion section 6.9.
In line with the 5-year average for the ASHE wage rates covering the years 2015-2019, the GDP number applied in this research, as well as the population estimate of the UK adult resident population, was also based on a 5-year average of the years 2015-2019. Based on Table 2.1 the UK GDP number of that average period was calculated at £2,095,731,200,000. The UK adult population was estimated at 52,422,894 residents, in line with data from the OECD (2022b), ONS (2021c), and United Nations (2022b). The annual population estimates are available in Appendix C.

The presentation of the VoL results follows the order of the steps and scenarios outlined in Chapter 5. Each table in Sections 6.3 to 6.6 showed the aggregated $\mathrm{VoL_{all}}$ that combines all 2-digit UKTUS codes from 30 to 35 and thus includes all 31 UKTUS activity codes that were investigated in this study. For each of those 2-digit codes, a breakdown was shown ($\mathrm{VoL_{30}}$ to $\mathrm{VoL_{35}}$) that provided an overview of the contribution from each 2-digit activity code towards the $\mathrm{VoL_{all}}$. An additional column in the tables in Sections 6.3 to 6.6 also presents this contribution as a percentage of the total $\mathrm{VoL_{all}}$. To be able to clearly distinguish the different VoL estimates of the various steps investigated, each VoL was assigned with an index, in line with the notation used in Equations 5.3 to 5.13, in the previous chapter. For example, index TH ($\mathrm{VoL^{TH}}$) for the traditional approach using the housekeeper wage, or MQ ($\mathrm{VoL^{MQ}}$) for the VoL considering multitasking and adjusting for quality. Further, the step or scenario looked at is clearly labelled. For example, 'Step1TS' denotes for the first step using the traditional approach with specialist wage rates. Similarly, 'Step3Scen4' is for the third step and fourth scenario.
Apart from rounding differences, the sum of all the six breakdown estimates $\mathrm{VoL_{30}}$ to $\mathrm{VoL_{35}}$ matches the $\mathrm{VoL_{all}}$. However, adding up the monetary values for men and women in each row of the tables does not exactly match the monetary value of both genders combined for that row. The reasons for this are, in addition to rounding differences, the way that gender-based wage rates were applied, as presented in Table 5.5 and the complex matching of UKTUS activity codes with *questionnaire activity*

groups, as described in Tables 5.24 and 5.25.

Furthermore, in Section 6.7, the VoL results of steps 1 to 4 are summarised for the VoL_{all} and VoL_{30} to VoL_{35} to allow a better comparison in terms of the magnitudes of changes which are required to answer research question 3.

6.3 Step 1 - VoL using the Traditional Approach

Step one presented the results for the traditional approach using the housekeeper wage, and the specialist wage rates without any adjustments or modifications. The traditional approach only valued primary activities; namely multitasking is not considered.

6.3.1 VoL of Traditional Approach using the Housekeeper Wage

The VoL results for the traditional approach using the housekeeper wage are shown in Table 6.1. For the entire sample, the $\text{VoL}_{\text{all}}^{\text{TH}}$ was £276,397 for both genders combined, £101,906 for men and £175,372 for women. The average daily $\text{VoL}_{\text{all}}^{\text{TH}}$ on a per person basis was £19.35 for both, £15.56 for men and £22.68 for women.

Table 6.1: VoL of traditional approach using the housekeeper wage

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
$\text{VoL}_{\text{all}}^{\text{TH}}$	£276,397	£19.35	100.00	£101,906	£15.56	100.00	£175,372	£22.68	100.00
$\text{VoL}_{30}^{\text{TH}}$	£13,456	£0.94	4.87	£2,792	£0.43	2.74	£10,662	£1.38	6.08
$\text{VoL}_{31}^{\text{TH}}$	£108,998	£7.63	39.44	£36,303	£5.54	35.62	£72,963	£9.44	41.60
$\text{VoL}_{32}^{\text{TH}}$	£68,049	£4.76	24.62	£23,507	£3.59	23.07	£44,727	£5.78	25.50
$\text{VoL}_{33}^{\text{TH}}$	£26,717	£1.87	9.67	£3,828	£0.58	3.76	£22,850	£2.96	13.03
$\text{VoL}_{34}^{\text{TH}}$	£43,220	£3.03	15.64	£22,579	£3.45	22.16	£20,915	£2.70	11.93
$\text{VoL}_{35}^{\text{TH}}$	£15,956	£1.12	5.77	£12,896	£1.97	12.65	£3,255	£0.42	1.86

Source: The author

The Table 6.1 also provides six breakdowns for the 2-digit codes $\text{VoL}_{30}^{\text{TH}}$ to $\text{VoL}_{35}^{\text{TH}}$ showing their contribution to the total $\text{VoL}_{\text{all}}^{\text{TH}}$ as monetary values for the sample, the average individual and as a percentage of the $\text{VoL}_{\text{all}}^{\text{TH}}$. The largest contribution to the $\text{VoL}_{\text{all}}^{\text{TH}}$ for male, female and both was identified in the $\text{VoL}_{31}^{\text{TH}}$ group 'food management' with 39.44% for both genders, 35.62% for men and 41.6% for women. The lowest contribution from both genders combined and men was found in the $\text{VoL}_{30}^{\text{TH}}$ group 'unspecified household and family care' with 4.87% and 2.74%. Women showed the lowest contribution in the $\text{VoL}_{35}^{\text{TH}}$ group 'construction and repairs' with only 1.86%. A comparison of the VoL in the typical household chores activity groups $\text{VoL}_{31}^{\text{TH}}$ 'food management', $\text{VoL}_{32}^{\text{TH}}$ 'household upkeep' and $\text{VoL}_{33}^{\text{TH}}$ 'making and care for textiles' between men and women revealed a higher contribution from women, while the contribution from men exceeded those from women for the groups $\text{VoL}_{34}^{\text{TH}}$ 'gardening and pet care' and $\text{VoL}_{35}^{\text{TH}}$ 'construction and repairs'.

6.3.2 VoL of Traditional Approach using the Specialist Wage

Table 6.2 presented the VoL results based on the traditional approach using specialist wages. For all UKTUS activity codes, the $\text{VoL}_{\text{all}}^{\text{TS}}$ resulted in a total of £307,947 for both genders, £117,164 for men and £184,011 for women. On a per person basis this averaged to £21.56 for both, £17.88 for men and £23.80 for women.

Table 6.2: VoL of traditional approach using the specialist wage

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
$\text{VoL}_{\text{all}}^{\text{TS}}$	£307,947	£21.56	100.00	£117,164	£17.88	100.00	£184,011	£23.80	100.00
$\text{VoL}_{30}^{\text{TS}}$	£14,791	£1.04	4.80	£3,116	£0.48	2.66	£11,677	£1.51	6.35
$\text{VoL}_{31}^{\text{TS}}$	£117,560	£8.23	38.18	£39,418	£6.02	33.64	£75,511	£9.77	41.04
$\text{VoL}_{32}^{\text{TS}}$	£75,177	£5.26	24.41	£26,566	£4.06	22.67	£46,213	£5.98	25.11
$\text{VoL}_{33}^{\text{TS}}$	£30,141	£2.11	9.79	£4,356	£0.66	3.72	£23,557	£3.05	12.80
$\text{VoL}_{34}^{\text{TS}}$	£47,374	£3.32	15.38	£25,476	£3.89	21.74	£22,889	£2.96	12.44
$\text{VoL}_{35}^{\text{TS}}$	£22,904	£1.60	7.44	£18,230	£2.78	15.56	£4,164	£0.54	2.26

Source: The author

Similarly to Table 6.1 listing the housekeeper wage results, Table 6.2 provides six breakdowns for the 2-digit codes $\text{VoL}_{30}^{\text{TS}}$ to $\text{VoL}_{35}^{\text{TS}}$ that reflect their monetary contribution to the total $\text{VoL}_{\text{all}}^{\text{TS}}$.

The largest contribution to the $\text{VoL}_{\text{all}}^{\text{TS}}$ for both genders, male and female, came from the $\text{VoL}_{31}^{\text{TS}}$ activity group 'food management' with 38.18% for both genders, 33.64% for men and 41.04% for women. The lowest contributions were found with 4.8% for both genders, 2.66% for men in $\text{VoL}_{30}^{\text{TS}}$ 'unspecified household and family care', and 2.26% for women in the $\text{VoL}^{\text{TS}}_{35}$ group 'construction and repairs'. For the typical household chores covering activity groups $\text{VoL}^{\text{TS}}_{31}$ 'food management', $\text{VoL}^{\text{TS}}_{32}$ 'household upkeep' and $\text{VoL}^{\text{TS}}_{33}$ 'making and care for textiles' women seemed to contribute more to the $\text{VoL}^{\text{TS}}_{\text{all}}$ than men, but less for the groups $\text{VoL}^{\text{TS}}_{34}$ 'gardening and pet care' and $\text{VoL}^{\text{TS}}_{35}$ 'construction and repairs'.

6.4 Step 2 - VoL of Modified Traditional Approach by Considering Multitasking

The VoL results of step 2 that modified the traditional approach using specialist wage rates by considering not only the primary, but all four simultaneous activities of the UKTUS, are presented in Table 6.3. At this point it needs to be mentioned again, as already explained in the model building section in Chapter 5, that all modifications to the traditional approach were done for specialist wages only.
The $\text{VoL}^{\text{M}}_{\text{all}}$ for male, female and both combined resulted in a total of £286,950 for both, £109,193 for men and £171,415 for women. On a per person basis this averaged to £20.09 for both, £16.67 for men and £22.17 for women.

Table 6.3: VoL of modified traditional approach by considering multitasking

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
$\text{VoL}^{\text{M}}_{\text{all}}$	£286,950	£20.09	100.00	£109,193	£16.67	100.00	£171,415	£22.17	100.00
$\text{VoL}^{\text{M}}_{30}$	£13,714	£0.96	4.78	£2,843	£0.43	2.60	£10,872	£1.41	6.34
$\text{VoL}^{\text{M}}_{31}$	£105,454	£7.38	36.75	£35,238	£5.38	32.27	£67,830	£8.77	39.57
$\text{VoL}^{\text{M}}_{32}$	£71,147	£4.98	24.79	£25,066	£3.83	22.96	£43,804	£5.67	25.55
$\text{VoL}^{\text{M}}_{33}$	£28,835	£2.02	10.05	£4,111	£0.63	3.77	£22,547	£2.92	13.15
$\text{VoL}^{\text{M}}_{34}$	£46,619	£3.26	16.25	£24,972	£3.81	22.87	£22,602	£2.92	13.19
$\text{VoL}^{\text{M}}_{35}$	£21,182	£1.48	7.38	£16,963	£2.59	15.54	£3,760	£0.49	2.19

Source: The author

The contribution of each 2-digit $\text{VoL}^{\text{M}}_{30}$ to $\text{VoL}^{\text{M}}_{35}$ codes towards the $\text{VoL}^{\text{M}}_{\text{all}}$ showed a similar picture as the results of step 1. The largest contribution to the $\text{VoL}^{\text{M}}_{\text{all}}$ was found in the 2-digit level group 31 'food management' for both genders (36.75%), male (32.27%) and female (39.57%). This was also the case for the lowest contributions. The $\text{VoL}^{\text{M}}_{30}$ 'unspecified household and family care' showed the lowest percentages, with 4.78% for both genders and 2.60% for men. Women contributed least in the $\text{VoL}^{\text{M}}_{35}$ group 'construction and repairs' with 2.19%.

6.5 Step 3 - VoL of Modified Traditional Approach by Adding Quality and Productivity

The VoL results for step 3 were based on adding modifications of quality and productivity to the traditional approach using specialist wages. However, Step 3 only considered primary activities and disregarded splits of multitasking. Results were separately reported for each of the four scenarios.

6.5.1 Scenario 3.1: Adjusting for Quality

The VoL in the first scenario of step 3 was calculated based on the quality adjustment, and results were summarised in Table 6.4. For both genders the total $\text{VoL}^{\text{Q}}_{\text{all}}$ amounted to £281,305. On a gender basis, the $\text{VoL}^{\text{Q}}_{\text{all}}$ for men was £103,543 and £171,313 for women. Individual averages of £19.70 were found for both, £15.81 for men and £22.16 for women.

Table 6.4: Scenario 3.1 VoL of modified traditional approach by adding quality adjustments

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
$\text{VoL}^{\text{Q}}_{\text{all}}$	£281,305	£19.70	100.00	£103,543	£15.81	100.00	£171,313	£22.16	100.00
$\text{VoL}^{\text{Q}}_{30}$	£12,957	£0.91	4.61	£2,730	£0.42	2.64	£10,229	£1.32	5.97
$\text{VoL}^{\text{Q}}_{31}$	£108,743	£7.61	38.66	£36,462	£5.57	35.21	£69,848	£9.03	40.77
$\text{VoL}^{\text{Q}}_{32}$	£74,951	£5.25	26.64	£26,487	£4.04	25.58	£46,074	£5.96	26.89
$\text{VoL}^{\text{Q}}_{33}$	£28,996	£2.03	10.31	£4,191	£0.64	4.05	£22,662	£2.93	13.23
$\text{VoL}^{\text{Q}}_{34}$	£40,651	£2.85	14.45	£21,770	£3.32	21.03	£19,738	£2.55	11.52
$\text{VoL}^{\text{Q}}_{35}$	£15,007	£1.05	5.33	£11,904	£1.82	11.50	£2,762	£0.36	1.61

Source: The author

The 2-digit $\text{VoL}^{\text{Q}}_{31}$ activity code 'food management' accounts for more than one-third of the contribution to the $\text{VoL}^{\text{Q}}_{\text{all}}$. Results indicated 38.66% for both genders, 35.21% for men and 40.77% for women. Lowest percentage rates for both genders and males appeared in group $\text{VoL}^{\text{Q}}_{30}$ 'unspecified household and family care' with

4.61% for both and 2.64% for men. For women the lowest contribution came from group $\mathrm{VoL}^{\mathrm{Q}}_{35}$ 'construction and repairs' with only 1.6%.

6.5.2 Scenario 3.2: Adjusting for Productivity

The second scenario of step 3 estimated the VoL by adding a productivity adjustment to the traditional approach using specialist wages. This resulted in a total $\mathrm{VoL}^{\mathrm{P}}_{\mathrm{all}}$ of £262,782 for both genders, £99,180 for men and £157,863 for women. On a per person basis this averaged to £18.40 for both, £15.14 for men and £20.42 for women. Results are shown in Table 6.5.

Table 6.5: Scenario 3.2 - VoL of modified traditional approach by adding productivity adjustments

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
$\mathrm{VoL}^{\mathrm{P}}_{\mathrm{all}}$	£262,782	£18.40	100.00	£99,180	£15.14	100.00	£157,863	£20.42	100.00
$\mathrm{VoL}^{\mathrm{P}}_{30}$	£12,602	£0.88	4.80	£2,655	£0.41	2.68	£9,949	£1.29	6.30
$\mathrm{VoL}^{\mathrm{P}}_{31}$	£94,165	£6.59	35.83	£31,574	£4.82	31.84	£60,484	£7.82	38.31
$\mathrm{VoL}^{\mathrm{P}}_{32}$	£68,561	£4.80	26.09	£24,229	£3.70	24.43	£42,146	£5.45	26.70
$\mathrm{VoL}^{\mathrm{P}}_{33}$	£26,916	£1.88	10.24	£3,890	£0.59	3.92	£21,036	£2.72	13.33
$\mathrm{VoL}^{\mathrm{P}}_{34}$	£43,494	£3.05	16.55	£23,249	£3.55	23.44	£21,163	£2.74	13.41
$\mathrm{VoL}^{\mathrm{P}}_{35}$	£17,044	£1.19	6.49	£13,583	£2.07	13.70	£3,084	£0.40	1.95

Source: The author

The $\mathrm{VoL}^{\mathrm{P}}_{31}$ 'food management' contributed 35.83% for both genders, 31.84% for men and 38.31% for women towards the $\mathrm{VoL}^{\mathrm{P}}_{\mathrm{all}}$. This 2-digit breakdown code showed the highest values. In contrast, only 4.8% for both genders and 2.68% for men came from $\mathrm{VoL}^{\mathrm{P}}_{30}$ 'unspecified household and family care'. Women contributed least to the $\mathrm{VoL}^{\mathrm{P}}_{\mathrm{all}}$ from $\mathrm{VoL}^{\mathrm{P}}_{35}$ 'construction and repairs' with only 1.95%. This is the lowest contribution among the 2-digit breakdown codes.

6.5.3 Scenario 3.3: Adjusting for Average of Quality and Productivity

The VoL results for scenario 3.3 are presented in Table 6.6 and include the combination of both adjustments by considering the average of the quality and productivity adjustment. The $\mathrm{VoL}^{\mathrm{QPA}}_{\mathrm{all}}$ resulted in a total of £272,096 for both genders, £101,382 for men and £164,621 for women. On a per person basis this averaged to £19.05 for both, £15.48 for men and £21.29 for women.

Table 6.6: Scenario 3.3 - VoL of modified traditional approach by adding the average of quality and productivity adjustments

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
VoL_{all}^{QPA}	£272,096	£19.05	100.00	£101,382	£15.48	100.00	£164,621	£21.29	100.00
VoL_{30}^{QPA}	£12,794	£0.90	4.70	£2,695	£0.41	2.66	£10,101	£1.31	6.14
VoL_{31}^{QPA}	£101,454	£7.10	37.29	£34,018	£5.19	33.55	£65,166	£8.43	39.59
VoL_{32}^{QPA}	£71,794	£5.03	26.39	£25,371	£3.87	25.03	£44,133	£5.71	26.81
VoL_{33}^{QPA}	£27,941	£1.96	10.27	£4,038	£0.62	3.98	£21,837	£2.82	13.27
VoL_{34}^{QPA}	£42,096	£2.95	15.47	£22,522	£3.44	22.21	£20,462	£2.65	12.43
VoL_{35}^{QPA}	£16,017	£1.12	5.89	£12,737	£1.94	12.56	£2,921	£0.38	1.77

Source: The author

Women contributed 39.59% of the VoL_{31}^{QPA} 'food management' to the VoL_{all}^{QPA}. This is a higher contribution of that 2-digit activity code than both genders (37.29%) and men (33.55%). The second highest contribution was found in the group VoL_{32}^{QPA} 'household upkeep' with 26.39% for both genders, 25.03% for men and 26.81% for women. The lowest contribution for both genders and males came from group VoL_{30}^{QPA} with 4.7% for both and 2.66% for men, while for women the lowest contribution came from group VoL_{35}^{QPA} with 1.77%.

6.5.4 Scenario 3.4: Adjusting for Product of Quality and Productivity

In scenario 3.4 the VoL results were based on adding the product of the quality and productivity adjustment to the traditional approach. The calculation showed a VoL_{all}^{QPX} of £241,220 for both genders, £88,290 for men and £147,434 for women. On a per person basis this averaged to £16.89 for both, £13.48 for men and £19.07 for women. Results are summarised in Table 6.7.

Table 6.7: Scenario 3.4 - VoL of modified traditional approach by adding the product of quality and productivity adjustments

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
$\mathrm{VoL}_{\mathrm{all}}^{\mathrm{QPX}}$	£241,220	£16.89	100.00	£88,290	£13.48	100.00	£147,434	£19.07	100.00
$\mathrm{VoL}_{30}^{\mathrm{QPX}}$	£11,167	£0.78	4.63	£2,353	£0.36	2.67	£8,816	£1.14	5.98
$\mathrm{VoL}_{31}^{\mathrm{QPX}}$	£87,112	£6.10	36.11	£29,209	£4.46	33.08	£55,954	£7.24	37.95
$\mathrm{VoL}_{32}^{\mathrm{QPX}}$	£68,411	£4.79	28.36	£24,175	£3.69	27.38	£42,054	£5.44	28.52
$\mathrm{VoL}_{33}^{\mathrm{QPX}}$	£25,891	£1.81	10.73	£3,742	£0.57	4.24	£20,235	£2.62	13.72
$\mathrm{VoL}_{34}^{\mathrm{QPX}}$	£37,494	£2.63	15.54	£19,960	£3.05	22.61	£18,332	£2.37	12.43
$\mathrm{VoL}_{35}^{\mathrm{QPX}}$	£11,145	£0.78	4.62	£8,851	£1.35	10.02	£2,042	£0.26	1.39

Source: The author

The highest contribution from men, women and both genders to the $\mathrm{VoL}_{\mathrm{all}}^{\mathrm{QPX}}$ was in the group of $\mathrm{VoL}_{31}^{\mathrm{QPX}}$ 'food management'. Both genders contributed 36.11%, which is slightly lower than the one of women (37.95%), but higher than the one of men (33.08%). The lowest contribution for both genders came from two different groups. For group $\mathrm{VoL}_{35}^{\mathrm{QPX}}$ it was 4.62% and for group $\mathrm{VoL}_{30}^{\mathrm{QPX}}$ 4.6%. Similarly, for men, the lowest contribution was also seen in group $\mathrm{VoL}_{30}^{\mathrm{QPX}}$ with 2.7%. A different result was obtained for women, who only contributed 1.4% to the $\mathrm{VoL}_{\mathrm{all}}^{\mathrm{QPX}}$ from group $\mathrm{VoL}_{35}^{\mathrm{QPX}}$.

6.6 Step 4 - VoL of Modified Traditional Approach by Adding Multitasking, Quality and Productivity

The VoL results for step 4 were based on considering not only the primary, but all four simultaneous activities and adding modifications of quality and productivity to the traditional approach. It is pointed out again, as already explained in the model building section in Chapter 5, that all modifications to the traditional approach were done for specialist wages only. Similar to the previous step, the results were separately reported for each of the four scenarios.

6.6.1 Scenario 4.1: Adjusting for Quality

The VoL in the first scenario of step 4 was calculated based on applying the splits for up to four multitasking activities and the quality adjustment. Results are summarised in Table 6.8. The $\text{VoL}_{\text{all}}^{\text{MQ}}$ resulted in a total of £262,138 for both genders, £96,449 for men and £159,639 for women. On a per person basis this averaged to £18.35 for both genders, £14.72 for men and £20.65 for women respectively.

Table 6.8: Scenario 4.1 - VoL of modified traditional approach by adding multitasking splits and quality adjustments

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
$\text{VoL}_{\text{all}}^{\text{MQ}}$	£262,138	£18.35	100.00	£96,449	£14.72	100.00	£159,639	£20.65	100.00
$\text{VoL}_{30}^{\text{MQ}}$	£12,013	£0.84	4.58	£2,490	£0.38	2.58	£9,524	£1.23	5.97
$\text{VoL}_{31}^{\text{MQ}}$	£97,545	£6.83	37.21	£32,595	£4.98	33.80	£62,743	£8.11	39.30
$\text{VoL}_{32}^{\text{MQ}}$	£70,933	£4.97	27.06	£24,990	£3.81	25.91	£43,673	£5.65	27.36
$\text{VoL}_{33}^{\text{MQ}}$	£27,739	£1.94	10.58	£3,955	£0.60	4.10	£21,691	£2.81	13.59
$\text{VoL}_{34}^{\text{MQ}}$	£40,036	£2.80	15.27	£21,344	£3.26	22.13	£19,517	£2.52	12.23
$\text{VoL}_{35}^{\text{MQ}}$	£13,872	£0.97	5.29	£11,074	£1.69	11.48	£2,492	£0.32	1.56

Source: The author

Women contributed 39.30% of the $\text{VoL}_{\text{all}}^{\text{MQ}}$ from the $\text{VoL}_{31}^{\text{MQ}}$ 'food management' and 27.36% from the $\text{VoL}_{32}^{\text{MQ}}$ 'household upkeep'. In both VoL groups 31 and 32, their contribution is higher than the ones of both genders, with 37.21% for group 31 and 27.06% for group 32, and men with 33.80% for group 31 and 25.91% for group 32. For both genders, the lowest contribution of 4.58% was found for the group $\text{VoL}_{30}^{\text{MQ}}$ 'unspecified household and family care' towards the $\text{VoL}_{\text{all}}^{\text{MQ}}$. Similarly, men contributed least in the same group, with only 2.58%. The lowest percentage rate for women was identified for $\text{VoL}_{35}^{\text{MQ}}$ 'construction and repairs' with 1.56%.

6.6.2 Scenario 4.2: Adjusting for Productivity

Scenario 4.2 involved estimating the VoL by applying the splits for up to four multitasking activities and adding a productivity adjustment to the traditional approach using specialist wages. Table 6.9 provides the results. For both genders, the total $\text{VoL}_{\text{all}}^{\text{MP}}$ was £245,403, while men accounted for £92,617 and women for £147,403. On a per person basis this averages to £17.18 for both, £14.14 for men and £19.06

for women.

Table 6.9: Scenario 4.2 - VoL of modified traditional approach by adding multitasking splits and productivity adjustments

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
$\text{VoL}^{\text{MP}}_{\text{all}}$	£245,403	£17.18	100.00	£92,617	£14.14	100.00	£147,403	£19.06	100.00
$\text{VoL}^{\text{MP}}_{30}$	£11,684	£0.82	4.76	£2,422	£0.37	2.62	£9,263	£1.20	6.28
$\text{VoL}^{\text{MP}}_{31}$	£84,468	£5.91	34.42	£28,226	£4.31	30.48	£54,332	£7.03	36.86
$\text{VoL}^{\text{MP}}_{32}$	£64,886	£4.54	26.44	£22,860	£3.49	24.68	£39,949	£5.17	27.10
$\text{VoL}^{\text{MP}}_{33}$	£25,750	£1.80	10.49	£3,671	£0.56	3.96	£20,135	£2.60	13.66
$\text{VoL}^{\text{MP}}_{34}$	£42,850	£3.00	17.46	£22,798	£3.48	24.62	£20,938	£2.71	14.20
$\text{VoL}^{\text{MP}}_{35}$	£15,765	£1.10	6.42	£12,640	£1.93	13.65	£2,786	£0.36	1.89

Source: The author

The group of $\text{VoL}^{\text{MP}}_{31}$ ‘food management’ showed the highest percentages for its contribution to the $\text{VoL}^{\text{MP}}_{\text{all}}$. In that group, men’s contribution was the lowest with 30.48%, while both genders contributed 34.42% and women 36.86%. The least contribution for both genders and men was found in the group $\text{VoL}^{\text{MP}}_{30}$, with 4.76% and 2.62% respectively. The group $\text{VoL}^{\text{MP}}_{35}$ ‘construction and repairs’ with 1.89% contributed the lowest percentage for women towards the $\text{VoL}^{\text{MP}}_{\text{all}}$.

6.6.3 Scenario 4.3: Adjusting for Average of Quality and Productivity

The VoL results for scenario 4.3 are presented in Table 6.10 and include the application of splits for up to four multitasking activities and the combination of both adjustments by considering the average of the quality and productivity adjustment. The $\text{VoL}^{\text{MQPA}}_{\text{all}}$ resulted in a total value of £253,821 for both genders, £94,552 for men and £153,552 for women. On a per person basis this averaged to £17.77 for both, £14.43 for men and £19.86 for women.

Table 6.10: Scenario 4.3 - VoL of modified traditional approach by adding multitasking splits and the average of quality and productivity adjustments

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
$\text{VoL}_{\text{all}}^{\text{MQPA}}$	£253,821	£17.77	100.00	£94,552	£14.43	100.00	£153,552	£19.86	100.00
$\text{VoL}_{30}^{\text{MQPA}}$	£11,862	£0.83	4.67	£2,459	£0.38	2.60	£9,404	£1.22	6.12
$\text{VoL}_{31}^{\text{MQPA}}$	£91,007	£6.37	35.85	£30,410	£4.64	32.16	£58,538	£7.57	38.12
$\text{VoL}_{32}^{\text{MQPA}}$	£67,945	£4.76	26.77	£23,938	£3.65	25.32	£41,833	£5.41	27.24
$\text{VoL}_{33}^{\text{MQPA}}$	£26,730	£1.87	10.53	£3,811	£0.58	4.03	£20,901	£2.70	13.61
$\text{VoL}_{34}^{\text{MQPA}}$	£41,466	£2.90	16.34	£22,084	£3.37	23.36	£20,239	£2.62	13.18
$\text{VoL}_{35}^{\text{MQPA}}$	£14,810	£1.04	5.83	£11,851	£1.81	12.53	£2,637	£0.34	1.72

Source: The author

The largest contribution to the $\text{VoL}_{\text{all}}^{\text{MQPA}}$ was found in the group $\text{VoL}_{31}^{\text{MQPA}}$ 'food management'. Women contributed 38.12% to this group, the contribution of men was only 32.16%, and the contribution of both genders was in between at 35.85%. A similar result, but with a lower percentage difference, showed the $\text{VoL}_{32}^{\text{MQPA}}$ group 'household upkeep'. Women contributed 27.24%, men 25.32% and both genders 26.77%. The group $\text{VoL}_{30}^{\text{MQPA}}$ contributed only 4.67% for both genders and 2.6% for men, while in the same group women contributed 6.12%. Women's contribution in the $\text{VoL}_{35}^{\text{MQPA}}$ group 'construction and repairs' was only 1.72%, while both genders achieved 5.83% and men even 12.53% in the same VoL group.

6.6.4 Scenario 4.4: Adjusting for Product of Quality and Productivity

In scenario 4.4 the VoL results were based on applying the splits for up to four multitasking activities and adding the product of the quality and productivity adjustment to the traditional approach. The $\text{VoL}_{\text{all}}^{\text{MQPX}}$ resulted in a total of £225,280 for both genders, £82,411 for men and £137,704 for women. On a per person basis this averages to £15.77 for both, £12.58 for men and £17.81 for women. Results are presented in Table 6.11.

Table 6.11: Scenario 4.4 - VoL of modified traditional approach by adding multi-tasking splits and the product of quality and productivity adjustments

	Both			**Male**			**Female**		
	sample	**person**	**%**	**sample**	**person**	**%**	**sample**	**person**	**%**
$\text{VoL}_{\text{all}}^{\text{MQPX}}$	£225,280	£15.77	100.00	£82,411	£12.58	100.00	£137,704	£17.81	100.00
$\text{VoL}_{30}^{\text{MQPX}}$	£10,354	£0.72	4.60	£2,146	£0.33	2.60	£8,208	£1.06	5.96
$\text{VoL}_{31}^{\text{MQPX}}$	£78,141	£5.47	34.69	£26,111	£3.99	31.68	£50,262	£6.50	36.50
$\text{VoL}_{32}^{\text{MQPX}}$	£64,744	£4.53	28.74	£22,810	£3.48	27.68	£39,862	£5.16	28.95
$\text{VoL}_{33}^{\text{MQPX}}$	£24,769	£1.73	10.99	£3,532	£0.54	4.29	£19,368	£2.50	14.07
$\text{VoL}_{34}^{\text{MQPX}}$	£36,968	£2.59	16.41	£19,578	£2.99	23.76	£18,160	£2.35	13.19
$\text{VoL}_{35}^{\text{MQPX}}$	£10,304	£0.72	4.57	£8,235	£1.26	9.99	£1,843	£0.24	1.34

Source: The author

It can be seen from Table 6.11 that both genders contributed 34.69%, men 31.68% and women 36.5% from the group of $\text{VoL}_{31}^{\text{MQPX}}$ 'food management' to the $\text{VoL}_{\text{all}}^{\text{MQPX}}$. This was the largest contribution. Contrarily, the lowest contribution, from both genders with 4.57% and from women with 1.34%, was found in the $\text{VoL}_{35}^{\text{MQPX}}$ group 'construction and repairs'. Men contributed least with 2.6% from the group $\text{VoL}_{30}^{\text{MQPX}}$ 'unspecified household and family care'.

6.7 Summary of the VoL Results of Steps 1 to 4

This section summarises the results of the VoL presented in Sections 6.3 to 6.6 to demonstrate how the different modifications compare to each other, and how they have changed the VoL compared to the traditional approach without any modifications in step 1.

The following preliminary explanation applies to all tables in Section 6.7 and is essential for understanding how the information is presented.

6.7.1 Preliminary Explanation of Reporting the Summary of the VoL Results

The results in this Section 6.7 are summarised in seven different tables, one for the VoL_{all} and six for each 2-digit breakdown of the VoL_{30} to the VoL_{35}, each presenting the VoL results for all steps including the scenarios. The reference group for the comparison is the traditional approach using specialist wages, which was indicated

as 'Step1TS' in the tables of this Section 6.7, because the modifications are based on that step. However, the traditional approach using the housekeeper wage, described in the tables of this Section 6.7 as 'Step1TH', was used for comparison reasons as recommended in the literature review, and as outlined above, although 'Step1TH' has not undergone any modifications.
The tables in this Section 6.7 further include a column '%(TS)' which compares the VoL of the corresponding step with the VoL of the traditional approach using specialist wages on a percentage level. For example, a value of 80% would indicate that the VoL of the step in question achieved only 80% of the value of 'Step1TS'. Based on this preliminary information, the results are reported below.

6.7.2 Summary and Comparison of Results for the VoL_{all}

Table 6.12 summarises the VoL_{all} results allowing for easily comparing them and showing the magnitude of differences between those VoL_{all} valuations stemming from the application of the traditional and the modified approaches.

Table 6.12: Comparison of VoL_{all} results of steps 1 to 4

		Both			**Male**			**Female**		
		sample	**person**	**% (TS)**	**sample**	**person**	**% (TS)**	**sample**	**person**	**% (TS)**
Step1TH	$\text{VoL}_{\text{all}}^{\text{TH}}$	£276,397	£19.35	-	£101,906	£15.56	-	£175,372	£22.68	-
Step1TS	$\text{VoL}_{\text{all}}^{\text{TS}}$	£307,947	£21.56	100.00	£117,164	£17.88	100.00	£184,011	£23.80	100.00
Step2	$\text{VoL}_{\text{all}}^{\text{M}}$	£286,950	£20.09	93.18	£109,193	£16.67	93.20	£171,415	£22.17	93.15
Step3Scen1	$\text{VoL}_{\text{all}}^{\text{Q}}$	£281,305	£19.70	91.35	£103,543	£15.81	88.37	£171,313	£22.16	93.10
Step3Scen2	$\text{VoL}_{\text{all}}^{\text{P}}$	£262,782	£18.40	85.33	£99,180	£15.14	84.65	£157,863	£20.42	85.79
Step3Scen3	$\text{VoL}_{\text{all}}^{\text{QPA}}$	£272,096	£19.05	88.36	£101,382	£15.48	86.53	£164,621	£21.29	89.46
Step3Scen4	$\text{VoL}_{\text{all}}^{\text{QPX}}$	£241,220	£16.89	78.33	£88,290	£13.48	75.36	£147,434	£19.07	80.12
Step4Scen1	$\text{VoL}_{\text{all}}^{\text{MQ}}$	£262,138	£18.35	85.12	£96,449	£14.72	82.32	£159,639	£20.65	86.75
Step4Scen2	$\text{VoL}_{\text{all}}^{\text{MP}}$	£245,403	£17.18	79.69	£92,617	£14.14	79.05	£147,403	£19.06	80.11
Step4Scen3	$\text{VoL}_{\text{all}}^{\text{MQPA}}$	£253,821	£17.77	82.42	£94,552	£14.43	80.70	£153,552	£19.86	83.45
Step4Scen4	$\text{VoL}_{\text{all}}^{\text{MQPX}}$	£225,280	£15.77	73.16	£82,411	£12.58	70.34	£137,704	£17.81	74.83

Source: The author

From Table 6.12 it can be seen that for both genders, the traditional approach using the housekeeper approach ('Step1TH') estimated a $\text{VoL}_{\text{all}}^{\text{TH}}$ of £276,397 or £19.35 per average person of the sample. Applying the traditional approach using specialist wages ('Step1TS'), the $\text{VoL}_{\text{all}}^{\text{TS}}$ is £307,947 or £21.56, which is £31.550 higher than 'Step1TH'.

'Step2' considered multitasking splits and resulted in a $\text{VoL}_{\text{all}}^{\text{M}}$ of £286,950 or £20.09 per person. This value, compared to the 'Step1TS', shows that the modification step of including multitasking had reduced the VoL_{all} from £307,947 to £286,950 or from £21.56 to £20.09. This is a reduction of 6.82% or in other words the 'Step2' adjustment only achieved 93.18% of the 'Step1TS' $\text{VoL}_{\text{all}}^{\text{TS}}$.

A similar, but not that meaningful comparison can be made between the $\text{VoL}_{\text{all}}^{\text{M}}$ of 'Step2' and the $\text{VoL}_{\text{all}}^{\text{TH}}$ of the traditional approach using the housekeeper wage 'Step1TH'. It is not considered meaningful, because two different wage concepts, the one of specialists and the one of the housekeeper, were contrasted. Nevertheless, the comparison of both is required at some stages of the results and discussion chapter, and thus is presented here.

Between the $\text{VoL}_{\text{all}}^{\text{M}}$ and the $\text{VoL}_{\text{all}}^{\text{TH}}$ the estimates reveal a difference of £10,553 in total (£286,950 - 276,397) or £0.74 per person (£20.09 - £19.35).

The lowest VoL_{all} of all steps for both genders was seen in 'Step4Scen4' where multitasking splits and the product of quality and productivity adjustments were taken into account. The $\text{VoL}_{\text{all}}^{\text{MQPX}}$ was £225,280 or £15.77 and thus achieved only 73.16% of the $\text{VoL}_{\text{all}}^{\text{TS}}$ using the traditional approach specialist wage 'Step1TS'.

Table 6.12 also provides corresponding results for men and women. Looking at men, women and both genders, modification for quality, involving 'Step3Scen1' ($\text{VoL}_{\text{all}}^{\text{Q}}$) and 'Step4Scen1' ($\text{VoL}_{\text{all}}^{\text{MQ}}$), resulted in a higher VoL than modifications for productivity which involved 'Step3Scen2' ($\text{VoL}_{\text{all}}^{\text{P}}$) and 'Step4Scen2' ($\text{VoL}_{\text{all}}^{\text{MP}}$).

Overall, the lowest VoL_{all} was identified for 'Step4Scen4' ($\text{VoL}_{\text{all}}^{\text{MQPX}}$) for men with £82,411 or £12.58 compared to the $\text{VoL}_{\text{all}}^{\text{TS}}$ of 'Step1TS' with £117.164 or £17.88. This 'Step4Scen4' considers multitasking splits and applies the product of quality and productivity adjustments. The $\text{VoL}_{\text{all}}^{\text{MQPX}}$ with all those modifications only achieved 70.34% of the $\text{VoL}_{\text{all}}^{\text{TS}}$ using 'Step1TS'.

A comparison of VoL_{all} results, based on specialist wages, with 'Step1TS' revealed that all modifications had led to a reduced VoL_{all}. This applied to both genders as well as men and women. A slightly different picture showed the comparison of the VoL_{all} results with the traditional approach using the housekeeper wage $\text{VoL}_{\text{all}}^{\text{TH}}$ ('Step1TH'). For men and for both genders combined the modifications applied in 'Step2' (considering multitasking) and 'Step3Scen1' (adjusting quality) led to a higher VoL_{all} than the one achieved in 'Step1TH'. Contrarily, for women, all the modifications of steps 2, 3 and 4 had led to a lower VoL_{all} than the $\text{VoL}_{\text{all}}^{\text{TH}}$ of 'Step1TH'.

6.7.3 Summary and Comparison of Results for the VoL_{30}

Table 6.13 presents the results for group VoL_{30} 'unspecified household and family care'.

Table 6.13: Comparison of VoL_{30} results of steps 1 to 4

		Both			**Male**			**Female**		
		sample	**person**	**% (TS)**	**sample**	**person**	**% (TS)**	**sample**	**person**	**% (TS)**
Step1TH	$\text{VoL}_{30}^{\text{TH}}$	£13,456	£0.94	-	£2,792	£0.43	-	£10,662	£1.38	-
Step1TS	$\text{VoL}_{30}^{\text{TS}}$	£14,791	£1.04	100.00	£3,116	£0.48	100.00	£11,677	£1.51	100.00
Step2	$\text{VoL}_{30}^{\text{M}}$	£13,714	£0.96	92.72	£2,843	£0.43	91.23	£10,872	£1.41	93.10
Step3Scen1	$\text{VoL}_{30}^{\text{Q}}$	£12,957	£0.91	87.60	£2,730	£0.42	87.61	£10,229	£1.32	87.60
Step3Scen2	$\text{VoL}_{30}^{\text{P}}$	£12,602	£0.88	85.20	£2,655	£0.41	85.21	£9,949	£1.29	85.20
Step3Scen3	$\text{VoL}_{30}^{\text{QPA}}$	£12,794	£0.90	86.50	£2,695	£0.41	86.49	£10,101	£1.31	86.50
Step3Scen4	$\text{VoL}_{30}^{\text{QPX}}$	£11,167	£0.78	75.50	£2,353	£0.36	75.51	£8,816	£1.14	75.50
Step4Scen1	$\text{VoL}_{30}^{\text{MQ}}$	£12,013	£0.84	81.22	£2,490	£0.38	79.92	£9,524	£1.23	81.56
Step4Scen2	$\text{VoL}_{30}^{\text{MP}}$	£11,684	£0.82	79.00	£2,422	£0.37	77.73	£9,263	£1.20	79.32
Step4Scen3	$\text{VoL}_{30}^{\text{MQPA}}$	£11,862	£0.83	80.20	£2,459	£0.38	78.91	£9,404	£1.22	80.53
Step4Scen4	$\text{VoL}_{30}^{\text{MQPX}}$	£10,354	£0.72	70.00	£2,146	£0.33	68.88	£8,208	£1.06	70.29

Source: The author

The table shows that the $\text{VoL}_{30}^{\text{TS}}$ for the traditional approach using specialist wages 'Step1TS' results in £14,791 for both, £3,116 for men and £11,677 for women. On a per person basis this accounts for £1.04 for both genders, £0.48 for men and £1.51 for women.

Compared to the VoL_{all} the contribution of the 2-digit activity code 30 'unspecified household and family care' is small. This is expected because code 30 is a residual code and includes those activities that could not be matched to any other activity code.

All modifications from steps 3 and 4 resulted in a lower VoL_{30} than both traditional approaches 'Step1TH' and 'Step1TS' or $\text{VoL}_{30}^{\text{TH}}$ and $\text{VoL}_{30}^{\text{TS}}$, respectively. This finding holds for both genders combined, as well as for men and women.

Contrarily, the modification of 'Step2' considering multitasking splits led to different results. While the $\text{VoL}_{30}^{\text{M}}$ with £13,714 or £0.96 per person for 'Step2' compared to the traditional approach using the specialist wage ('Step1TS') with a $\text{VoL}_{30}^{\text{TS}}$ of £14,791 or £1.04 per person was lower, its value was higher compared to the traditional approach using the housekeeper wage ('Step1TH') with a $\text{VoL}_{30}^{\text{TH}}$ of £13,456 or £0.94 for the average person. Again, this finding holds for both genders combined

as well as for men and women.
Furthermore, it is clearly visible that women achieved more than 3.7 times the value of men to the $\mathrm{VoL}_{30}^{\mathrm{TS}}$ with £11,677 compared to £3,116.

6.7.4 Summary and Comparison of Results for the VoL_{31}

Table 6.14 presents the results for group VoL_{31} 'food management'.

Table 6.14: Comparison of VoL_{31} results of steps 1 to 4

		Both			**Male**			**Female**		
		sample	**person**	**% (TS)**	**sample**	**person**	**% (TS)**	**sample**	**person**	**% (TS)**
Step1TH	$\mathrm{VoL}_{31}^{\mathrm{TH}}$	£108,998	£7.63	-	£36,303	£5.54	-	£72,963	£9.44	-
Step1TS	$\mathrm{VoL}_{31}^{\mathrm{TS}}$	£117,560	£8.23	100.00	£39,418	£6.02	100.00	£75,511	£9.77	100.00
Step2	$\mathrm{VoL}_{31}^{\mathrm{M}}$	£105,454	£7.38	89.70	£35,238	£5.38	89.40	£67,830	£8.77	89.83
Step3Scen1	$\mathrm{VoL}_{31}^{\mathrm{Q}}$	£108,743	£7.61	92.50	£36,462	£5.57	92.50	£69,848	£9.03	92.50
Step3Scen2	$\mathrm{VoL}_{31}^{\mathrm{P}}$	£94,165	£6.59	80.10	£31,574	£4.82	80.10	£60,484	£7.82	80.10
Step3Scen3	$\mathrm{VoL}_{31}^{\mathrm{QPA}}$	£101,454	£7.10	86.30	£34,018	£5.19	86.30	£65,166	£8.43	86.30
Step3Scen4	$\mathrm{VoL}_{31}^{\mathrm{QPX}}$	£87,112	£6.10	74.10	£29,209	£4.46	74.10	£55,954	£7.24	74.10
Step4Scen1	$\mathrm{VoL}_{31}^{\mathrm{MQ}}$	£97,545	£6.83	82.97	£32,595	£4.98	82.69	£62,743	£8.11	83.09
Step4Scen2	$\mathrm{VoL}_{31}^{\mathrm{MP}}$	£84,468	£5.91	71.85	£28,226	£4.31	71.61	£54,332	£7.03	71.95
Step4Scen3	$\mathrm{VoL}_{31}^{\mathrm{MQPA}}$	£91,007	£6.37	77.41	£30,410	£4.64	77.15	£58,538	£7.57	77.52
Step4Scen4	$\mathrm{VoL}_{31}^{\mathrm{MQPX}}$	£78,141	£5.47	66.47	£26,111	£3.99	66.24	£50,262	£6.50	66.56

Source: The author

A comparison of both traditional approaches showed that the $\mathrm{VoL}_{31}^{\mathrm{TS}}$ of 'Step1TS' is higher than the one for 'Step1TH'.
The $\mathrm{VoL}_{31}^{\mathrm{TS}}$ for 'Step1TS' results in £117,560 for both genders, £39,418 for men and £75,511 for women, or £8.23, £6.02 and £9.77 for the average person, respectively.
The $\mathrm{VoL}_{31}^{\mathrm{TS}}$ for women, compared to that of men, was almost twice as high, with £75,511 compared to £39,418.
Furthermore, the modifications from steps 2, 3 and 4 resulted in a lower VoL_{31} than both traditional approaches 'Step1TH' and 'Step1TS', apart from 'Step3Scen1' for men.
The lowest VoL_{31} was found for 'Step4Scen4' that considers multitasking splits and applies the product of quality and productivity adjustments. The $\mathrm{VoL}_{31}^{\mathrm{MQPX}}$ was £78,141 for both genders, £26,111 for men and £50,262 for women. Compared to the $\mathrm{VoL}_{31}^{\mathrm{TS}}$ of 'Step1TS', the modifications of 'Step4Scen4' achieved only two-thirds of the traditional approach using specialist wage rates. That difference is lower if the

$\text{VoL}_{31}^{\text{MQPX}}$ is compared to the traditional approach using housekeeper wages $\text{VoL}_{31}^{\text{TS}}$.

6.7.5 Summary and Comparison of Results for the VoL_{32}

Table 6.15 presents the results for group VoL_{32} 'household upkeep'.

Table 6.15: Comparison of VoL_{32} results of steps 1 to 4

		Both			**Male**			**Female**		
		sample	**person**	**% (TS)**	**sample**	**person**	**% (TS)**	**sample**	**person**	**% (TS)**
Step1TH	$\text{VoL}_{32}^{\text{TH}}$	£68,049	£4.76	-	£23,507	£3.59	-	£44,727	£5.78	-
Step1TS	$\text{VoL}_{32}^{\text{TS}}$	£75,177	£5.26	100.00	£26,566	£4.06	100.00	£46,213	£5.98	100.00
Step2	$\text{VoL}_{32}^{\text{M}}$	£71,147	£4.98	94.64	£25,066	£3.83	94.35	£43,804	£5.67	94.79
Step3Scen1	$\text{VoL}_{32}^{\text{Q}}$	£74,951	£5.25	99.70	£26,487	£4.04	99.70	£46,074	£5.96	99.70
Step3Scen2	$\text{VoL}_{32}^{\text{P}}$	£68,561	£4.80	91.20	£24,229	£3.70	91.20	£42,146	£5.45	91.20
Step3Scen3	$\text{VoL}_{32}^{\text{QPA}}$	£71,794	£5.03	95.50	£25,371	£3.87	95.50	£44,133	£5.71	95.50
Step3Scen4	$\text{VoL}_{32}^{\text{QPX}}$	£68,411	£4.79	91.00	£24,175	£3.69	91.00	£42,054	£5.44	91.00
Step4Scen1	$\text{VoL}_{32}^{\text{MQ}}$	£70,933	£4.97	94.36	£24,990	£3.81	94.07	£43,673	£5.65	94.50
Step4Scen2	$\text{VoL}_{32}^{\text{MP}}$	£64,886	£4.54	86.31	£22,860	£3.49	86.05	£39,949	£5.17	86.45
Step4Scen3	$\text{VoL}_{32}^{\text{MQPA}}$	£67,945	£4.76	90.38	£23,938	£3.65	90.11	£41,833	£5.41	90.52
Step4Scen4	$\text{VoL}_{32}^{\text{MQPX}}$	£64,744	£4.53	86.12	£22,810	£3.48	85.86	£39,862	£5.16	86.26

Source: The author

The table indicates that the VoL_{32} covering the 2-digit activity code of 'household upkeep' results in a $\text{VoL}_{32}^{\text{TS}}$ of £75,177 for both genders, £26,566 for men and £46,213 for women, based on the traditional approach using specialist wages ('Step1TS'). On a per person basis this accounts to £5.26 for both genders, £4.06 for men and £5.98 for women.

Furthermore, all modifications from steps 2, 3 and 4 resulted in a lower VoL_{32} than the $\text{VoL}_{32}^{\text{TS}}$ of the traditional approach in 'Step1TS'. This finding covers men, women and both genders.

A comparison of the VoL_{32} modifications with the traditional approach using the housekeeper wage 'Step1TH' revealed that for men as well as for both genders, all modifications of steps 2 and 3 achieved a higher VoL_{32} than the $\text{VoL}_{32}^{\text{TH}}$ in 'Step1TH'. Table 6.15 also shows that the modifications of step 4 resulted either in a higher or lower VoL_{32} than the $\text{VoL}_{32}^{\text{TH}}$ in 'Step1TH', depending on the scenario looked at.

Contrarily, the results are different for women. Only the modifications in 'Step3Scen1' that applied the quality adjustment to the traditional approach using the specialist wage ($\text{VoL}_{32}^{\text{Q}}$), achieved a higher value (£46,074) than the $\text{VoL}_{32}^{\text{TH}}$ estimated in

'Step1TH' (£44,727), while all other modifications led to lower results.
The $\text{VoL}_{32}^{\text{TS}}$ achieved by men was lower than the one achieved by women $\text{VoL}_{32}^{\text{TS}}$ with £26,566 compared to £46,213, but it appeared less one-sided than in the previous two summary tables for VoL_{30} and VoL_{31} where women had achieved significantly higher values than men.
The lowest VoL_{32} was found for 'Step4Scen4' (considering multitasking and adjusting for the product of quality and productivity) with a $\text{VoL}_{32}^{\text{MQPX}}$ of £64,744 for both genders, £22,810 for men and £39,862 for women.
Compared to the $\text{VoL}_{32}^{\text{TS}}$ of 'Step1TS', the modifications of 'Step4Scen4' achieved around 86% of the traditional approach using specialist wage rates. This is a lower percentage than the ones comparing the 'Step4Scen4' $\text{VoL}_{32}^{\text{MQPX}}$ with the traditional approach using the housekeeper wage rate $\text{VoL}_{32}^{\text{TH}}$. That percentage ranged between 89% (£39,862 / £44,727) and 97% (£22,810 / £23,507) of the $\text{VoL}_{32}^{\text{TH}}$.

6.7.6 Summary and Comparison of Results for the VoL_{33}

Table 6.16 presents the results for group VoL_{33} 'making and care for textiles'.

Table 6.16: Comparison of VoL_{33} results of steps 1 to 4

		Both			**Male**			**Female**		
		sample	**person**	**% (TS)**	**sample**	**person**	**% (TS)**	**sample**	**person**	**% (TS)**
Step1TH	$\text{VoL}_{33}^{\text{TH}}$	£26,717	£1.87	-	£3,828	£0.58	-	£22,850	£2.96	-
Step1TS	$\text{VoL}_{33}^{\text{TS}}$	£30,141	£2.11	100.00	£4,356	£0.66	100.00	£23,557	£3.05	100.00
Step2	$\text{VoL}_{33}^{\text{M}}$	£28,835	£2.02	95.67	£4,111	£0.63	94.38	£22,547	£2.92	95.71
Step3Scen1	$\text{VoL}_{33}^{\text{Q}}$	£28,996	£2.03	96.20	£4,191	£0.64	96.21	£22,662	£2.93	96.20
Step3Scen2	$\text{VoL}_{33}^{\text{P}}$	£26,916	£1.88	89.30	£3,890	£0.59	89.30	£21,036	£2.72	89.30
Step3Scen3	$\text{VoL}_{33}^{\text{QPA}}$	£27,941	£1.96	92.70	£4,038	£0.62	92.70	£21,837	£2.82	92.70
Step3Scen4	$\text{VoL}_{33}^{\text{QPX}}$	£25,891	£1.81	85.90	£3,742	£0.57	85.90	£20,235	£2.62	85.90
Step4Scen1	$\text{VoL}_{33}^{\text{MQ}}$	£27,739	£1.94	92.03	£3,955	£0.60	90.79	£21,691	£2.81	92.08
Step4Scen2	$\text{VoL}_{33}^{\text{MP}}$	£25,750	£1.80	85.43	£3,671	£0.56	84.28	£20,135	£2.60	85.47
Step4Scen3	$\text{VoL}_{33}^{\text{MQPA}}$	£26,730	£1.87	88.68	£3,811	£0.58	87.49	£20,901	£2.70	88.73
Step4Scen4	$\text{VoL}_{33}^{\text{MQPX}}$	£24,769	£1.73	82.18	£3,532	£0.54	81.07	£19,368	£2.50	82.22

Source: The author

The $\text{VoL}_{33}^{\text{TS}}$ for the 'Step1TS' results in £30,141 for both genders, £4,356 for men and £23,557 for women, or £2.11, £0.66 and £3.05 for the average person respectively.
From a monetary perspective, the $\text{VoL}_{33}^{\text{TS}}$ results show that women contribute more

than five times the value of men towards the VoL (£23,557 / £4,356 = 5.41). Therefore, the 2-digit activity code 33 'making and care for textiles' could be termed as the *women dominated group*.

Moreover, for both genders, men and women, all modifications from steps 2, 3 and 4 resulted in a lower VoL_{33} than the traditional approach using specialist wage rates in 'Step1TS'.

A comparison of the VoL_{33} modifications with the traditional approach using the housekeeper wage 'Step1TH' revealed that for both genders and men, 11 of the 18 modifications of steps 2, 3 and 4 achieved a higher VoL_{33} than the $\text{VoL}_{33}^{\text{TH}}$ in 'Step1TH'. However, the results show a different picture for women where none of the modifications achieved a higher VoL_{33} than the value estimated in 'Step1TH'.

The lowest VoL_{33} was found for 'Step4Scen4' with values of £24,769 for both genders, £3,532 for men and £19,368 for women. Compared to the $\text{VoL}_{33}^{\text{TS}}$ of 'Step1TS' and to the $\text{VoL}_{33}^{\text{TH}}$ of 'Step1TH', the modifications of 'Step4Scen4' achieved around 82% of the traditional approach using specialist wage rates ('Step1TS') and between 84.7% (£19,368 / £22,850) and 92.7% (£24,769 / £26,717) of the traditional approach using the housekeeper wage rate ('Step1TH').

6.7.7 Summary and Comparison of Results for the VoL_{34}

Table 6.17 presents the results for group VoL_{34} 'gardening and pet care'.

Table 6.17: Comparison of VoL_{34} results of steps 1 to 4

		Both			**Male**			**Female**		
		sample	**person**	**% (TS)**	**sample**	**person**	**% (TS)**	**sample**	**person**	**% (TS)**
Step1TH	$\text{VoL}_{34}^{\text{TH}}$	£43,220	£3.03	-	£22,579	£3.45	-	£20,915	£2.70	-
Step1TS	$\text{VoL}_{34}^{\text{TS}}$	£47,374	£3.32	100.00	£25,476	£3.89	100.00	£22,889	£2.96	100.00
Step2	$\text{VoL}_{34}^{\text{M}}$	£46,619	£3.26	98.41	£24,972	£3.81	98.02	£22,602	£2.92	98.75
Step3Scen1	$\text{VoL}_{34}^{\text{Q}}$	£40,651	£2.85	85.81	£21,770	£3.32	85.45	£19,738	£2.55	86.23
Step3Scen2	$\text{VoL}_{34}^{\text{P}}$	£43,494	£3.05	91.81	£23,249	£3.55	91.26	£21,163	£2.74	92.46
Step3Scen3	$\text{VoL}_{34}^{\text{QPA}}$	£42,096	£2.95	88.86	£22,522	£3.44	88.40	£20,462	£2.65	89.40
Step3Scen4	$\text{VoL}_{34}^{\text{QPX}}$	£37,494	£2.63	79.14	£19,960	£3.05	78.35	£18,332	£2.37	80.09
Step4Scen1	$\text{VoL}_{34}^{\text{MQ}}$	£40,036	£2.80	84.51	£21,344	£3.26	83.78	£19,517	£2.52	85.27
Step4Scen2	$\text{VoL}_{34}^{\text{MP}}$	£42,850	£3.00	90.45	£22,798	£3.48	89.49	£20,938	£2.71	91.48
Step4Scen3	$\text{VoL}_{34}^{\text{MQPA}}$	£41,466	£2.90	87.53	£22,084	£3.37	86.68	£20,239	£2.62	88.42
Step4Scen4	$\text{VoL}_{34}^{\text{MQPX}}$	£36,968	£2.59	78.04	£19,578	£2.99	76.85	£18,160	£2.35	79.34

Source: The author

For the 2-digit activity code 34 ‘gardening and pet care’ the VoL_{34} for ‘Step1TS’ were estimated at a $\text{VoL}_{34}^{\text{TS}}$ of £47,374 for both genders, £25,476 for men and £22,889 for women. In other words, this is £3.32, £3.89 and £2.96 per average person.

Different to all previously reported comparison results from VoL_{30} to VoL_{33}, the monetary contribution of men towards the $\text{VoL}_{34}^{\text{TS}}$ is higher than the one for women, with £25,476 compared to £22,889.

Furthermore, all modifications from steps 2, 3 and 4 resulted in a lower VoL_{34} than the traditional approach using specialist wages ‘Step1TS’.

While the $\text{VoL}_{34}^{\text{M}}$ for ‘Step2’ (considering multitasking) compared to the traditional approach using the specialist wage ‘Step1TS’ ($\text{VoL}_{34}^{\text{TS}}$) was lower, it achieved around 7% to 10% higher values for both genders, men and women, compared to the traditional approach using the housekeeper wage ‘Step1TH’ ($\text{VoL}_{34}^{\text{TH}}$).

The modifications of adding productivity adjustments ‘Step3Scen2’ ($\text{VoL}_{34}^{\text{P}}$) and ‘Step4Scen2’ ($\text{VoL}_{34}^{\text{MP}}$) had led to a higher VoL_{34} compared to the modifications of adding the quality adjustment ‘Step3Scen1’ ($\text{VoL}_{34}^{\text{Q}}$) and ‘Step4Scen1’ ($\text{VoL}_{34}^{\text{MQ}}$). A similar result has not been found in the previous comparison tables.

The highest VoL_{34} for the modification steps, apart from ‘Step1TS’, was identified for ‘Step2’ (considering multitasking) with $\text{VoL}_{34}^{\text{M}}$ values of £46,619 for both genders, £24,972 for men and £22,602 for women.

The lowest $\text{VoL}_{34}^{\text{MQPX}}$ was found for ‘Step4Scen4’ with values of £36,968 for both genders, £19,578 for men and £18,160 for women.

The modifications of ‘Step4Scen4’ considering multitasking and adjusting the product of quality and productivity achieved a $\text{VoL}_{34}^{\text{MQPX}}$ between 76.85% and 79.34% of the traditional approach using specialist wage rates ‘Step1TS’ ($\text{VoL}_{34}^{\text{TS}}$). Compared with the ‘Step1TH’ applying the housekeeper wage ($\text{VoL}_{34}^{\text{TH}}$) the percentage rates of the $\text{VoL}_{34}^{\text{MQPX}}$ range between 85.5% (£36,968 / £43,220) and 86.8% (£18,160 / £20,915).

6.7.8 Summary and Comparison of Results for the VoL_{35}

Table 6.18 presents the results for group VoL_{35} ‘construction and repairs’.

Table 6.18: Comparison of VoL_{35} results of steps 1 to 4

		Both			Male			Female		
		sample	**person**	**% (TS)**	**sample**	**person**	**% (TS)**	**sample**	**person**	**% (TS)**
Step1TH	VoL_{35}^{TH}	£15,956	£1.12	-	£12,896	£1.97	-	£3,255	£0.42	-
Step1TS	VoL_{35}^{TS}	£22,904	£1.60	100.00	£18,230	£2.78	100.00	£4,164	£0.54	100.00
Step2	VoL_{35}^{M}	£21,182	£1.48	92.48	£16,963	£2.59	93.05	£3,760	£0.49	90.30
Step3Scen1	VoL_{35}^{Q}	£15,007	£1.05	65.52	£11,904	£1.82	65.30	£2,762	£0.36	66.33
Step3Scen2	VoL_{35}^{P}	£17,044	£1.19	74.41	£13,583	£2.07	74.51	£3,084	£0.40	74.06
Step3Scen3	VoL_{35}^{QPA}	£16,017	£1.12	69.93	£12,737	£1.94	69.87	£2,921	£0.38	70.15
Step3Scen4	VoL_{35}^{QPX}	£11,145	£0.78	48.66	£8,851	£1.35	48.55	£2,042	£0.26	49.04
Step4Scen1	VoL_{35}^{MQ}	£13,872	£0.97	60.57	£11,074	£1.69	60.74	£2,492	£0.32	59.85
Step4Scen2	VoL_{35}^{MP}	£15,765	£1.10	68.83	£12,640	£1.93	69.34	£2,786	£0.36	66.90
Step4Scen3	VoL_{35}^{MQPA}	£14,810	£1.04	64.66	£11,851	£1.81	65.01	£2,637	£0.34	63.34
Step4Scen4	VoL_{35}^{MQPX}	£10,304	£0.72	44.99	£8,235	£1.26	45.17	£1,843	£0.24	44.27

Source: The author

The VoL_{35}^{TS} for 'Step1TS' were estimated at £22,904 for both genders, £18,230 for men and £4,164 for women. For the average person this is £1.60 for both genders, £2.78 for men and £0.54 for women.

The monetary contribution of men towards the VoL_{35}^{TS}, similar to the VoL_{34}^{TS}, is higher than the one for women with £18,230 compared to £4,164. The VoL_{35}^{TS} results show that men contribute more than four times the value achieved by women toward the VoL_{35}^{TS}. Thus, the 2-digit activity code 34 'construction and repairs' could be termed as the *men dominated group.*

All modifications from steps 2, 3 and 4 resulted in a lower VoL_{35} than the traditional approach using specialist wages 'Step1TS'.

While the VoL_{35}^{M} for 'Step2', considering multitasking, compared to the traditional approach using the specialist wage 'Step1TS' (VoL_{35}^{TS}) was lower, it achieved around 16% to 33% higher VoL_{35}^{M} for both genders, men and women, compared to the traditional approach using the housekeeper wage 'Step1TH' VoL_{35}^{TH}.

Moreover, the modifications of adding productivity adjustments 'Step3Scen2' (VoL_{35}^{P}) and 'Step4Scen2' (VoL_{35}^{MP}) had led to a higher VoL_{35} compared to the modifications of adding the quality adjustment 'Step3Scen1' (VoL_{35}^{Q}) and 'Step4Scen1' (VoL_{35}^{MQ}).

The highest VoL_{35} for the modification steps, apart from 'Step1TS', was identified for 'Step2' with a VoL_{35}^{M} of £21,182 for both genders, £16,963 for men and £3,760 for women.

The lowest VoL_{35} was found for 'Step4Scen4' with values of £10,304 for both gen-

ders, £8,235 for men and £1,843 for women.
The modifications of ‘Step4Scen4’ dropped the $\text{VoL}_{35}^{\text{MQPX}}$ significantly compared to all other summary tables. Compared to the $\text{VoL}_{35}^{\text{TS}}$ of ‘Step1TS’, the modifications of ‘Step4Scen4’ $\text{VoL}_{35}^{\text{MQPX}}$ achieved only around 45% of the traditional approach using specialist wage rates $\text{VoL}_{35}^{\text{TS}}$ and only between 56.6% (£ 1,843 / £3,255) and 64.5% (£10,304 / £15,956) of the $\text{VoL}_{35}^{\text{TH}}$ in ‘Step1TH’ using the housekeeper wage.

6.8 Impact of Applying Primary Data Splits and Adjustments Separated by Gender on the VoL and Presenting the Results of that Additional Calculations

As pointed out in Section 6.2, the presented VoL results so far were based on secondary data by gender, while the primary data was not applied separated by gender. This means that in the previous VoL calculations, only the data shown in the column ‘both’ of the three Tables 5.16, 5.18 and 5.21 were used as the multitasking splits, quality and productivity adjustments. The columns ‘male’ and ‘female’ in those tables were disregarded.
In this section those splits and adjustments of the columns ‘male’ and ‘female’ from the Tables 5.16, 5.18 and 5.21 were applied to the VoL estimates. This required a new calculation of all VoL steps and scenarios for men and women. Those results are presented in this section and allow the investigation to what extent the application of primary data adjustments, separated by gender, would impact on the previously reported VoL results. This further supplements the gender-based analysis of this research and helps to evaluate whether the primary data application by gender would improve the VoL estimates.

6.8.1 Preliminary Explanation of Reporting the Results in this Section

Similar to the previous sections, the VoL results in this section are shown in seven different tables, one for the VoL_{all} and six for each 2-digit breakdown VoL_{30} to VoL_{35}. Different to the previous sections, the VoL results are presented only for steps 2, 3

and 4 including the different scenarios.
The labelling of variables is kept consistent with the same notations used above, but adding a 'G' for gender to the subscripts of the variable names (e.g. $\text{VoL}_{32\text{G}}$) was required to clearly distinguish them from previously used variables. Furthermore, a shorter form for the notations for the steps and scenarios was also introduced to have a clear distinction from previous sections. For example, the variable $\text{VoL}^{\text{P}}_{\text{allG}}$ and 'St3Sc2G' means that the VoL was calculated based on step 3, scenario 2, and used primary data productivity adjustments by gender.
This section only provides information on the VoL for men and women, because the VoL results for both genders combined were already reported in previous sections and were not affected by the application of the primary data splits and adjustments by gender.

The gender-based result tables provided in this section include the columns 'sample' and 'pers' indicating the corresponding VoL estimates for men and women, extracted from the tables of the previous Sections 6.3 to 6.7. The values in those two columns act as the reference group to allow a comparison with the new VoL results calculated for this section. To maintain a comprehensible presentation of the results, the author always referred back to the relevant tables that contain the reference values. These reference values are built on the specialist wage rates only. Hence, the housekeeper wage is not relevant and also not illustrated in this section. Different to the tables in previous sections, the tables in this section do not provide the VoL results for 'Step1TH' and 'Step1TS'. The reason for this choice is based on the fact that 'Step1TH' and 'Step1TS' were not affected by considering primary data splits and adjustments by gender, because those two were based on the traditional approaches without any modifications applied to them. Those values were already displayed in the columns for both genders in the previous sections.

In order to present the results more clearly, the focus of the reporting is given to the values of the average person and the percentage changes rather than the total values for the entire sample.

6.8.2 Impact of Applying Primary Data Splits and Adjustments by Gender on the $\mathrm{VoL}_{\mathrm{allG}}$

Table 6.19 contains the $\mathrm{VoL}_{\mathrm{allG}}$ results of applying primary data by gender, allowing to easily compare results and showing the magnitude of differences between those $\mathrm{VoL}_{\mathrm{allG}}$ valuations stemming from the application of different approaches. The 'sample' and 'pers' reference values were taken from the corresponding steps presented in Table 6.12.

Table 6.19: Impact of applying primary data by gender on $\mathrm{VoL}_{\mathrm{allG}}$

		Male						Female					
		sample	**new**	**pers.**	**new**	**diff.**	**%**	**sample**	**new**	**pers.**	**new**	**diff.**	**%**
St2G	$\mathrm{VoL}^{\mathrm{M}}_{\mathrm{allG}}$	£109,193	£109,178	£16.67	£16.67	£0.00	-0.01	£171,415	£171,437	£22.17	£22.17	£0.00	0.01
St3Sc1G	$\mathrm{VoL}^{\mathrm{Q}}_{\mathrm{allG}}$	£103,543	£98,830	£15.81	£15.09	-£0.72	-4.55	£171,313	£181,681	£22.16	£23.50	£1.34	6.05
St3Sc2G	$\mathrm{VoL}^{\mathrm{P}}_{\mathrm{allG}}$	£99,180	£95,782	£15.14	£14.62	-£0.52	-3.43	£157,863	£162,111	£20.42	£20.97	£0.55	2.69
St3Sc3G	$\mathrm{VoL}^{\mathrm{QPA}}_{\mathrm{allG}}$	£101,382	£97,289	£15.48	£14.85	-£0.62	-4.04	£164,621	£171,901	£21.29	£22.23	£0.94	4.42
St3Sc4G	$\mathrm{VoL}^{\mathrm{QPX}}_{\mathrm{allG}}$	£88,290	£81,369	£13.48	£12.42	-£1.06	-7.84	£147,434	£160,295	£19.07	£20.73	£1.66	8.72
St4Sc1G	$\mathrm{VoL}^{\mathrm{MQ}}_{\mathrm{allG}}$	£96,449	£92,134	£14.72	£14.06	-£0.66	-4.47	£159,639	£169,248	£20.65	£21.89	£1.24	6.02
St4Sc2G	$\mathrm{VoL}^{\mathrm{MP}}_{\mathrm{allG}}$	£92,617	£89,432	£14.14	£13.65	-£0.49	-3.44	£147,403	£151,390	£19.06	£19.58	£0.52	2.70
St4Sc3G	$\mathrm{VoL}^{\mathrm{MQPA}}_{\mathrm{allG}}$	£94,552	£90,767	£14.43	£13.86	-£0.58	-4.00	£153,552	£160,323	£19.86	£20.74	£0.88	4.41
St4Sc4G	$\mathrm{VoL}^{\mathrm{MQPX}}_{\mathrm{allG}}$	£82,411	£76,010	£12.58	£11.60	-£0.98	-7.77	£137,704	£149,672	£17.81	£19.36	£1.55	8.69

Source: The author

The table is explained as follows. The two columns labelled 'new' include the VoL results for the sample, and per person, when gender differences of the primary data were taken into account. The columns 'diff' show the changes between the old and new VoL, and thus present the magnitude of applying primary data splits and adjustments by gender. The magnitudes of the changes are also expressed as a percentage rate in the columns '%'.
The row 'St3Sc2G' describes that the $\mathrm{VoL}_{\mathrm{allG}}$ calculated for step 3, scenario 2 was £99,180 as can be seen in Table 6.12 for 'Step3Scen2'. The new estimated $\mathrm{VoL}^{\mathrm{P}}_{\mathrm{allG}}$ applying the primary data adjustments by gender was £95,782 (Table 6.19), a reduction of £3,398 or 3.43%. Similarly, on the average person basis, £15.14 had reduced to £14.62, a reduction of £0.52 or again 3.43%. The same logic applies for women.

The application of primary data by gender changes the $\mathrm{VoL}_{\mathrm{allG}}$ for the modifications done in steps 3 and 4, but almost did not change the $\mathrm{VoL}^{\mathrm{M}}_{\mathrm{allG}}$ for 'St2G' which reflects step 2 and its consideration of multitasking splits, as shown in Table 6.19. For all steps, the newly calculated values for $\mathrm{VoL}_{\mathrm{allG}}$ applying the primary data by

gender compared to the corresponding values of the reference group (columns 'sample' and 'pers') had reduced for men, while those for women had increased.
The largest impact for men was identified in 'St3Sc4G' that adjusts for the product of quality and productivity. From the reference group $\mathrm{VoL}_{\mathrm{all}}^{\mathrm{QPX}}$ and values of £88,290 or £13.48 per individual, down to a $\mathrm{VoL}_{\mathrm{allG}}^{\mathrm{QPX}}$ of £81,369 or £12.42, this is a reduction of £6,921 or £1.06, in other words, a reduction of 7.84%. The highest impact for women was found in the same step 'St3Sc4' with an increase of the $\mathrm{VoL}_{\mathrm{allG}}^{\mathrm{QPX}}$ by 8.72% (£1.66) compared to the reference group $\mathrm{VoL}_{\mathrm{all}}^{\mathrm{QPX}}$.
The lowest reduction of 3.43% (£0.52) for men on a percentage basis, apart from 'St2G', was found for step 'St3Sc2G' that adjusts for productivity, while women showed the lowest increase of 2.69% (£0.55) for the same step 'St3Sc2G' and the $\mathrm{VoL}_{\mathrm{allG}}^{\mathrm{P}}$.

6.8.3 Impact of Applying Primary Data Splits and Adjustments by Gender on the $\mathrm{VoL}_{\mathrm{30G}}$

The following Table 6.20 contains the results for group $\mathrm{VoL}_{\mathrm{30G}}$ 'unspecified household and family care'. The 'sample' and 'pers' reference values were taken from the corresponding steps presented in Table 6.13.

Table 6.20: Impact of applying primary data by gender on $\mathrm{VoL}_{\mathrm{30G}}$

		Male						**Female**					
		sample	**new**	**pers.**	**new**	**diff.**	**perc**	**sample**	**new**	**pers.**	**new**	**diff.**	**perc**
St2G	$\mathrm{VoL}_{\mathrm{30G}}^{\mathrm{M}}$	£2,843	£2,842	£0.43	£0.43	£0.00	-0.02	£10,872	£10,873	£1.41	£1.41	£0.00	0.01
St3Sc1G	$\mathrm{VoL}_{\mathrm{30G}}^{\mathrm{Q}}$	£2,730	£2,627	£0.42	£0.40	-£0.02	-3.77	£10,229	£10,626	£1.32	£1.37	£0.05	3.88
St3Sc2G	$\mathrm{VoL}_{\mathrm{30G}}^{\mathrm{P}}$	£2,655	£2,543	£0.41	£0.39	-£0.02	-4.22	£9,949	£10,323	£1.29	£1.34	£0.05	3.76
St3Sc3G	$\mathrm{VoL}_{\mathrm{30G}}^{\mathrm{QPA}}$	£2,695	£2,586	£0.41	£0.39	-£0.02	-4.04	£10,101	£10,474	£1.31	£1.35	£0.05	3.69
St3Sc4G	$\mathrm{VoL}_{\mathrm{30G}}^{\mathrm{QPX}}$	£2,353	£2,163	£0.36	£0.33	-£0.03	-8.07	£8,816	£9,470	£1.14	£1.22	£0.08	7.42
St4Sc1G	$\mathrm{VoL}_{\mathrm{30G}}^{\mathrm{MQ}}$	£2,490	£2,396	£0.38	£0.37	-£0.01	-3.78	£9,524	£9,895	£1.23	£1.28	£0.05	3.90
St4Sc2G	$\mathrm{VoL}_{\mathrm{30G}}^{\mathrm{MP}}$	£2,422	£2,319	£0.37	£0.35	-£0.02	-4.24	£9,263	£9,612	£1.20	£1.24	£0.05	3.77
St4Sc3G	$\mathrm{VoL}_{\mathrm{30G}}^{\mathrm{MQPA}}$	£2,459	£2,359	£0.38	£0.36	-£0.02	-4.06	£9,404	£9,753	£1.22	£1.26	£0.05	3.71
St4Sc4G	$\mathrm{VoL}_{\mathrm{30G}}^{\mathrm{MQPX}}$	£2,146	£1,972	£0.33	£0.30	-£0.03	-8.10	£8,208	£8,818	£1.06	£1.14	£0.08	7.43

Source: The author

The application of primary data by gender seemed to have almost no impact on the $\mathrm{VoL}_{\mathrm{30G}}^{\mathrm{M}}$ for 'St2G' which reflects step 2 and the consideration of multitasking splits.
For the modifications done in steps 3 and 4, the application of primary data by

gender changed the $\text{VoL}_{30\text{G}}$ in all those cases. The change was negative (a reduction) for men in all cases while changes for women were positive and increased the previous VoL_{30} estimates.

For men, a reduction of the $\text{VoL}_{30\text{G}}$ was between 3.77% or £0.02 for 'St3Sc1G' (adjusting for quality) and 8.1% or £0.03 for 'St4Sc4G' (considering multitasking and adjusting for the product of quality and productivity), while the $\text{VoL}_{30\text{G}}$ increased for women between 3.69% or £0.05 for 'St3Sc3G' (adjusting for the average of quality and productivity) and 7.43% or £0.08 for 'St4Sc4G' reflecting the $\text{VoL}_{30\text{G}}^{\text{MQPX}}$.

6.8.4 Impact of Applying Primary Data Splits and Adjustments by Gender on the $\text{VoL}_{31\text{G}}$

The following Table 6.21 contains the results for group $\text{VoL}_{31\text{G}}$ 'food management'. The 'sample' and 'pers' reference values were taken from the corresponding steps presented in Table 6.14.

Table 6.21: Impact of applying primary data by gender on $\text{VoL}_{31\text{G}}$

		Male						Female					
		sample	**new**	**pers.**	**new**	**diff.**	**perc**	**sample**	**new**	**pers.**	**new**	**diff.**	**perc**
St2G	$\text{VoL}_{31\text{G}}^{\text{M}}$	£35,238	£35,230	£5.38	£5.38	£0.00	-0.02	£67,830	£67,844	£8.77	£8.77	£0.00	0.02
St3Sc1G	$\text{VoL}_{31\text{G}}^{\text{Q}}$	£36,462	£33,111	£5.57	£5.05	-£0.51	-9.19	£69,848	£75,587	£9.03	£9.78	£0.74	8.22
St3Sc2G	$\text{VoL}_{31\text{G}}^{\text{P}}$	£31,574	£30,707	£4.82	£4.69	-£0.13	-2.75	£60,484	£61,995	£7.82	£8.02	£0.20	2.50
St3Sc3G	$\text{VoL}_{31\text{G}}^{\text{QPA}}$	£34,018	£31,890	£5.19	£4.87	-£0.32	-6.26	£65,166	£68,791	£8.43	£8.90	£0.47	5.56
St3Sc4G	$\text{VoL}_{31\text{G}}^{\text{QPX}}$	£29,209	£25,780	£4.46	£3.94	-£0.52	-11.74	£55,954	£62,070	£7.24	£8.03	£0.79	10.93
St4Sc1G	$\text{VoL}_{31\text{G}}^{\text{MQ}}$	£32,595	£29,593	£4.98	£4.52	-£0.46	-9.21	£62,743	£67,912	£8.11	£8.78	£0.67	8.24
St4Sc2G	$\text{VoL}_{31\text{G}}^{\text{MP}}$	£28,226	£27,444	£4.31	£4.19	-£0.12	-2.77	£54,332	£55,700	£7.03	£7.20	£0.18	2.52
St4Sc3G	$\text{VoL}_{31\text{G}}^{\text{MQPA}}$	£30,410	£28,501	£4.64	£4.35	-£0.29	-6.28	£58,538	£61,806	£7.57	£7.99	£0.42	5.58
St4Sc4G	$\text{VoL}_{31\text{G}}^{\text{MQPX}}$	£26,111	£23,041	£3.99	£3.52	-£0.47	-11.76	£50,262	£55,768	£6.50	£7.21	£0.71	10.95

Source: The author

Similar to the previous tables for VoL_{allG} and $\text{VoL}_{30\text{G}}$, the results in the above table show that the application of primary data by gender seemed to have almost no impact on the $\text{VoL}_{31\text{G}}^{\text{M}}$ for 'St2G' considering the multitasking splits.

For the modifications done in steps 3 and 4, the application of primary data by gender changed the $\text{VoL}_{31\text{G}}$. The change was negative (a reduction) for men in all cases, while changes for women were positive and increased the previous VoL_{31} estimates.

For men, a reduction of the $\text{VoL}_{31\text{G}}$ was between 2.75% or £0.13 for the $\text{VoL}_{31\text{G}}^{\text{P}}$ of 'St3Sc2G' (adjusting for productivity) and 11.76% or £0.47 for the $\text{VoL}_{31\text{G}}^{\text{MQPX}}$ of

'St4Sc4G' (considering multitasking and adjusting for the product of quality and productivity). The highest increase for women was found for the $\mathrm{VoL}_{31G}^{MQPX}$ with 10.95% (£0.71) in 'St4Sc4G', while the lowest increase was 2.5% or £0.20 for 'St3Sc2G' and the VoL_{31G}^{P}.

6.8.5 Impact of Applying Primary Data Splits and Adjustments by Gender on the VoL_{32G}

The following Table 6.22 contains the results for group VoL_{32G} 'household upkeep'. The 'sample' and 'pers' reference values were taken from the corresponding steps presented in Table 6.15.

Table 6.22: Impact of applying primary data by gender on VoL_{32G}

		Male						**Female**					
		sample	**new**	**pers.**	**new**	**diff.**	**perc**	**sample**	**new**	**pers.**	**new**	**diff.**	**perc**
St2G	VoL_{32G}^{M}	£25,066	£25,063	£3.83	£3.83	£0.00	-0.01	£43,804	£43,808	£5.67	£5.67	£0.00	0.01
St3Sc1G	VoL_{32G}^{Q}	£26,487	£24,840	£4.04	£3.79	-£0.25	-6.22	£46,074	£48,662	£5.96	£6.29	£0.33	5.62
St3Sc2G	VoL_{32G}^{P}	£24,229	£23,989	£3.70	£3.66	-£0.04	-0.99	£42,146	£42,562	£5.45	£5.50	£0.05	0.99
St3Sc3G	VoL_{32G}^{QPA}	£25,371	£24,414	£3.87	£3.73	-£0.15	-3.77	£44,133	£45,612	£5.71	£5.90	£0.19	3.35
St3Sc4G	VoL_{32G}^{QPX}	£24,175	£22,422	£3.69	£3.42	-£0.27	-7.25	£42,054	£44,780	£5.44	£5.79	£0.35	6.48
St4Sc1G	VoL_{32G}^{MQ}	£24,990	£23,434	£3.81	£3.58	-£0.24	-6.23	£43,673	£46,129	£5.65	£5.97	£0.32	5.63
St4Sc2G	VoL_{32G}^{MP}	£22,860	£22,632	£3.49	£3.45	-£0.03	-1.00	£39,949	£40,347	£5.17	£5.22	£0.05	0.99
St4Sc3G	$\mathrm{VoL}_{32G}^{MQPA}$	£23,938	£23,033	£3.65	£3.52	-£0.14	-3.78	£41,833	£43,238	£5.41	£5.59	£0.18	3.36
St4Sc4G	$\mathrm{VoL}_{32G}^{MQPX}$	£22,810	£21,153	£3.48	£3.23	-£0.25	-7.26	£39,862	£42,450	£5.16	£5.49	£0.33	6.49

Source: The author

Similar to the previous tables, the application of primary data by gender for multitasking seemed to have almost no impact on the VoL_{32G} ('St2G').

All modifications done in steps 3 and 4, compared to the reference group, showed that the VoL_{32G} for men dropped, while it increased for women. The highest changes in percent were found for $\mathrm{VoL}_{32G}^{MQPX}$ for men and women. While the VoL in 'St4Sc4G' that considers multitasking and adjusts for the product of quality and productivity was reduced by 7.26% or £0.25 for men, it increased by 6.49% or £0.33 for women. The lowest changes for men and women were identified for VoL_{32G}^{P}, 'St3Sc2G' (adjusting for productivity) with a 0.99% or £0.04 decrease for men and a 0.99% or £0.05 increase for women. Although the VoL_{32G}^{MP} (considering multitasking and adjusting for productivity) for women also showed a 0.99% increase, due to rounding differences, its value was higher than the one for VoL_{32G}^{P}.

6.8.6 Impact of Applying Primary Data Splits and Adjustments by Gender on the VoL_{33G}

The following Table 6.23 contains the results for group VoL_{33G} ‘making and care for textiles’. The ‘sample’ and ‘pers’ reference values were taken from the corresponding steps presented in Table 6.16.

Table 6.23: Impact of applying primary data by gender on VoL_{33G}

		Male						Female					
		sample	**new**	**pers.**	**new**	**diff.**	**perc**	**sample**	**new**	**pers.**	**new**	**diff.**	**perc**
St2G	VoL^{M}_{33G}	£4,111	£4,111	£0.63	£0.63	£0.00	-0.01	£22,547	£22,549	£2.92	£2.92	£0.00	0.01
St3Sc1G	VoL^{Q}_{33G}	£4,191	£3,877	£0.64	£0.59	-£0.05	-7.49	£22,662	£24,169	£2.93	£3.13	£0.19	6.65
St3Sc2G	VoL^{P}_{33G}	£3,890	£3,659	£0.59	£0.56	-£0.04	-5.94	£21,036	£22,144	£2.72	£2.86	£0.14	5.27
St3Sc3G	VoL^{QPA}_{33G}	£4,038	£3,768	£0.62	£0.58	-£0.04	-6.69	£21,837	£23,156	£2.82	£2.99	£0.17	6.04
St3Sc4G	VoL^{QPX}_{33G}	£3,742	£3,258	£0.57	£0.50	-£0.07	-12.93	£20,235	£22,709	£2.62	£2.94	£0.32	12.23
St4Sc1G	VoL^{MQ}_{33G}	£3,955	£3,659	£0.60	£0.56	-£0.05	-7.50	£21,691	£23,135	£2.81	£2.99	£0.19	6.66
St4Sc2G	VoL^{MP}_{33G}	£3,671	£3,453	£0.56	£0.53	-£0.03	-5.95	£20,135	£21,196	£2.60	£2.74	£0.14	5.27
St4Sc3G	$\mathrm{VoL}^{MQPA}_{33G}$	£3,811	£3,556	£0.58	£0.54	-£0.04	-6.70	£20,901	£22,166	£2.70	£2.87	£0.16	6.05
St4Sc4G	$\mathrm{VoL}^{MQPX}_{33G}$	£3,532	£3,075	£0.54	£0.47	-£0.07	-12.93	£19,368	£21,737	£2.50	£2.81	£0.31	12.23

Source: The author

Again, and similar to the previous four tables, the application of multitasking primary data by gender ‘St2G’ seemed to have almost no impact on the VoL_{33G}.
For the modifications done in steps 3 and 4, the application of primary data by gender changed the VoL_{33G} by lowering the values for men and increasing them for women. This also has been found in the previous tables above.
Due to rounding, some of the percentage rates presented in Table 6.23 had equal values; for example, the ones for ‘St3Sc4G’ and ‘St4Sc4G’ for men and women. In those cases, non-rounded values were used to identify the highest and lowest values. The VoL^{P}_{33G} of ‘St3Sc2G’ that adjusts for productivity shows the lowest percentage reduction for men, with 5.94% (£0.04) and the lowest increase for women with 5.27% (£0.14). The $\mathrm{VoL}^{MQPX}_{33G}$ of ‘St4Sc4G’ (considering multitasking and adjusting for the product of quality and productivity) had the highest drop of 12.93% or £0.07 for men and the highest increase for women with 12.23% and £0.31.

6.8.7 Impact of Applying Primary Data Splits and Adjustments by Gender on the $\mathbf{VoL_{34G}}$

The following Table 6.24 contains the results for group VoL_{34G} 'gardening and pet care'. The 'sample' and 'pers' reference values were taken from the corresponding steps presented in Table 6.17.

Table 6.24: Impact of applying primary data by gender on VoL_{34G}

		Male						Female					
		sample	**new**	**pers.**	**new**	**diff.**	**perc**	**sample**	**new**	**pers.**	**new**	**diff.**	**perc**
St2G	VoL^{M}_{34G}	£24,972	£24,971	£3.81	£3.81	£0.00	0.00	£22,602	£22,602	£2.92	£2.92	£0.00	0.00
St3Sc1G	VoL^{Q}_{34G}	£21,770	£21,518	£3.32	£3.28	-£0.04	-1.16	£19,738	£20,065	£2.55	£2.60	£0.04	1.66
St3Sc2G	VoL^{P}_{34G}	£23,249	£22,477	£3.55	£3.43	-£0.12	-3.32	£21,163	£21,777	£2.74	£2.82	£0.08	2.90
St3Sc3G	VoL^{QPA}_{34G}	£22,522	£21,997	£3.44	£3.36	-£0.08	-2.33	£20,462	£20,925	£2.65	£2.71	£0.06	2.26
St3Sc4G	VoL^{QPX}_{34G}	£19,960	£19,000	£3.05	£2.90	-£0.15	-4.81	£18,332	£19,227	£2.37	£2.49	£0.12	4.88
St4Sc1G	VoL^{MQ}_{34G}	£21,344	£21,093	£3.26	£3.22	-£0.04	-1.18	£19,517	£19,857	£2.52	£2.57	£0.04	1.74
St4Sc2G	VoL^{MP}_{34G}	£22,798	£22,041	£3.48	£3.36	-£0.12	-3.32	£20,938	£21,542	£2.71	£2.79	£0.08	2.88
St4Sc3G	VoL^{MQPA}_{34G}	£22,084	£21,566	£3.37	£3.29	-£0.08	-2.34	£20,239	£20,704	£2.62	£2.68	£0.06	2.30
St4Sc4G	VoL^{MQPX}_{34G}	£19,578	£18,633	£2.99	£2.84	-£0.14	-4.83	£18,160	£19,059	£2.35	£2.46	£0.12	4.95

Source: The author

According to Table 6.24 the application of primary data by gender to 'St2G' (considering multitasking) seemed to have almost no impact on the VoL^{M}_{34G}.
Similar to previous tables, the VoL_{34G} compared to the reference group VoL_{34} reduces for men and increases for women, for all calculations done in steps 3 and 4. However, the changes of the percentage rates were lower than in previous tables.
Compared to the reference group, for men a reduction of the VoL_{34G} was found between 1.16% (£0.04) for 'St3Sc1G' that adjusts for quality (VoL^{Q}_{34G}) and 4.83% (£0.14) for 'St4Sc4G' that considers multitasking and adjusts for the product of quality and productivity (VoL^{MQPX}_{34G}).
The increase of the VoL_{34G} for women ranged between 1.66% or £0.04 for 'St3Sc1G' and 4.95% or £0.12 also for 'St4Sc4G'.

Different to the previous tables in this current section, where the quality adjustment 'St3Sc1G' compared to the productivity adjustment 'St3Sc2G' consistently led to a higher VoL, this has reversed for the VoL_{34G}. A similar result was found for the equivalent steps that also consider multitasking 'St4Sc1G' and 'St4Sc2G'. This is in line with the reference group values shown in Table 6.17, where this also has been identified.

6.8.8 Impact of Applying Primary Data Splits and Adjustments by Gender on the VoL_{35G}

The following Table 6.25 contains the results for group VoL_{35G} that involves 'construction and repairs'. The 'sample' and 'pers' reference values were taken from the corresponding steps presented in Table 6.18.

Table 6.25: Impact of applying primary data by gender on VoL_{35G}

		Male						Female					
		sample	**new**	**pers.**	**new**	**diff.**	**perc**	**sample**	**new**	**pers.**	**new**	**diff.**	**perc**
St2G	VoL^{M}_{35G}	£16,963	£16,961	£2.59	£2.59	£0.00	-0.01	£3,760	£3,761	£0.49	£0.49	£0.00	0.02
St3Sc1G	VoL^{Q}_{35G}	£11,904	£12,857	£1.82	£1.96	-£0.15	8.01	£2,762	£2,571	£0.36	£0.33	-£0.02	-6.92
St3Sc2G	VoL^{P}_{35G}	£13,583	£12,407	£2.07	£1.89	£0.18	-8.66	£3,084	£3,312	£0.40	£0.43	£0.03	7.39
St3Sc3G	VoL^{QPA}_{35G}	£12,737	£12,633	£1.94	£1.93	£0.02	-0.82	£2,921	£2,942	£0.38	£0.38	£0.00	0.72
St3Sc4G	VoL^{QPX}_{35G}	£8,851	£8,746	£1.35	£1.34	£0.02	-1.19	£2,042	£2,039	£0.26	£0.26	£0.00	-0.15
St4Sc1G	VoL^{MQ}_{35G}	£11,074	£11,960	£1.69	£1.83	-£0.14	8.00	£2,492	£2,319	£0.32	£0.30	-£0.02	-6.93
St4Sc2G	VoL^{MP}_{35G}	£12,640	£11,543	£1.93	£1.76	£0.17	-8.68	£2,786	£2,993	£0.36	£0.39	£0.03	7.43
St4Sc3G	$\mathrm{VoL}^{MQPA}_{35G}$	£11,851	£11,752	£1.81	£1.79	£0.01	-0.83	£2,637	£2,656	£0.34	£0.34	£0.00	0.71
St4Sc4G	$\mathrm{VoL}^{MQPX}_{35G}$	£8,235	£8,136	£1.26	£1.24	£0.02	-1.19	£1,843	£1,840	£0.24	£0.24	£0.00	-0.16

Source: The author

Not surprisingly, the final table of this section also illustrates that the application of primary data by gender seemed to have almost no impact on the VoL_{35G} for 'St2G', which reflects step 2 and its consideration of multitasking splits.
Nevertheless, this table reveals differences that did not appear in the previous tables of this section. Contrary to the VoL estimates in the previous six Tables 6.19 to 6.24, the primary data by gender modifications done in steps 3 and 4 had a divergent impact on the VoL_{35G} for men and women, and did not show the typical overall reductions for men and the typical overall increases for women.

For men, apart from the calculations for 'St3Sc1G' and 'St4Sc1G', the application of primary data by gender lowers the VoL_{35G} compared to the reference group values of the VoL_{35}. Surprisingly, for 'St3Sc1G' and 'St4Sc1G' that reflect adjusting for quality, the VoL^{Q}_{35G} and the VoL^{MQ}_{35G} increased.
The highest reduction for men was found for the VoL^{MP}_{35G} at 8.68% or £0.17 for 'St4Sc2G' (considering multitasking and adjusting for productivity).

For women, compared to the reference group VoL_{35}, the $\text{VoL}_{35\text{G}}$ increased for 'St3Sc2G' (adjusting for productivity), 'St3Sc3G' (adjusting for the average of quality and productivity), 'St4Sc2G' (considering multitasking and adjusting for productivity) and 'St4Sc3G' (considering multitasking and adjusting for the average of quality and productivity), and decreased otherwise. The highest percentage increase for women was found for $\text{VoL}^{\text{MP}}_{35\text{G}}$ at 7.43% (£0.03), and the highest percentage decrease with 6.39% (£0.02) for $\text{VoL}^{\text{MQ}}_{35\text{G}}$.

An interesting result was noticed when comparing 'St3Sc1G' (adjusting for quality) with 'St3Sc2G' (adjusting for productivity), and 'St4Sc1G' (considering multitasking and adjusting for quality) with 'St4Sc2G' (considering multitasking and adjusting for productivity). Typically, the quality adjustment leads to a higher VoL than the productivity adjustments. That was different for the reference group of VoL_{35}, shown in Table 6.18, as well as the previous Table 6.24 for the $\text{VoL}_{34\text{G}}$ and its reference group VoL_{34}, as can be seen in Table 6.17. Surprisingly, the application of the primary data by gender has restored the typical relationship, that the quality adjustment leads to a higher VoL than the productivity adjustments, for the $\text{VoL}_{35\text{G}}$. This is shown by $\text{VoL}^{\text{Q}}_{35\text{G}}$ with £1.96 compared to $\text{VoL}^{\text{P}}_{35\text{G}}$ with only £1.89 per average person. A similar result was found for the equivalent scenarios in step 4, which also consider multitasking, 'St4Sc1G' with £1.83 compared to 'St4Sc2G' with only £1.76 per average person.

Following the presentation of the results, the key results are discussed in the next section.

6.9 Discussion of Results

This discussion section starts with a short recap. The aim of this research is to modify the currently dominating approach on valuing unpaid household work by taking consideration of simultaneous activities, quality and productivity. The recommendation and the necessity for improvements of the traditional approach have been discussed extensively in the literature, but the existing literature does not offer meaningful solutions. While previous studies have looked into single adjustments of wage rates or the consideration of secondary activities, the majority of those studies based their adjustments on arbitrary assumptions. This study goes one step further by calculating the adjustments based on the primary data. Additionally, the current study not only considers multitasking but also introduces two different adjustments in a new VoL approach, as illustrated in Figure 5.3. Considering multitasking and adjusting for quality and productivity based on the real data is the originality of this work. While the previous sections showed the results of the modified approach, in this section, the key findings are discussed and connected with the literature review and previous research studies whenever possible. The discussion also follows the four steps explained in Figure 5.3.

It is important to point out that the total VoL estimations derived in this study cannot be compared with existing literature, for several reasons. First, this research study uses a unique approach that has not been applied before. Second, a meaningful comparison would only be possible if the results could be compared using the same data sources. In this study, the VoL values were obtained using the primary data collected by the author himself. To the knowledge of the author, this has not been done before. Third, this research study estimates the VoL based on 31 different 4-digit level UKTUS activity codes. Unless another study uses the same activity groups, the magnitudes of the VoL are not comparable.

6.9.1 Discussion of Results from Step 1

Before starting the discussion, it is useful to highlight why the traditional approach applied in this study uses two different wage rates.

Based on the literature review that showed a variety of ways to put an economic value on unpaid work activities, the replacement cost approach was identified as the traditional approach for the VoL. Due to its simplicity, on one hand in terms of its application and on the other hand because of the manageable amount of data, the approach of solely valuing the labour input into household production was found to be the approach most applied in literature (Eurostat, 2003; Folbre, 2015), thus becoming the dominating approach.

Over time it has emerged that the housekeeper and the specialist wage rates appeared to be the most commonly used wage rates applied, together with the replacement cost VoL approach. While the specialist wage rate was recommended to be more appropriate than the housekeeper wage (Chadeau, 1992; Poissonnier & Roy, 2017), the housekeeper wage nevertheless was consistently used despite its known disadvantages. In many studies, the housekeeper wage rate was published alongside other calculations, using different wage rates, to show the differences it had caused. One reason for this could be the awareness that it is a nice to have and easy to include ‘add-on’ for comparison reasons. Another explanation could be the uncertainty based on the ongoing debate that the housekeeper wage rate may still be favoured in decades and therefore is still widely applied.

Although arguments for both wage rates of the debate were comprehensible, the researcher agreed with the majority of studies that identified that the housekeeper wage is easier to apply, but the specialist wage is the more appropriate one that should be used in the VoL. Therefore, this research adopted both wage rates, despite knowing that only the specialist wage is used for the modifications, while the housekeeper wage is included simply for comparison purposes.

To evaluate the modifications made in this study, the $\text{VoL}_{\text{all}}^{\text{TH}}$ and $\text{VoL}_{\text{all}}^{\text{TS}}$ need to be presented and assessed as a starting point for that evaluation.

6.9.1.1 Discussing Step 1: Results and Magnitudes of VoL based on the Housekeeper Wage and Specialist Wages

The results of Table 6.12 indicated that the $\text{VoL}_{\text{all}}^{\text{TS}}$ of the traditional approach using the specialist wage rate, without considering multitasking or any adjustments for quality and productivity (‘Step1TS’ in Table 6.12), resulted in a 11.41% (£307,947/£276,397) higher value than the $\text{VoL}_{\text{all}}^{\text{TH}}$ using the housekeeper wage for both genders combined (‘Step1TH’ in Table 6.12). For men the difference is 14.97% (£117,164/£101,906) and for women 4.93% (£184,011/£175,372).

This finding is in line with the literature. For example, research by Bridgman et al. (2012), Chadeau (1992), and Landefeld and McCulla (2000) stated that the traditional approach using the housekeeper wage may act as a lower boundary of the VoL, and therefore, the application of unadjusted specialist wages may lead to a higher valuation than the housekeeper wage.

The explanation for this difference is clearly visible when looking at Table 5.1, which contains the wage rates applied. The housekeeper wage with £9.07 for both genders, £9.22 for men and £9.03 is the lowest wage applied in this study.

In addition to the previous comment, the review of the literature also identified that unadjusted specialist wage rates would need to be significantly reduced to avoid an overestimation of the VoL. This suggests that the differences between the $\text{VoL}_{\text{all}}^{\text{TH}}$ and the $\text{VoL}_{\text{all}}^{\text{TS}}$ may be quite large. However, in this research, the VoL_{all} numbers that include all 31 UKTUS activities codes showed that those differences of up to 14.97% for men appeared not to be considerably large to justify a 'significant' reduction. The difference of 4.93% for women between the $\text{VoL}_{\text{all}}^{\text{TH}}$ and the $\text{VoL}_{\text{all}}^{\text{TS}}$ might even be considered small. An explanation of this may be found in Table 5.1, which presents the different wage rates, and Table 5.4, which provides the 'frequency count and time per UKTUS activity codes'. It appears that the majority of time is spent on activities that are valued with a wage rate close to the housekeeper wage rate, while the time spent on activities associated with higher wage rates was considerably less. This becomes visible when breaking the VoL_{all} down into the six 2-digit UKTUS activity codes VoL_{30} to VoL_{35}. The breakdown results show that in some instances the differences were higher than the 14.97% mentioned above. The results of the six breakdown groups of VoL_{30} to VoL_{35} are presented in Tables 6.13, 6.14, 6.15, 6.16, 6.17 and 6.18.

Those results further revealed that the gap between the VoL resulting from the application of the specialist wages and the housekeeper wage is smaller for women than for men. Leaving out the UKTUS activity code VoL_{35} 'construction and repairs', the largest difference for women was found at 9.52% (£11,677 / £10,662) for the VoL_{30} 'unspecified household and family care' and the lowest at 3.09% (£23,557 / £22,850) for the VoL_{33} 'making and care for textiles', while men's largest difference was at 13.79% (£4,356 / £3,828) for VoL_{33} and the lowest at 8.58% (£39,418 / £36,303) for VoL_{31} 'food management'.

More extreme are the numbers for VoL_{35}. The differences between $\text{VoL}_{35}^{\text{TH}}$ (traditional approach using the housekeeper wage) and the $\text{VoL}_{35}^{\text{TS}}$ (traditional approach using specialist wage rates) are 43.54% (£22,904 / £15,956) for both genders combined, 41.36% (£18,230 / £12,896) for men and 27.93% (£4,164 / £3,255) for women. This means that the $\text{VoL}_{35}^{\text{TS}}$ is much higher than the $\text{VoL}_{35}^{\text{TH}}$.

Those extreme differences are more in line with previous research by Chadeau (1992), Lowen and Sicilian (2015), and Varjonen and Niemi (2000), allowing 'significant' downward adjustments of the specialist wage rates while still maintaining the lower boundary threshold for the housekeeper wage $\text{VoL}_{35}^{\text{TH}}$. However, it needs to be noted that these extremes were only found for the VoL_{35} estimates.

Those differences can be explained by the different wage rates applied to the activities in the activity group VoL_{35}, as presented in Table 5.5. For 'construction and repairs' activities the wage rates for both genders and men are higher (ranging from £12.38 to £14.99) than for any other 2-digit UKTUS activity code, and are significantly higher than the housekeeper wage of £9.07 for both genders and £9.22 for men. For women and the VoL_{35} that wage difference is lower than for men, with the specialist wage rates ranging from £11.24 to £12.98 and the housekeeper wage at £9.03. This explains the smaller difference of 27.93% between $\text{VoL}_{35}^{\text{TH}}$ and the $\text{VoL}_{35}^{\text{TS}}$ for women.

The differences between the VoL of the 2-digit UKTUS activity codes find support in the work from Dulaney et al. (1992), who suggested that an over- or under-estimation of the VoL may be dependent on the activities investigated as well as the individual skill of the household member. A different but also supporting view was pointed out by Poissonnier and Roy (2017), who believe that most household activities require a low set of skills, which only leads to a small gap between market professionals and unpaid household members for those activities. This could explain the small differences between the VoL^{TH} and the VoL^{TS} for the 2-digit activity codes 30 to 34. Poissonnier and Roy (2017) further stated that maintenance work, for example, requires higher skills than chore household tasks, which would explain the larger differences for the 2-digit activity code 35.

6.9.1.2 Magnitudes of VoL Results based on the Housekeeper Wage and Specialist Wages compared to GDP

As mentioned at the beginning of the results chapter in Section 6.2, it is important for the discussion to show the magnitude of the modifications compared to the UK GDP. In particular, for policy makers and NSOs, this level of comparison is essential because they often focus on the macroeconomic view of the entire economy rather than the microeconomic, household or personal level. For the convenience of the reader, those magnitudes are only presented for both genders combined.

According to Table 6.12, the traditional approach using the housekeeper wage estimated a $\text{VoL}_{\text{all}}^{\text{TH}}$ of £19.35 per average person. For the adult UK population of 52,422,894, according to the OECD (2022b), ONS (2021c), and United Nations (2022b), this accounts for a total annual $\text{VoL}_{\text{all}}^{\text{TH}}$ of £370.25 billion. Applying the traditional approach using the specialist wage rate, the $\text{VoL}_{\text{all}}^{\text{TS}}$ estimated £21.56 per average person (Table 6.12), resulting in a total annual $\text{VoL}_{\text{all}}^{\text{TS}}$ of £412.54 billion, a difference of £42.29 billion.

Comparing those values with the annual UK GDP of £2,095.7 billion (based on Table 2.1), the $\text{VoL}_{\text{all}}^{\text{TH}}$ is equivalent to 17.67% and the $\text{VoL}_{\text{all}}^{\text{TS}}$ is equivalent to 19.68% of the annual UK GDP. It needs to be noted that this study only values a fraction of unpaid work and thus, compared to other studies, those percentages may appear to be low.

The difference of £42.29 billion between the $\text{VoL}_{\text{all}}^{\text{TH}}$ and $\text{VoL}_{\text{all}}^{\text{TS}}$ is equivalent to 2.02% of GDP. This percentage gives an impression of how large the magnitudes of different valuations are and highlights why it is important to aim for the most accurate VoL estimates and follow the recommendations by United Nations (2017) to have a more accurate valuation.

If the lower boundary assumption for the traditional approach using the housekeeper wage, outlined by Bridgman et al. (2012), Chadeau (1992), and Landefeld and McCulla (2000), would hold, and the VoL of the traditional approach using specialist wages would be the overestimated upper boundary, a more correct total annual VoL should be between the values of £370.25 billion and £412.54 billion.

6.9.2 Discussion of Results from Step 2

Below, the results from the step 2 modifications are discussed.

6.9.2.1 Discussion of Multitasking Splits

The traditional approach does not account for more than one activity and disregards simultaneous activities. In its traditional form, the VoL approach values the primary activity only and assigns the full time of each TUS episode to that primary activity. This has been debated in literature as being inaccurate (Craig & Bittmann, 2005; Floro & Miles, 2003; Quah, 1987). One problem is that this method may underestimate the true value of unpaid household work. Another problem is that this valuation procedure treats a single primary activity the same way as two simultaneous activities, which may not be accurate. This is crucial, in particular if the simultaneous activity is a leisure and thus a non-productive activity.

This debate on inaccuracy is supported by the findings from the primary data of this thesis. The results in Figure 5.2 led to the conclusion that in the case where a primary activity is accompanied with a secondary activity, it reduces the time spent on that primary activity. This was found for the three investigated simultaneous activities 'talking on the phone', 'socialising with family and friends' and 'listening to the radio', that were assumed to be done in addition to another household chore activity, as illustrated in Figure 5.2. The primary data showed that 8 out of 10 and 7 out of 10 respondents found it likely or even very likely that a phone conversation (81,5%) or socialising with family and friends (74.4%) would reduce time spent on another activity. Only 4 out of 10 respondents believed that this is the case for the activity 'listening to the radio'.

The above findings provide fresh insight into the argument that time spent on a single primary activity should not be treated the same way as the time where the primary activity is accompanied by a second activity. This is corroborated by literature on neuroscience and multitasking, presented in Chapter 3, which explained that multitasking is similar to task switching, which costs time caused by the switching process (Rogers & Monsell, 1995; Rubinstein et al., 2001).
It may be assumed that a similar result would also apply for tertiary or quaternary activities but that has not been investigated as part of this study.
The current study found that the degree to which the secondary activity affects the primary activity differs, according to the nature of the secondary activity. For example, the difference between the 'social' or 'phone' related activity compared with 'listening to the radio' could be explained by the fact that the first two activities require a higher rate of attention from the person performing them than 'listening to the radio'.
This result also supports the view of Spink et al. (2008), that it might be necessary to distinguish between active and passive activities. Passive activities may require less attention – for example, 'listening to the radio' – while active activities require a higher attention; for example, 'talking on the phone', 'watching TV' or even 'socialising with friends and family'.

Moreover, those research findings presented in Figure 5.2 may also contribute to the discussion in the literature led by the United Nations (2005, 2013) and Waring (2010) about the order respondents write down their simultaneously performed activities in a TUS diary and whether or not this order should be kept or changed when coding the diary responses. It is assumed that there might be differences between the order of 1) 'gardening' and 'listening to music' versus 2) 'listening to music' and 'gardening'. In the first case, the person does gardening work and listens to music, while in the second case the importance seems to be on the 'listening part' and less attention might be given to 'gardening'. Considering the impact of secondary activities on the primary, as shown in Figure 5.2, this may also support the view that changing the order of activities may lead to biased data in the TUS.

Furthermore, there was no scientific basis on which all the splits for multitasking can be accurately determined. Some literature identified that splits for multiple activities were necessary but data and clarification on how this should be done is scarce, as pointed out by Kenyon (2010) and United Nations (2017).
Few studies looked into how two activities can be split, but since some TUS collect data on more than two activities, there are no guidelines or research on how a suitable split for more than two simultaneous activities would look like.
One of the unique contributions of this research is to calculate appropriate splits for up to four simultaneous activities, using the primary data.

Findings presented in Table 5.16 revealed that for two activities a possible split would be 56.9% for the primary and 43.1% for the secondary activity of both genders combined. Looking at gender-based splits, changes would only be minor, at around 0.1%. These findings almost confirmed the results of 54.92% and 45.08% found by Cardia and Gomme (2018) for a split of primary and secondary childcare time, and those of 55% and 45% by Williams and Donath (1994). Their splits were calculated using a production function approach, which is different to the modified VoL approach used in this study. Therefore, a comparison should be treated carefully.
For three activities this research identified a split of 42.0% for the primary, 32.1% for the secondary and 25.9% for the tertiary activity, as described in Table 5.16 for both genders combined. The splits by gender for men and women did not differ for the primary activity and only showed a negligible difference for the secondary and tertiary activities.
For four activities the data in Table 5.16 presented a split of 33.3% for the primary, 26.4% for the secondary, 21.6% for the tertiary and 18.7% for the quaternary activity and both genders. Gender-based splits did not differ for the primary and

tertiary activities, but showed a small difference of around 1.1 percentage points for the secondary and quaternary activities between men and women. This was also an almost negligible difference.
Although this research found similar splits for two activities than the previous research, as shown above, the results for three and four activities signal to refute the suggestion of Williams and Donath (1994) of applying an equal split in the case there are more than two activities.

6.9.2.2 Magnitudes of VoL Results Considering Multitasking Compared to the Traditional Approach

This part of the discussion focuses on the $\mathrm{VoL}_{all}^{\mathrm{M}}$ results considering multitasking in the traditional approach using specialist wage rates, as presented in Table 6.12, and the values provided for 'Step2' in that table.

This modification lowered the VoL from £307,947 for the $\mathrm{VoL}_{all}^{\mathrm{TS}}$ using the traditional approach and specialist wages ('Step1TS') by 6.82% to £286,950 $\mathrm{VoL}_{all}^{\mathrm{M}}$ if looking at both genders combined. There is no noticeable change of that percentage rate if looking at men or women separately.
Results offer a different view, when breaking the $\mathrm{VoL}_{all}^{\mathrm{M}}$ down into the 2-digit UKTUS activity codes $\mathrm{VoL}_{30}^{\mathrm{M}}$ to $\mathrm{VoL}_{35}^{\mathrm{M}}$. For both genders combined, the reduction of those VoL activity codes, compared to the corresponding $\mathrm{VoL}^{\mathrm{TS}}$ of 'Step1TS', ranged from 1.59% for VoL_{31} (Table 6.14) 'food management' to 10.3% for VoL_{34} (Table 6.17) 'gardening and pet care'. A very similar result was found for men ranging between 1.98% also for VoL_{31} and 10.6% again for VoL_{34}. The Vol_{all} for women showed a slightly wider range between 1.25% for VoL_{30} (Table 6.13) 'unspecified household and family care' and 12.4% for VoL_{34}.
The results clearly show that the consideration of multitasking lowers the VoL compared to the traditional approach using the specialist wage rates $\mathrm{VoL}_{all}^{\mathrm{TS}}$ in all cases investigated.
A comparison of those findings to existing studies is not possible due to the lack of scientific data on magnitudes of the VoL. Nevertheless, a possible explanation why considering multitasking lowers the VoL might be that the traditional approach using specialist wages values only the primary data. In case the secondary activities are leisure, the time spent on them would nevertheless be fully included in the val-

uation. However, with the application of the multitasking splits, the time duration of that secondary leisure activity would not be included in the VoL which would lead to a reduction of the VoL estimates. The other way is also possible if the primary activity is a leisure activity and the secondary is an unpaid household work activity. In case of only valuing the primary activity, that activity would not be included in the VoL, but in case of considering multitasking splits, the proportion of the time spent on the secondary household work activity would be included. This additional inclusion would increase the VoL compared to the traditional approach. However, the reduction on one side and the increase on the other do not even out, because the reductions exceed the increases, leading to the above shown lower $\mathrm{VoL}^{\mathrm{M}}_{all}$.

Another interesting finding is the comparison between the $\mathrm{VoL}^{\mathrm{M}}_{all}$ and the $\mathrm{VoL}^{\mathrm{TH}}_{all}$ of the traditional approach using the housekeeper wage. The assumption, mentioned by Bridgman et al. (2012), Chadeau (1992), and Landefeld and McCulla (2000), that the traditional approach using the housekeeper wage may act as a lower boundary of the VoL could not be fully supported, in the case of including multitasking to the VoL. Although the majority of $\mathrm{VoL}^{\mathrm{M}}_{all}$ results for 'Step2' presented in Tables 6.12, 6.13, 6.14, 6.15, 6.16, 6.17 and 6.18 showed higher VoLs than the $\mathrm{VoL}^{\mathrm{TH}}$ using the housekeeper wage, some VoLs, in particular those of women (for example, the $\mathrm{VoL}^{\mathrm{M}}_{31}$, $\mathrm{VoL}^{\mathrm{M}}_{32}$ and $\mathrm{VoL}^{\mathrm{M}}_{33}$) were lower than the corresponding $\mathrm{VoL}^{\mathrm{TH}}$ of the housekeeper wage. A possible explanation of why lower VoLs were particularly found for women and concern typical household chore activities of the 2-digit activity codes 31, 32 and 33, can be found in Table 5.5. The table shows that for those household chore activities, the specialist wage rates for women range between £9.22 and £9.35, while the housekeeper wage rate for women is £9.03. This difference appears to be so small that the application of multitasking splits is already large enough to lower the $\mathrm{VoL}^{\mathrm{M}}$ below the $\mathrm{VoL}^{\mathrm{TH}}$.

6.9.2.3 Magnitudes of VoL Results Considering Multitasking Compared to GDP

The total difference between the modification 'Step2' and the traditional approach can be better understood by comparing the results with the annual GDP in the UK. The GDP comparison is done on the VoL_{all} level for both genders based on the results presented in Table 6.12. The difference between the $\mathrm{VoL}^{\mathrm{M}}_{\mathrm{all}}$ of £20.09 and the

$\text{VoL}_{all}^{\text{TS}}$ for 'Step1TS' of £21.56 is £1.47 per day for the average person living in the UK. With an adult UK population of 52,422,894 people and 365 days per year, this would result in a total $\text{VoL}_{\text{all}}^{\text{M}}$ of £384.41 billion and a $\text{VoL}_{\text{all}}^{\text{TS}}$ of £412.54 billion. The difference between the two values is £28.13 billion, and based on a GDP of £2,095.7 billion, this difference is equivalent to 1.34% of GDP.
This means that considering multitasking reduces the VoL_{all} by the size of 1.34% of annual GDP in the UK.

Looking at the comparison of the $\text{VoL}_{all}^{\text{M}}$ with the $\text{VoL}_{all}^{\text{TH}}$ using the housekeeper wage without any modifications, according to Table 6.12, the difference between the two values is £0.74 (£20.09 - £19.35). This means that using the 'Step2' (considering multitasking) rather than 'Step1TH' (traditional approach using the housekeeper wage) would increase the VoL_{all} by £14.16 billion, which is equivalent to 0.68% of GDP.

6.9.3 Discussion of Results from Step 3

Below, the results from the step 3 modifications are discussed.

6.9.3.1 Discussion of Adjusting for Quality

The application of specialist wage rates for the VoL is claimed to be inaccurate unless they are adjusted for quality, as described in the literature review by Landefeld and McCulla (2000) and Bridgman et al. (2012). While previous studies, for example by Bridgman et al. (2012), Landefeld and McCulla (2000), Landefeld et al. (2009), Lowen and Sicilian (2015), National Research Council (2005), and United Nations (2017), commonly supported downward adjustments for quality that reduces the specialist wage rate by a certain percentage rate, the size of appropriate adjustments is uncertain due to the lack of scientific data. Therefore, quality adjustments in previous studies were chosen arbitrarily, and thus were often subjective. An example is the 25% reduction of the specialist wage rate based on assumptions by Landefeld et al. (2009).

This study found that the quality adjustments differ for each of the seven *questionnaire activity groups* investigated, not only for both genders but also for men and women, as can be seen in Table 5.18. Compared to a market professional, who would achieve 100%, the quality levels for both genders combined ranged between 58.69% for the quality of vehicle maintenance and 99.72% for the quality of cleaning activities. This is quite a large spread and was even larger for women, with a quality level ranging between 52.71% and 105.31% for the same two *questionnaire activity groups*, but was smaller for men, ranging between 65.34% and 93.49%.

This variety of adjustments for different activity groups is in line with the view of Blades (2000), who recommended adjustments for some but not necessarily all household activities. Nevertheless, the results of this study do not fully support the 25% reduction of the specialist wage rate suggested by Landefeld et al. (2009).

Findings show that for classical household chores, represented by the three activity groups *food*, *cleaning* and *laundry*, the quality level was close to the 100% of the market professional for both genders, and above the 100% level for women (Table 5.18). While in those classical household activity groups women's quality level exceeded the one of men significantly, opposing results were found for the typical 'manly' activity groups *renovation* and *vehicle*, where men's quality level surpassed that of women. Those results were generally expected, apart from the values exceeding the 100% level of the professional worker.

The results could be explained by the classical gender role model, where individuals believe they are good at those tasks that the cultural norms expect them to be good at (Blackstone, 2003). The surprisingly high quality level of more than 100% for women in the activity groups *food*, *cleaning* and *laundry* may be a result of women believing they are able to achieve at least the same or even a little higher quality than a market professional, because they also typically perform those types of activities on a regular or even daily basis.

Another explanation is based on work from Poissonnier and Roy (2017), who believe, as already outlined above, that household chores are less skill intensive than other household tasks. This could mean that many people believe they are able to achieve a similar quality level for chore household activities than market professionals because the differences in required skills are considered small.

In line with Poissonnier and Roy (2017), the requirement of higher skills for activities in the groups of *renovation* and *vehicle* might explain the large drop in the quality levels for those two *questionnaire activity groups*. Compared to a professional market worker, a household member might not possess the same set of skills in those areas, in particular because renovating and maintenance activities are usually not done on a day-to-day basis, like household chores. Therefore, the experience level of household members is assumed to be lower than that of market professionals, which leads to a lower quality level.

The next section discusses the magnitude of the above adjustments when applied to UKTUS data, and how this changes the VoL after adopting the modified approach, adjusting for quality.

6.9.3.1.1 Magnitudes of VoL Results Adjusting for Quality Compared to Traditional Approach

This part of the discussion focuses on the $\mathrm{VoL}^{\mathrm{Q}}_{all}$ when the traditional approach using specialist wage rates is adjusted for quality. The results are presented in Table 6.12, 'Step3Scen1'.

This modification lowered the VoL from £307,947 for the $\mathrm{VoL}^{\mathrm{TS}}_{all}$ using the traditional approach with specialist wages ('Step1TS') by 8.65% to £281,305 for the $\mathrm{VoL}^{\mathrm{Q}}_{all}$, if looking at both genders combined.
For men, this reduction is larger than the overall 8.65% with 11.63% (£103,543 compared to £117,164), but was smaller for women, with only 6.9% (£171,313 compared to £184,011).
An explanation of this larger drop for men cannot be found in the quality adjustments Table 5.18 because for both genders, men and women, the same primary data quality adjustments (column 'both' of Table 5.18) above were applied in this step. Therefore, it is assumed that this larger drop comes from the following influencing factors. The lowest quality levels were identified in the *questionnaire activity groups* '*renovation*' and '*vehicle*' with 67.85% and 58.69% respectively, as shown in Table 5.18. Also, the majority of the work in those activity groups is done by men, who, according to Table 5.5, also have higher specialist wages than women for those activity groups. The combination of those factors is assumed to have caused this larger drop of the VoL for men, when the modified approach is applied.

The 2-digit breakdown for the $\mathrm{VoL}^{\mathrm{Q}}_{30}$ to $\mathrm{VoL}^{\mathrm{Q}}_{35}$ (Tables 6.13 to 6.18, 'Step3Scen1') reveals that the quality adjustment reduces the VoL compared to the traditional approach using specialist wages 'Step1TS' in all cases, and the drop ranges between 0.3% for the $\mathrm{VoL}^{\mathrm{Q}}_{32}$ for both genders, men and women, and 34.7% for the $\mathrm{VoL}^{\mathrm{Q}}_{35}$ for men.

For the typical household chore activities covered by $\mathrm{VoL}^{\mathrm{Q}}_{31}$ to $\mathrm{VoL}^{\mathrm{Q}}_{33}$, the largest drop is 7.5% but when looking at the $\mathrm{VoL}^{\mathrm{Q}}_{34}$ and $\mathrm{VoL}^{\mathrm{Q}}_{35}$ that drop increased significantly to 14.55% for men in $\mathrm{VoL}^{\mathrm{Q}}_{34}$ and 34.7% for men in $\mathrm{VoL}^{\mathrm{Q}}_{35}$.
The different breakdown levels show large discrepancies, which are a result of the interaction of the divergent wage rates (Table 5.5), the adjustments (Table 5.18) and the different amount of time spent on the various activities.

Similar to the finding for considering multitasking, the assumption by Bridgman et al. (2012), Chadeau (1992), and Landefeld and McCulla (2000) that the traditional approach using the housekeeper wage may act as a lower boundary of the VoL also cannot be supported by this research, if quality adjustments are considered. For more than half of the VoL estimates, the $\mathrm{VoL}^{\mathrm{Q}}$ was lower than its corresponding $\mathrm{VoL}^{\mathrm{TH}}$ of 'Step1TH' in the Tables 6.12, 6.13, 6.14, 6.15, 6.16, 6.17 and 6.18.

6.9.3.1.2 Magnitudes of VoL Results Adjusting for Quality Compared to GDP

The total magnitude of 'Step3Scen1' adjusting the specialist wage rates for quality differences is shown by estimating the VoL for the total adult UK population. According to Table 6.12, the difference between the $\mathrm{VoL}^{\mathrm{Q}}_{all}$ of £19.70 and the $\mathrm{VoL}^{\mathrm{TS}}_{all}$ for 'Step1TS' of £21.56 is £1.86 per day for the average person living in the UK. With an adult UK population of 52,422,894 people and 365 days per year, this would result in a total $\mathrm{VoL}^{\mathrm{Q}}_{all}$ of £376.95 billion and a $\mathrm{VoL}^{\mathrm{TS}}_{all}$ of £412.54 billion. The difference is £35.59 billion, which is equivalent to 1.70% of GDP.
Adjusting for quality reduces the VoL_{all} by the size of 1.70% of annual GDP in the UK.

Based on Table 6.12, the difference between the $\mathrm{VoL}^{\mathrm{Q}}_{all}$ and the $\mathrm{VoL}^{\mathrm{TH}}_{all}$ using the housekeeper wage without any modifications is £0.35 (£19.70 - £19.35). This means that using the 'Step3Scen1' (adjusting for quality) rather than 'Step1TH' (traditional approach using the housekeeper wage) would increase the VoL_{all} by £6.70 billion, which is equivalent to 0.32% of GDP.

6.9.3.2 Discussion of Adjusting for Productivity

The application of the specialist wage rate is also claimed to be inaccurate unless it is adjusted for productivity, as described in the literature review (Dulaney et al., 1992;

Fitzgerald et al., 1996; Gørtz, 2006; National Research Council, 2005; Poissonnier & Roy, 2017). Measuring productivity in households is a complicated task because it requires input data as well as output data. As outlined in Chapter 2, the output data is usually not available and is hard to collect (Ironmonger & Soupourmas, 2009). To overcome this problem, this study applied a new way of collecting the required information. Here, productivity was calculated using the time respondents would require, compared to a market specialist, to produce one output unit of a typical unpaid household work activity, for each of the seven *questionnaire activity groups* (*food*, *cleaning*, *laundry*, *gardening*, *pet*, *renovation*, and *vehicle*).
The data, presented in Table 5.21, indicated that a productivity adjustment would be suitable for all seven *questionnaire activity groups* to increase the accuracy of the VoL estimates. All productivity values for both genders combined were below 100%, which means that for none of the seven *questionnaire activity groups* was the productivity believed to be equal or higher than that of a professional worker.
Adjustment levels for the seven *questionnaire activity groups* ranged between 73.4% and 98.44%, as presented in Table 5.21. The adjustment levels for men were also consistently below 100%, ranging from 67.8% to 95.76%.
However, two interesting findings appeared with productivity data for women. The first unexpected finding concerned the activity group *pet*, where the productivity level of women did exceed that of a professional worker by 0.85 percentage points and was found to be 100.85%. This was the only productivity level reported exceeding 100%. The second interesting finding was the comparative productivity rate between men and women. For all seven *questionnaire activity groups*, women reported having a higher productivity level than men. The differences between men and women in percentage points were also quite large and ranged from as low as 1.75% for the activity group *cleaning* up to 16.41% for the activity group *vehicle*, as can be seen in Table 5.21. For the activity groups *laundry* and *renovation* the difference in percentage points was also larger than 10%. Although these differences may have been expected for *laundry*, it was particularly surprising for *renovation* and *vehicle*, which are generally considered more ‘classic men’ activities.

The possible explanations for this unexpected finding could be as follows.
The first argument of explanation could be that women might have overestimated themselves. The questionnaire contained one question with the purpose of investigating the overestimation of respondents in general. The data in Table 5.19 showed

clearly that only 31% of women compared to 39% of men responded that they may likely or very likely tend to overestimate themselves. Those findings are in line with work from Kan (2008), who found that in stylised questionnaires men have a tendency to overestimate time spent on unpaid household activities for typical manly tasks, such as maintenance work. According to Robinson et al. (2002), for example, the magnitude of overestimation of reported time spent on activities can be very large, and in some cases may even exceed the 24 hours per day boundary by reporting more than 24 hours.
However, the study by Kan (2008) also revealed that men had the tendency to report fewer hours on unpaid household activities than they really spent, to fit their bread-earner role. This might explain more conservative responses by men.
Although overestimation may still be an issue, it can be summarised from above that the overestimation results from the primary data questionnaire shown in Table 5.19 did not help to explain the differences in the productivity levels between men and women, presented in Table 5.21.

The second argument of explanation could be desirability effects, where respondents may provide misleading information (Gershuny, 2011). In particular, it could be seen as a social desirability bias, where respondents provide a wrong answer to be in line with socially acceptable rules or cultural norms (Sekaran & Bougie, 2010), or to impress the interviewer or researcher (Brace, 2013). The design of this research study used an online questionnaire, which ensured the anonymity of respondents and required no interviewer. According to Brace (2013), the absence of an interviewer should have significantly reduced social desirability bias. Therefore, the latter argument of impressing the interviewer or researcher is very unlikely. However, the explanation of being in line with socially acceptable rules might be a solid explanation. Similar to the findings from the research by Córdova Cazar (2016), where respondents provided socially accepted answers on their enjoyment level rather than reporting their actual feelings, the women in this study might have reported higher productivity levels, because they did not want to look weaker compared to men.

Furthermore, the findings of this study do partly support the recommendation of Blades (2000) to use adjustments of between 50% and 70% of the specialist wage rate to adjust for the productivity differences of non-chore household activities. For both genders combined, Table 5.21 reveals productivity levels of 73.38% for the non-household chore activity group *renovation* and 77.33% for the non-household chores activity group *vehicle*. Both percentage rates were slightly above Blades' recommendation. A similar picture is shown for women, who are also well above the 70% threshold with productivity levels of 78.36% for *renovation* and 85.09% for *vehicle*. In contrast, men only reported productivity levels of 67.82% for *renovation* and 68.68% for *vehicle*, and thus, those percentage rates fell into the range proposed by Blades (2000).

Blades (2000) further suggested that for chore household activities, the housekeeper wage would be more appropriate to value those activities, instead of adjusting specialist wage rates for productivity. The results of this research, which were presented in Tables 6.14, 6.15 and 6.16 and reflect chore household activities, showed that the $\mathrm{VoL}^{\mathrm{TH}}$ of the traditional approach using the housekeeper wage rate mostly differs from the $\mathrm{VoL}^{\mathrm{P}}$ using the specialist wage rates adjusted for productivity. Therefore, the view of Blades (2000) regarding household chores cannot be supported based on the results of this research.

6.9.3.2.1 Magnitudes of VoL Results Adjusting for Productivity Compared to Traditional Approach

This part of the discussion focuses on the $\mathrm{VoL}^{\mathrm{P}}_{all}$ when the traditional approach using specialist wage rates is adjusted for productivity, based on the results in Table 6.12, 'Step3Scen2'.

This modification lowered the VoL from £307,947 for the $\mathrm{VoL}^{\mathrm{TS}}_{all}$ using the traditional approach and specialist wages ('Step1TS') by 14.67% to £262,782 $\mathrm{VoL}^{\mathrm{P}}_{all}$ if looking at both genders combined. The reduction for men is 15.35% (£99,180 compared to §117,164) and the reduction for women is 14.21% (£157,683 compared to £184,011).
Looking at the 2-digit breakdown of the $\mathrm{VoL}^{\mathrm{P}}_{30}$ to $\mathrm{VoL}^{\mathrm{P}}_{35}$ for both genders combined (Tables 6.13 to 6.18), the drop for the specialist wage rate ranges between 8.19% for the UKTUS activity code 34 'gardening and pet care' and 25.59% for code 35 'construction and repairs'.

It was found that the productivity adjustment of 'Step3Scen2' compared to the quality adjustment of 'Step3Scen1' has a larger impact on the VoL reduction, apart

from VoL_{34} and VoL_{35} where the reduction of the VoL was lower than the one of the quality adjustment.
This can be explained by comparing Tables 5.18 and 5.21. The relevant adjustment levels that were applied to estimate the VoL_{31}, VoL_{32} and VoL_{33} (activity groups *food*, *cleaning* and *laundry*) revealed higher percentages for quality than for productivity, which led to that larger reduction for productivity. However, this is different for the VoL_{34} and VoL_{35}, because from Tables 5.18 and 5.21 it is clearly visible that the relevant percentage rate for quality in the activity groups *gardening*, *pet*, *renovation* and *vehicle* were lower than the ones for productivity. This led to the lower VoL reduction for productivity.

Similar to the finding for considering multitasking and adjusting for quality, the assumption by Bridgman et al. (2012), Chadeau (1992), and Landefeld and McCulla (2000) that the traditional approach using the housekeeper wage may act as a lower boundary of the VoL also cannot be supported by this research, if productivity adjustments are considered. In more than half of the VoL estimates, the VoL^{P} was lower than its corresponding VoL^{TH} of 'Step1TH' in the Tables 6.12, 6.13, 6.14, 6.15, 6.16, 6.17 and 6.18.

6.9.3.2.2 Magnitudes of VoL Results Adjusting for Productivity Compared to GDP

The total magnitude of the 'Step3Scen2' that adjusted the specialist wage rates for productivity differences, can be illustrated by estimating the VoL for the total adult UK population. The difference between the VoL^{P}_{all} of £18.40 and the VoL^{TS}_{all} for 'Step1TS' of £21.56 is £3.16 per day for the average person living in the UK, based on Table 6.12. With an adult UK population of 52,422,894 people and 365 days per year this would result in a total VoL^{P}_{all} of £352.07 billion and a VoL^{TS}_{all} of £412.54 billion. The difference is £60.46 billion, which is equivalent to 2.89% of GDP.
Adjusting for productivity reduces the VoL_{all} by the size of 2.89% of annual GDP in the UK.

Based on Table 6.12, the difference between the VoL^{P}_{all} and the VoL^{TH}_{all} using the housekeeper wage without any modifications is -£0.95 (£18.40 - £19.35). This means that using the 'Step3Scen2' (adjusting for productivity) rather than 'Step1TH' (traditional approach using the housekeeper wage) would reduce the VoL$_{all}$ by £18.18 billion, which is a reduction equivalent to 0.87% of GDP.

6.9.3.3 Adjusting for the Average of Quality and Productivity

The literature review in Chapter 3 indicated that using market wage rates for unpaid work activities requires downward adjustments to account for a lower quality of unpaid work and a lower productivity. A unique approach of this study is to apply both adjustments as modifications of the VoL estimates. It is believed that this is the first of its kind; thus, the results are not comparable with other studies since they are not available.
In 'Step3Scen3', the average of both adjustments was applied. The adjustment levels were calculated based on Tables 5.18 and 5.21 for each *questionnaire activity group*. Due to the calculation of the average adjustments, the VoL estimates for 'Step3Scen3' were expected to be in between the VoL$^{\mathrm{Q}}$ of the single quality adjustment and the VoL$^{\mathrm{P}}$ of the single productivity adjustment.

As previously discussed, the results of 'Step3Scen1' applying the quality adjustment, did not fully support the 25% reduction of the specialist wage rate suggested by Landefeld et al. (2009), and the results of 'Step3Scen2' only partly supported the productivity adjustments of between 50% and 70% of the specialist wage rate as recommended by Blades (2000). The results of 'Step3Scen3', based on the average of both the quality and productivity adjustments, can also not fully support either of those two recommendations.

6.9.3.3.1 Magnitudes of VoL Results Adjusting for Average of Quality and Productivity Compared to Traditional Approach

This part of the discussion focuses on the VoL$_{all}^{\mathrm{QPA}}$ when the traditional approach using specialist wage rates is adjusted for the average of quality and productivity, as shown in Table 6.12, 'Step3Scen3'.

This modification lowered the VoL from £307,947 for the VoL$_{all}^{\mathrm{TS}}$ using the traditional approach and specialist wages ('Step1TS') by 11.64% to £272,096 VoL$_{all}^{\mathrm{QPA}}$ if looking at both genders combined. For men, this reduction with 13.47% is larger than the 11.64% of both genders combined, while it is smaller for women with 10.54%.

As expected and outlined above, the results for the $\mathrm{VoL}_{all}^{\mathrm{QPA}}$ are in between the $\mathrm{VoL}^{\mathrm{Q}}$ (8.65% for both, 11.63% for men, 6.9% for women) and the $\mathrm{VoL}^{\mathrm{P}}$ (14.67% for both, 15.63% for men, 14.21% for women).
Overall, compared to the single adjustment, either for quality or productivity, the adjustments of 'Step3Scen3' could be seen as a 'modest' adjustment.

The results of the 2-digit breakdown for the $\mathrm{VoL}_{30}^{\mathrm{QPA}}$ to $\mathrm{VoL}_{35}^{\mathrm{QPA}}$ of 'Step3Scen3' (Tables 6.13 to 6.18) reveal that the average of the quality and productivity adjustment reduces the VoL compared to the traditional approach using specialist wages 'Step1TS' in all cases. The reduction ranges between 4.5% for the $\mathrm{VoL}_{32}^{\mathrm{QPA}}$ and 30.07% for the $\mathrm{VoL}_{35}^{\mathrm{QPA}}$ for both genders combined.

Similar to the finding for considering multitasking and the single quality or productivity adjustments, the assumption by Bridgman et al. (2012), Chadeau (1992), and Landefeld and McCulla (2000) that the traditional approach using the housekeeper wage may act as a lower boundary of the VoL also cannot be supported by this research study, if the average of the quality and productivity adjustments are considered. In more than two-thirds of the VoL estimates, the $\mathrm{VoL}^{\mathrm{QPA}}$ was lower than its corresponding $\mathrm{VoL}^{\mathrm{TH}}$ of 'Step1TH' in the Tables 6.12, 6.13, 6.14, 6.15, 6.16, 6.17 and 6.18.

6.9.3.3.2 Magnitudes of VoL Results Adjusting for Average of Quality and Productivity Compared to GDP

The total magnitude of 'Step3Scen3', adjusting the specialist wage rates for the average of quality and productivity differences, is shown by estimating the VoL for the total adult UK population. Based on Table 6.12, the difference between the $\mathrm{VoL}_{all}^{\mathrm{QPA}}$ of £19.05 and the $\mathrm{VoL}_{all}^{\mathrm{TS}}$ for 'Step1TS' of £21.56 is £2.51 per day for the average person living in the UK. With an adult UK population of 52,422,894 people and 365 days per year, this would result in a total $\mathrm{VoL}_{all}^{\mathrm{QPA}}$ of £364.51 billion and a $\mathrm{VoL}_{all}^{\mathrm{TS}}$ of £412.54 billion. The difference is £48.03 billion, which is equivalent to 2.29% of GDP.
Adjusting for the average of quality and productivity reduces the VoL_{all} by the size of 2.29% of annual GDP in the UK.

According to Table 6.12, the difference between the $\mathrm{VoL}_{all}^{\mathrm{QPA}}$ and the $\mathrm{VoL}_{all}^{\mathrm{TH}}$

using the housekeeper wage without any modifications is -£0.30 (£19.05 - £19.35). This means that using the 'Step3Scen3' (adjusting for the average of quality and productivity) rather than 'Step1TH' (traditional approach using the housekeeper wage) would lower the VoL_{all} by £5.74 billion, which is equivalent to 0.27% of GDP.

6.9.3.4 Adjusting for the Product of Quality and Productivity

Another unique approach of this study is to apply the product of the quality and productivity adjustment as a modification of the VoL estimates ('Step3Scen4').
The required adjustments for this step were calculated based on the quality percentage rates of Table 5.18 and the productivity percentage rates shown in Table 5.21. For both genders the combined adjustment levels ranged from 45.38% of the specialist wage for the *questionnaire activity group* '*vehicle*', up to 90.98% of the specialist wage for the *questionnaire activity group* '*cleaning*'. This range is very large and can be explained by the way the combined adjustment levels were calculated, based on Tables 5.18 and 5.21.
While for both genders in the three activity groups *cleaning*, *laundry* and *pet* the adjustment levels were above 85.85%, the adjustment levels of the remaining four activity groups were 74.08% for *food*, 67.13% for *gardening*, 49.79% for *renovating* and 45.38% for *vehicle*. It was expected that those lower adjustment levels, compared to the adjustments used in 'Step3Scen1', 'Step3Scen2' and 'Step3Scen3', lead to a significantly lower VoL compared to all previous modifications.

While the literature suggests deductions of 25% for quality (Landefeld et al., 2009) or adjustments for productivity between 50% and 70% of the specialist wage rate for non-household chore activities (Blades, 2000), the results of adjusting for the product of quality and productivity, similar to previous sections above, can only partially support those suggestions. For some *questionnaire activity groups*, as mentioned above, the combination of the two adjustments still shows adjustment levels of well above 75% to be applied in 'Step3Scen4'. For those activity groups, the recommendations by Blades (2000) and Landefeld et al. (2009) were not supported by the results of this research.
However, the literature-based suggestion of an adjustment between 50% to 70% of the specialist wage rates for non-household chore activities is in line with the results of this research for the activity group *gardening* with 67.13% and almost in line

for the group *renovating* with 49.79%. But, the recommended adjustment levels by Blades (2000) and Landefeld et al. (2009) were not as large as the adjustment level for the *questionnaire activity group* '*vehicle*' with only 45.38% found in this research. Thus, for that activity group the literature-based suggestions also could not be supported.

It needs to be noted that the statements about supporting or not supporting the recommendation are limited by the fact that Blades (2000) and Landefeld et al. (2009) both suggested just one adjustment, either for quality or productivity, while in this step of the study ('Step3Scen4') a combined adjustment was applied.

Different to the previous 'modest' modification in 'Step3Scen3', the adjustment of the product of quality and productivity ('Step3Scen4') could be termed as 'drastic'.

6.9.3.4.1 Magnitudes of VoL Results Adjusting for the Product of Quality and Productivity Compared to Traditional Approach

This part of the discussion focuses on the $\mathrm{VoL}_{all}^{\mathrm{QPX}}$ when the traditional approach using specialist wage rates is adjusted for the product of quality and productivity, as shown in Table 6.12, 'Step3Scen4'.

This modification lowered the VoL from £307,947 for the $\mathrm{VoL}_{all}^{\mathrm{TS}}$ using the traditional approach and specialist wages ('Step1TS') by 21.67% to £241,220 $\mathrm{VoL}_{all}^{\mathrm{QPX}}$ if looking at both genders combined. For men, this reduction with 24.64% is larger than the 21.67% for both, while it is smaller for women with 19.88%. An explanation of the larger reduction for men can be explained by the large differences of the adjustment levels between men and women, as already discussed above.

Looking at the 2-digit level breakdown for both genders for the $\mathrm{VoL}_{30}^{\mathrm{QPX}}$ to $\mathrm{VoL}_{35}^{\mathrm{QPX}}$ ('Step3Scen4' in Tables 6.13 to 6.18) shows that the product of the quality and productivity adjustment reduces the VoL compared to the traditional approach using specialist wages 'Step1TS' in all cases. The range of reduction lies between 9.0% for the $\mathrm{VoL}_{32}^{\mathrm{QPX}}$ and 51.34% for the $\mathrm{VoL}_{35}^{\mathrm{QPX}}$.
The $\mathrm{VoL}_{35}^{\mathrm{QPX}}$ reduction for men is slightly higher with 51.45%, while women have a slightly lower reduction of 50.96%. This means that, for the 2-digit activity code 35 'construction and repairs', the adjustment for the product of quality and produc-

tivity would reduce the $\text{VoL}^{\text{TS}}_{35}$ of the traditional approach using specialist wages in 'Step1TS' by more than half.

It was also found that all VoL^{QPX} estimates are lower than any of the previously discussed VoL^{M}, VoL^{Q}, VoL^{P} and VoL^{QPA}, which is in line with the expectation in that regard, mentioned above.

Similar to the finding for considering multitasking and the quality and productivity adjustments discussed so far, the assumption by Bridgman et al. (2012), Chadeau (1992), and Landefeld and McCulla (2000) that the traditional approach using the housekeeper wage may act as a lower boundary of the VoL also cannot be supported by this research, if the product of quality and productivity adjustments is considered. Apart from two, namely the $\text{VoL}^{\text{QPX}}_{32}$ for men and for both genders, all other VoL^{QPX} were lower than its corresponding VoL^{TH} of 'Step1TH' in the Tables 6.12, 6.13, 6.14, 6.15, 6.16, 6.17 and 6.18.

6.9.3.4.2 Magnitudes of VoL Results Adjusting for the Product of Quality and Productivity Compared to GDP

The total magnitude of 'Step3Scen4', adjusting the specialist wage rates for the product of quality and productivity differences, can be illustrated by looking at the total adult UK population. The difference between the $\text{VoL}^{\text{QPX}}_{all}$ of £16.89 and the $\text{VoL}^{\text{TS}}_{all}$ for 'Step1TS' of £21.56 is £4.67 per day for the average person living in the UK, according to Table 6.12. With an adult UK population of 52,422,894 people and 365 days per year, this would result in a total $\text{VoL}^{\text{QPX}}_{all}$ of £323.18 billion and a $\text{VoL}^{\text{TS}}_{all}$ of £412.54 billion. The difference between the two values is £89.36 billion, which is equivalent to 4.26% of GDP.
Adjusting for the product of quality and productivity reduces the VoL_{all} by the size of 4.26% of annual GDP in the UK.

Based on Table 6.12, the difference between the $\text{VoL}^{\text{QPX}}_{all}$ and the $\text{VoL}^{\text{TH}}_{all}$ using the housekeeper wage without any modifications is -£2.46 (£16.89 - £19.35). This means that using the 'Step3Scen4' (adjusting for the product of quality and productivity) rather than 'Step1TH' (traditional approach using the housekeeper wage) would lower the VoL_{all} by £47.07 billion, which is equivalent to 2.25% of GDP.

6.9.4 Discussion of Results from Step 4

Step 4 of the modifications looked at the magnitudes of adjustments to the specialist wage rate considering multitasking and adjusting for quality and productivity. Step 4 combines the modifications of steps 2 and 3, considering multitasking in addition to the four scenarios of step 3. This modification is completely new and has never been done according to the author's knowledge.

Different to the steps 1, 2 and 3, the discussion of step 4 is kept shorter. The reason for this is that step 4 combines the previous steps 2 and 3, which were already discussed in great detail. While step 4 applies the same splits for multitasking and adjustments for quality and productivity, there is no new information to be discussed in that regard. Therefore, the focus of the step 4 discussion is given to the most important findings regarding the magnitudes of the modifications and how those compare to the UK's annual GDP.

The results for the four scenarios of step 4 ('Step4Scen1' considering multitasking and adjusting for quality, 'Step4Scen2' considering multitasking and adjusting for productivity, 'Step4Scen3' considering multitasking and adjusting for the average of quality and productivity, and 'Step4Scen4' considering multitasking and adjusting for the product of quality and productivity) are presented in Tables 6.12, 6.13, 6.14, 6.15, 6.16, 6.17 and 6.18.

Similar to step 3, the assumption by Bridgman et al. (2012), Chadeau (1992), and Landefeld and McCulla (2000) that the traditional approach using the housekeeper wage may act as a lower boundary of the VoL also cannot be supported by the results of step 4, for any of the four scenarios investigated.

6.9.4.1 Discussing Step 4 Scenario 1 Considering Multitasking and Adjusting for Quality

This part of the discussion focuses on the $\text{VoL}_{all}^{\text{MQ}}$ when the traditional approach using specialist wage rates considers multitasking and is adjusted for quality, as shown in Table 6.12, 'Step4Scen1'.

This modification lowered the VoL from £307,947 for the $\text{VoL}_{all}^{\text{TS}}$ ('Step1TS') by

14.88% to £262,138 for the $\text{VoL}_{all}^{\text{MQ}}$ if looking at both genders combined. The reduction for men is 17.68% and for women 13.25%.

The difference between the $\text{VoL}_{all}^{\text{MQ}}$ of £18.35 and the $\text{VoL}_{all}^{\text{TS}}$ for 'Step1TS' of £21.56 is £3.21 per day for the average person living in the UK. This would result in a total $\text{VoL}_{all}^{\text{MQ}}$ of £351.12 billion and a $\text{VoL}_{all}^{\text{TS}}$ of £412.54 billion, for the adult population in the UK. The difference is £61.42 billion, equivalent to 2.93% of GDP. Considering multitasking and adjusting for quality reduces the VoL_{all} by the size of 2.93% of annual GDP in the UK.

Based on Table 6.12, the difference between the $\text{VoL}_{all}^{\text{MQ}}$ and the $\text{VoL}_{all}^{\text{TH}}$ using the housekeeper wage without any modifications is -£1.00 (£18.35 - £19.35). This means that using the 'Step4Scen1' (adjusting for quality) rather than 'Step1TH' (traditional approach using the housekeeper wage) would decrease the VoL_{all} by £19.13 billion, which is equivalent to 0.91% of GDP.

6.9.4.2 Discussing Step 4 Scenario 2 Considering Multitasking and Adjusting for Productivity

This part of the discussion focuses on the $\text{VoL}_{all}^{\text{MP}}$ when the traditional approach using specialist wage rates considers multitasking and is adjusted for productivity, as shown in Table 6.12, 'Step4Scen2'.

This modification lowered the VoL from £307,947 for the $\text{VoL}_{all}^{\text{TS}}$ ('Step1TS') by 20.31% to £245,405 for the $\text{VoL}_{all}^{\text{MP}}$ if looking at both genders combined. For men the reduction is 20.95% and for women 19.89%.

The difference between the $\text{VoL}_{all}^{\text{MP}}$ of £17.18 and the $\text{VoL}_{all}^{\text{TS}}$ for 'Step1TS' of £21.56 is £4.38 per day for the average person living in the UK. This would result in a total $\text{VoL}_{all}^{\text{MP}}$ of £328.73 billion and a $\text{VoL}_{all}^{\text{TS}}$ of £412.54 billion, for the adult population in the UK. The difference is £83.81 billion, equivalent to 4.00% of GDP. Considering multitasking and adjusting for productivity reduces the VoL_{all} by the size of 4.00% of annual GDP in the UK.

Based on Table 6.12, the difference between the $\text{VoL}_{all}^{\text{MP}}$ and the $\text{VoL}_{all}^{\text{TH}}$ using the housekeeper wage without any modifications is -£2.17 (£17.18 - £19.35). This means that using the 'Step4Scen2' (adjusting for productivity) rather than 'Step1TH' (traditional approach using the housekeeper wage) would decrease the VoL_{all} by £41.52 billion, which is equivalent to 1.98% of GDP.

6.9.4.3 Discussing Step 4 Scenario 3 Considering Multitasking and Adjusting for the Average of Quality and Productivity

This part of the discussion focuses on the $\text{VoL}_{all}^{\text{MQPA}}$ when the traditional approach using specialist wage rates considers multitasking and is adjusted for the average of quality and productivity, as shown in Table 6.12, 'Step4Scen3'.

This modification lowered the VoL from £307,947 for the $\text{VoL}_{all}^{\text{TS}}$ ('Step1TS') by 17.58% to £253,821 for the $\text{VoL}_{all}^{\text{MQPA}}$ if looking at both genders combined. For men the reduction is 19.30% and for women 16.55%.

The difference between the $\text{VoL}_{all}^{\text{MQPA}}$ of £17.77 and the $\text{VoL}_{all}^{\text{TS}}$ for 'Step1TS' of £21.56 is £3.79 per day for the average person living in the UK. This would result in a total $\text{VoL}_{all}^{\text{MQPA}}$ of £340.02 billion and a $\text{VoL}_{all}^{\text{TS}}$ of £412.54 billion, for the adult population in the UK. The difference is £72.52 billion, equivalent to 3.46% of GDP. Considering multitasking and adjusting for the average of quality and productivity reduces the VoL_{all} by the size of 3.46% of annual GDP in the UK.

Based on Table 6.12, the difference between the $\text{VoL}_{all}^{\text{MQPA}}$ and the $\text{VoL}_{all}^{\text{TH}}$ using the housekeeper wage without any modifications is -£1.58 (£17.77 - £19.35). This means that using the 'Step4Scen3' (adjusting for the average of quality and productivity) rather than 'Step1TH' (traditional approach using the housekeeper wage) would decrease the VoL_{all} by £30.23 billion, which is equivalent to 1.44% of GDP.

6.9.4.4 Discussing Step 4 Scenario 4 Considering Multitasking and Adjusting for the Product of Quality and Productivity

This part of the discussion focuses on the $\text{VoL}_{all}^{\text{MQPX}}$ when the traditional approach using specialist wage rates considers multitasking and is adjusted for the product of quality and productivity, as shown in Table 6.12, 'Step4Scen4'.

This modification lowered the VoL from £307,947 for the $\text{VoL}_{all}^{\text{TS}}$ ('Step1TS') by 26.84% to £225,280 for the $\text{VoL}_{all}^{\text{MQPX}}$ if looking at both genders combined. For men the reduction is 29.66% and for women 25.17%.

The difference between the $\text{VoL}_{all}^{\text{MQPX}}$ of £15.77 and the $\text{VoL}_{all}^{\text{TS}}$ for 'Step1TS' of £21.56 is £5.79 per day for the average person living in the UK. This would result in a total $\text{VoL}_{all}^{\text{MQPX}}$ of £301.75 billion and a $\text{VoL}_{all}^{\text{TS}}$ of £412.54 billion, for the adult population in the UK. The difference is £110.79 billion, equivalent to 5.29% of GDP. Considering multitasking and adjusting for the product of quality and productivity reduces the VoL_{all} by the size of 5.29% of annual GDP in the UK.

Based on Table 6.12, the difference between the $\text{VoL}_{all}^{\text{MQPX}}$ and the $\text{VoL}_{all}^{\text{TH}}$ using the housekeeper wage without any modifications is -£3.58 (£15.77 - £19.35). This means that using the 'Step4Scen4' (adjusting for the product of quality and productivity) rather than 'Step1TH' (traditional approach using the housekeeper wage) would decrease the VoL_{all} by £68.50 billion, which is equivalent to 3.27% of GDP.

6.9.5 Discussion of the Impact of Applying Primary Data Splits and Adjustments by Gender on the VoL

In Section 6.8 the impact of applying male and female primary data splits and adjustments on the VoL was investigated, which required new calculations of the VoL for all steps. Here, the main findings regarding these impacts are discussed.

The questionnaire of this research was designed to collect, analyse and include data on splits and adjustments for both genders combined as well as for men and women separately. The Tables 5.16, 5.18 and 5.21 present the splits and adjustments for men and women, while the Tables 6.19 to 6.25 showed how those splits and adjustments affected the VoL results. The previously discussed VoL estimates, reported in Tables 6.12 to 6.18, served as the reference group for assessing the impact of primary data splits and adjustments for men and women.

From Tables 6.19 to 6.25 it can be seen that, if primary data splits and adjustments for men and women are taken into account, the VoL_{allG} decreased for men but increased for women, compared to the reference group VoL_{all} described in Table

6.12. This result also holds for the VoL of the 2-digit level breakdown VoL_{30G} to VoL_{35G}, apart from two adjustments for VoL_{35G} that showed different results. Those differences concerned the quality adjustment of Step3 Scenario1 and Step4 Scenario1 ('St3Sc1G' and 'St4Sc1G' in Table 6.25), for which the VoL_{35G} increased for men and decreased for women, compared to the corresponding reference group.
An explanation for this may be found by looking at the quality adjustments for men and women, as presented in Table 5.18. Furthermore, Table 5.25 revealed that for the calculation of the VoL_{35G}, the quality adjustments of the two *questionnaire activity groups* '*renovation*' and '*vehicle*' were applied. Compared to both genders, Table 5.18 shows that the adjustment levels for the quality of *renovation* and *vehicle* for men have increased from 67.85% to 72.58% for *renovation* and from 58.69% to 65.34% for *vehicle*. This caused the increase of the VoL_{35G} for the quality adjustment steps 'St3Sc1G' and 'St4Sc1G' for men and consequently led to a decrease for women.

The application of separate multitasking splits for men and women, as can be seen in Table 5.16, did not lead to noticeable changes in the VoL^{M}_{allG} or any of the six 2-digit breakdown levels VoL^{M}_{30G} to VoL^{TS}_{35G} for either men or women.
It is clearly visible from Tables 6.19 to 6.25 that the gender-based multitasking splits obviously did not have an impact on the VoL estimates. Those tables revealed changes of less than £0.01 on a per person basis, after applying the multitasking splits by gender and comparing VoL^{M}_{G} results with the corresponding reference groups VoL^{M}.
This finding was expected because the gender-based multitasking splits for men and women were only marginally different from the splits of both genders combined, as can be clearly seen in Table 5.16.

Different to multitasking, the results in Tables 6.19 to 6.25 show that primary data adjustments by gender for quality and productivity had an impact on the VoL calculation. For men, the VoL changes ranged from 3.43% to 7.84% and for women that range was between 2.69% and 8.72%, compared to the VoL results of the corresponding reference groups in Tables 6.12 to 6.18. The largest VoL change compared to the reference group was identified for the VoL_{33G} with 12.93% for men and 12.23% for women. Those changes were claimed significant.

Based on the results presented in Tables 6.19 to 6.25, it can be suggested that gender-based primary data adjustments for quality, productivity or a combination of both may increase the accuracy of the VoL estimates, while no impact of primary data multitasking splits by gender was found.
Moreover, it can be assumed that women, compared to men, would benefit from the application of adjustments by gender because they would increase the VoL for women and decrease that of men.
Thus, a recommendation of applying specialist wage rate adjustments by gender could be supported by the data of this research study, but not necessarily for multitasking splits by gender, solely because splits showed no effect.

6.9.6 Evaluation of the Magnitudes of the Modifications

The following Figure 6.1 summarises the above discussed and illustrates the magnitudes of the modified VoL_{all} approaches used in steps 2, 3 and 4. It presents for each step and scenario on the macroeconomic level to what extent the modifications changed the VoL compared to the traditional approach. This is visualised by showing the percentage rate changes in relation to UK's annual GDP of around £2,095.7 billion, compared to the traditional approach using the specialist wage (blue) or the housekeeper wage (red).

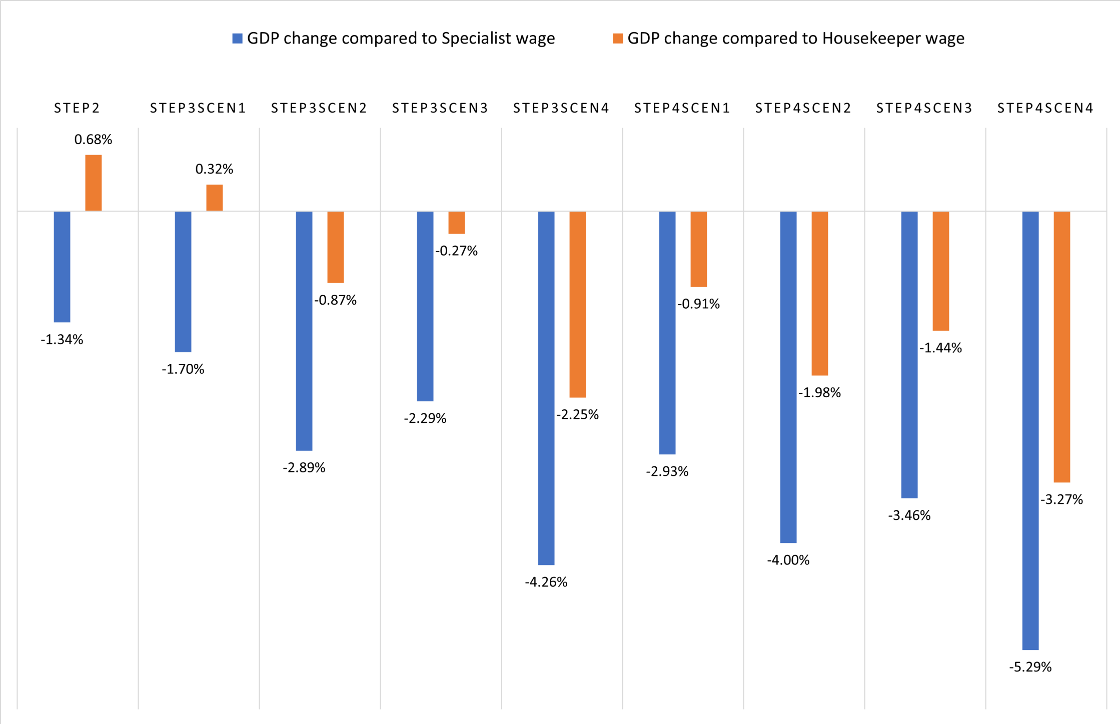


Figure 6.1: GDP change compared to traditional approaches

Source: The author

The importance of this study is clearly visualised through Figure 6.1. Depending on the choice of the valuation approach and its modifications, the VoL of unpaid household work could be significantly different from the VoL result using the currently dominating, traditional approach.

For example, the application of the productivity adjustment ('Step3Scen2') would reduce the VoL, compared to the traditional approach using specialist wage rates by the monetary size equivalent to 2.89% of UK's annual GDP. Compared to the traditional approach using the housekeeper wage, that reduction would be equivalent to 0.87% of GDP. In other words, the differences show to what extent the calculation of the VoL using the traditional approach could differ from a more appropriate valuation. As the review of the literature revealed, the traditional approach is known to be inaccurate unless suitable modifications are applied.

This research not only investigated possible modifications, but also presents its magnitudes and thus highlights the necessity of the modifications. For example, as stated in the discussion sections above, the traditional approach using the specialist wages would estimate an unadjusted $\mathrm{VoL}_{\mathrm{all}}^{\mathrm{TS}}$ of £412.54 billion. However, if looking at 'Step4Scen4' above, this VoL might be wrong by 5.29% of UK's annual GDP, a monetary value of £110.79 billion, which is more than a quarter of the original value. While 'Step4Scen4' offers the largest difference, more conservative estimates show that the VoL might be incorrectly valued by a size comparable to 2.29% or 3.46% of UK's annual GDP, if specialist wage rates are applied.

Based on existing literature and the lower boundary assumption of the housekeeper wage by Bridgman et al. (2012), Chadeau (1992), and Landefeld and McCulla (2000), the lowest, most conservative estimate would be the traditional approach using the housekeeper wage, resulting in a total $\mathrm{VoL}_{\mathrm{all}}^{\mathrm{TH}}$ of £370.25 billion for the adult UK population. Based on Figure 6.1, this assumption cannot be confirmed because this research found that even this lower boundary might be undercut by a monetary value equivalent to 3.27% of the UK's annual GDP.

It is therefore hoped that this research study provides additional understanding on how important it is to find a more appropriate valuation approach. It has further provided fresh insight into how different modifications can be done, including how the data for modification can be collected and used for a more accurate estimation of unpaid labour.

6.10 Regression Results

The regression model introduced in Chapter 5 was used to examine whether the seven binary coded demographic variables *ageB*, *childB*, *employB*, *genderB*, *maritalB*, *educatB* and *healthB* may have an impact on the quality of unpaid household work in each of the seven *questionnaire activity groups* (*food*, *cleaning*, *laundry*, *gardening*, *pet*, *renovation* and *vehicle*). The results of the seven regressions are explained below.

It is highlighted by Zikmund et al. (2010) that the interpretation of parameters from a regression analysis may be problematic or even meaningless, if two or more independent variables are correlated. A test for this multicollinearity can be done by looking at a correlation matrix (Field, 2009). A commonly applied correlation test is Pearson's r, but it should only be used between two continuous variables (Schendera, 2008). If two variables are dichotomous, the Phi (ϕ) coefficient is the most appropriate measure for correlation (Bryman, 2008; Bryman & Bell, 2015; Cohen & Cohen, 1983; Field, 2009; Khamis, 2008; Mitchell & Jolley, 2010). The Phi coefficient is based on the Chi square (χ^2) test (Cooper & Schindler, 2014; Field, 2009; Mitchell & Jolley, 2010). According to Mitchell and Jolley (2010) who refer to prior work from Cohen and Cohen (1983) the Phi coefficient is based on the same Pearson's r correlation formula. The values of the Phi coefficient range between 0 and ±1 (Bryman & Bell, 2015; Mitchell & Jolley, 2010). While a value of $-0.30 \leq \phi \leq 0.30$ is a sign for no correlation (Khamis, 2008), values between -0.50 and -0.30 or 0.30 and 0.50 signal a week to moderate, and values of $\phi \geq 0.80$ or $\phi \leq -0.80$ indicate a strong correlation (Field, 2009; Khamis, 2008).

Table 6.26 summarises the Phi correlation results for the seven demographic variables used in this regression. Significant values are highlighted by an asterisk.

Table 6.26: Phi correlation coefficients

	1	**2**	**3**	**4**	**5**	**6**
1. ageB	-					
2. childB	.243***	-				
3. employedB	.427***	.106***	-			
4. genderB	-.164***	-.189***	-.012	-		
5. maritalB	-.145***	.159	-.041	.039	-	
6. educationB	.118***	.034	.265***	.018	.034	-
7. healthB	.085	.096	.237***	.010	.035	.139***

Source: The author

The highest relationship was identified between the variables *employedB* and *ageB* with a value of 0.427. All other values are closer to zero. Thus, it can be assumed that the correlation between the variables of the regression model is weak or extremely weak. According to Field (2009), not all forms of multicollinearity can be identified by a correlation table. Therefore, it is suggested to use the Variance Inflation Factor (VIF) which should be lower than 10 (Field, 2009) or ideally lower than 5 (Frost, 2019). In the special case of binary coded variables, Murray et al. (2012) recommend to carefully reconsider deleting variables with a VIF above 10. For the seven variables in this study, the VIF ranged between the value of 1.061 for *genderB* and 1.355 for *ageB* and *employB*, as can be seen in Table 6.27. Those values are well below the threshold of 5, showing no signs of multicollinearity. Therefore, both the Phi correlation coefficients and the VIF results confirmed that there is no issue of multicollinearity among the variables.

Table 6.27: Variance Inflation Factor

1. ageB	1.355
2. childB	1.145
3. employedB	1.355
4. genderB	1.061
5. maritalB	1.071
6. educationB	1.085
7. healthB	1.075

Source: The author

In addition to checking the data for multicollinearity, further assumptions are required to be checked. For OLS regression the data also needs to be checked for heteroscedasticity, linearity, normality distributed errors, autocorrelation and that the mean error has a value of zero (Backhaus et al., 2016; Field, 2009; Schendera, 2008; Urban & Mayerl, 2006).
The data used for the regression analysis did meet all required assumptions. Detailed information on those tests and relevant graphs are available in Appendix D.

The results of the seven different regression analyses, one completed for each of the seven *questionnaire activity groups*, were summarised in Table 6.28. Each column of the table represents one multiple regression analysis, one regression for each dependent variable. The dependent variables are labelled in a short form, for example, *vehi* for vehicle maintenance.

Table 6.28: Regression results for all seven questionnaire activity groups

		1 food	**2 clean**	**3 laund**	**4 gard**	**5 pet**	**6 reno**	**7 vehi**
	Constant	74.701***	91.103***	91.836***	61.139***	72.523***	40.925***	22.277***
	SE	6.293	6.261	6.617	7.033	8.211	7.142	7.412
	t	11.871	14.551	13.880	8.694	8.832	5.730	3.006
ageB	B	10.317*	5.578	0.580	4.168	11.354	6.476	7.496
	SE	5.788	5.759	6.086	6.469	7.553	6.569	6.818
	β	0.097	0.054	0.005	0.036	0.086	0.055	0.059
	t	1.782	0.968	0.095	0.644	1.503	0.986	1.100
childB	B	17.338***	9.387*	10.982**	13.711**	3.191	22.068***	28.366***
	SE	5.246	5.219	5.516	5.863	6.845	5.954	6.179
	β	0.165	0.093	0.103	0.121	0.025	0.189	0.228
	t	3.305	1.798	1.991	2.339	0.466	3.707	4.591
employB	B	3.648	-5.763	-0.866	-4.734	7.722	7.792	15.092***
	SE	4.611	4.588	4.849	5.153	6.017	5.234	5.431
	β	0.043	-0.071	-0.010	-0.052	0.073	0.082	0.150
	t	0.791	-1.256	-0.179	-0.919	1.283	1.489	2.779
genderB	B	-12.376***	-10.126**	-12.112***	6.877	-6.292	13.098***	17.923***
	SE	4.042	4.022	4.251	4.518	5.275	4.588	4.761
	β	-0.147	-0.125	-0.142	0.076	-0.060	0.140	0.180
	t	-3.061	-2.518	-2.849	1.522	-1.193	2.855	3.764
maritalB	B	9.330**	9.917**	6.467	13.699***	7.506	6.144	4.211
	SE	4.114	4.093	4.325	4.597	5.368	4.669	4.845
	β	0.109	0.121	0.075	0.149	0.071	0.065	0.042
	t	2.268	2.423	1.495	2.980	1.398	1.316	0.869
educatB	B	-10.447**	-6.300	-8.458*	-9.983**	-8.096	-12.250**	-8.547*
	SE	4.191	4.170	4.407	4.684	5.469	4.757	4.937
	β	-0.121	-0.076	-0.097	-0.107	-0.076	-0.128	-0.084
	t	-2.492	-1.511	-1.919	-2.131	-1.480	-2.575	-1.731
healthB	B	13.128***	10.992***	11.603***	13.376***	8.023	12.239**	13.226***
	SE	4.221	4.199	4.438	4.717	5.507	4.790	4.971
	β	0.150	0.131	0.131	0.142	0.074	0.126	0.128
	t	3.111	2.618	2.615	2.836	1.457	2.555	2.660
	F-value	8.931***	4.506***	4.211***	4.699***	2.275**	6.373***	9.536***
	R	.368	.271	.263	.276	.196	.317	.379
	R^2	.136	.073	.069	.076	.038	.101	.144
	Adj R^2	.121	.057	.053	.060	.022	.085	.129

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; N=406 ; df1=7 : df2 residuals =398

Source: The author

The overall finding of the regressions is that the independent variables have divergent impacts on the quality of unpaid household work, depending on the *questionnaire activity group* that is investigated.

Focusing on the dependent variables, for the quality of pet care none of the demographic predictors were significant. In all six other regressions, at least three demographic predictors showed a significant relationship with the quality of unpaid work. Most predictors were found to significantly affect the quality of food, except for age and education.

Focusing on the independent variables, the variable *ageB* appeared to have a positive but not significant impact on the quality of unpaid work for all seven *questionnaire*

activity groups, while the variable *healthB* showed a positive and also significant relationship with quality, for six of the seven activity groups.
The variables *childB* and *genderB* were found to be significant for five of the seven *questionnaire activity groups*. While *childB* had a positive impact on quality, *genderB* showed positive as well as negative signs of relationships. The results further revealed that both *maritalB* and *educatB* showed a significant impact in three of the seven regression models. It appears that the significant relationship for *maritalB* is positive but negative for *educatB*. Although *employB* did not appear to have a significant influence on the quality of unpaid work in six regression models, its impact on the quality of the *questionnaire activity group* '*vehicle*' was positive and significant at the $p \leq 0.01$ level.

6.11 Discussion of Regression Results

According to Field (2009), the value of R^2 can be used to evaluate the goodness of fit of a regression model. As can be seen in Table 6.28, the values of R^2 of the seven regression models ranged between 3.8% and 14.4% and they seem to be low. However, compared to the existing time use research in the literature, low R^2 values in this area are quite common. For example, Campolo et al. (2016) presented R^2 as low as 3.0%. In addition, even lower R^2 values for regression models, ranging from 0.2% to 2.9%, were published by Baxter (2011), Eriksson and Ortega (2011), and MacDonald (2016). Many other research studies on time use published R^2 values of their regression models lower than 10% (Cha, 2021; Gimenez-Nadal, 2010; Khitarishvili & Kim, 2015; Mangiavacchi & Rapallini, 2014; Michelson, 2014; Rebane, 2015). A reason for this could be seen in the fact that people and their responses may not be as predictable and consistent as technical, engineering or computational data. Furthermore, there may be many more determinants, apart from demographics, influencing the quality of unpaid household work.

The results of the regression analysis can be interpreted from two different perspectives. One perspective looks at the *questionnaire activity groups*, the dependent variables, explaining the predictors impacting on each group. The other perspective looks at the impacts of each demographic predictor on the seven *questionnaire activity groups* as a whole.

It further needs to be noted that the results cannot be linked with existing literature because, as stated several times in this research study, the literature on determinants, particularly demographic factors that may affect the quality of unpaid household work, is scarce. Therefore, the findings are new and unique to this field of research.

However, the findings of the regression analysis in this chapter can be compared with the results presented in Table 5.22 that show the respondents' views on the likelihood of the impact of selected demographic factors on the quality of unpaid household work. This likelihood question identified, for example, that health (81.5%), the age of respondents (68.9%) and the number of children (62.3%) were seen as likely or very likely to impact on the quality of unpaid household work. The marital status (45.3%) was thought unlikely or very unlikely to impact on quality, while results for gender and education were balanced. Those results are also evaluated in the following discussion.

6.11.1 Discussing the Results for each Questionnaire Activity Group as the Dependent Variable

First, the main findings of the regression analysis are discussed for each dependent variable separately. The influence of the predictor variables on the different *questionnaire activity groups* for the quality of unpaid household work varies in level of significance, number and direction. For the five activity groups *food*, *cleaning*, *laundry*, *gardening* and *renovation*, the demographic effects showed the sign of both negative and positive directions, if the predictor has a significant impact. A different result was found for the quality of the activity group *vehicle*, where all four significant predictors (childB, employB, genderB and healthB) had a positive relationship with the quality level. The findings reveal that the quality of unpaid household work for six of the seven *questionnaire activity groups* was significantly impacted by at least three, but up to five demographic predictor variables.

A surprising finding was the result for the quality of pet care (*pet*) that did not show any of the predictors to have a significant effect. A possible explanation could be that the affection and interest in animals plays a higher role than the demographic factors. People who enjoy the presence of, and caring for pets may have a personal, positive attitude towards animals, and that attitude seems to be less driven by demographic factors.

Overall, the most affected *questionnaire activity group* was *food*, followed by *gardening*, *renovation*, *vehicle*, *cleaning*, *laundry* and lastly *pet*.

6.11.2 Discussing the Results for each Independent Variable

Second, the main findings of the regression analysis are discussed for each predictor variable separately.

6.11.2.1 Variable *ageB*

Regarding the age of respondents, the results of Table 6.28 showed at the $p < 0.05$ level that those aged 65 years and younger, compared to the group or 66 years and older, did not show a significant impact on the quality of unpaid work in any of the seven *questionnaire activity groups* looked at. Nevertheless, the impact, although being non-specific, was positive for all seven groups. However, at the $p < 0.1$ level, a significant relationship between age and the quality of food was found.

Comparing those findings with Table 5.22, which indicates that 68.9% of respondents believed that age likely impacts on quality, the findings of the regression analysis seem to provide a similar picture. The findings suggest that a relationship between age and quality of unpaid household work exists, but it may not necessarily be strong.

It was noticed that the strongest impact was made for quality of *food*. The results showed that respondents aged 18-65 years achieved a 10.3% higher quality of *food*, compared to people aged 66 years and older. An explanation of this finding might be that younger people may be more sensitive for healthier food than people in their last quarter of life. Furthermore, they may have a desire to prepare and eat food of a higher quality in believing they can maintain a good level of personal health, while older people may have the tendency to have shifted their focus in life to spend more time on other activities, apart from food preparation, because the impact of unhealthy eating would not affect as many years of their life, compared to younger people.

Another explanation might be the reduced mobility due to the ageing process that may reduce the quality of food preparation, but it could also be their reduced capability, caused by a lack of concentration and by lower fitness levels, compared to younger people.

The findings suggest that the age of people may not be major determinant of the quality of unpaid work. This conclusion is based on the above discussion about the impact of the variable *ageB* and the regression results presented in Table 6.28. From a total of seven regressions considered, a slight influence could only be detected for one dependent variable (*food*), whereas no significant impact could be identified for the other six *questionnaire activity groups*. This single case (one out of seven) justifies the statement that *ageB* may not be a major determinant. This result finds partial support in the wider literature about the impact of age on the allocation of time and multitasking. While Zaiceva and Zimmermann (2011) showed that age is not a significant driver of multitasking but still positively correlated to simultaneous household activities, Drago (2011) stated that age has an impact on how many simultaneous activities are reported.

6.11.2.2 Variable *childB*

The presence of children aged between 0 and 7 years in the households tends to have a significant and positive impact on the quality of *food*, *laundry*, *gardening*, *renovation* and *vehicle*. Not a significant impact but a positive connection was found with the quality of *cleaning* and *pet*, while the impact on *cleaning* was significant at the $p < 0.1$ level.

According to the results of Table 5.22, 62.3% of the respondents believed that the number of children is likely or very likely impacting on the quality of unpaid work. Unfortunately, a direct comparison of both results needs to be treated with care, because, other than the variable *childB* in the regression, the relevant question in the questionnaire did not distinguish between younger and older children and also does not allow predicting the direction and magnitude of a possible impact.

The findings from the regression analysis showed that, with young children being present in a household, the quality in the *questionnaire activity group* '*food*' increased significantly by 17.34%, according to Table 6.28. This suggests that parents may have a tendency to prepare healthy meals for their children to support their development and growth, particularly in the earlier years of a child's life.

Strangely, it was noticed that the presence of young children in a household seems to increase the quality for *renovation* by 22.07% and the quality level for *vehicle* by 28.37%. Both are interesting findings and may be explained as follows.

One could assume that the presence of younger children in a household urges parents to increase the quality of renovation to have comfortable living arrangements. Parents of younger children often aim to have a new place or home due to the growing family, which either requires good quality renovation works of older dwellings, or a high quality of maintenance work, even if the dwellings are newly built, to maintain their new standard.
The presence of young children may force parents or grandparents into taking more care about their vehicles. For example, this could be because of increased safety concerns. Due to the expansion of the family, parents often require a newly bought car that needs to be maintained regularly to ensure safe travelling. This might require a good quality level for vehicle maintenance. In addition, there may also be other factors.

The regression findings explained above showed that the presence of young children aged 0-7 years may be a major determinant of the quality of unpaid household work. This conclusion is supported by the above discussion about the impact of the variable *childB*, the regression results presented in Table 6.28 and finds support in the wider literature. The presence of children had a significant impact on six of the seven *questionnaire activity groups* which clearly supports the statement that *childB* may be a major determinant. A comparison with existing literature in the field of multitasking and time allocation shows that the presence of children is a main determinant for an increase in unpaid household work (Bloemen & Stancanelli, 2014; Destatis, 2015; Hunady et al., 2014). This effect is larger for younger children than for older kids (Blekesaune, 2005; Craig & Bittmann, 2005). According to Craig (2007), Floro and Miles (2003), and Zaiceva and Zimmermann (2011) young children also are a key determinant for the increase on multitasking activities. That literature supports the conclusion that the presence of young children aged 0-7 years may also be a major determinant of the quality of unpaid household work.

6.11.2.3 Variable *employB*

This research found mixed results for the impact of employment on the quality of unpaid household work. It was negative for the three *questionnaire activity groups* '*cleaning*', '*laundry*' and '*gardening*', but positive for the other four groups *food*, *pet* care, *renovation* and *vehicle*. Nevertheless, the results only showed a significant

relationship for *vehicle*, but none for the remaining *questionnaire activity groups*. Employed respondents, compared to those who were unemployed, tended to achieve a quality increase for vehicle maintenance of 15.1%.
An explanation of this might be that employed people were more reliant on their cars than non-employed people, who may not regularly require a car for daily commuting, or may not even possess a car or other type of vehicle.
As outlined in Chapter 5, the employment status was not part of the determinant questions in the questionnaire. Therefore, a comparison with the views of respondents on the role employment played regarding the quality of unpaid work was unfortunately not possible.

The findings suggest that the employment status may not be a major determinant of the quality of unpaid work. This conclusion is based on the above discussion about the impact of the variable *employB* and the regression results presented in Table 6.28. From a total of seven regressions considered, a significant influence could only be detected for one dependent variable (*vehicle*), whereas no significant impact could be identified for the other six *questionnaire activity groups*. This single case (one out of seven) justifies the statement that *employB* may not be a major determinant. Placing this conclusion in the wider literature, it is in line with the research by Shelton and John (1996) who summarised earlier studies on the impact of the employment level of men and women on household unpaid work activities. They did not find a consistent result because the employment level could have a negative, a positive or even no impact on unpaid household activities (Shelton & John, 1996). Also uncertain is the extent to which the level of employment has an impact on multitasking (Floro & Miles, 2003; Zaiceva & Zimmermann, 2011).

6.11.2.4 Variable *genderB*

Gender as a demographic factor also had mixed impacts on the quality of unpaid work. For the typical household chores, *food*, *cleaning* and *laundry*, men compared to women achieved a lower quality. Contrarily, the impact on the quality of the *questionnaire activity groups* '*renovation*' and '*vehicle*' was positive for men compared to women. In all five cases, except for *gardening* and *pet*, the relationships were significant.
Those findings fit the classical gender role. Each gender type is expected to be spe-

cialised in certain activities and to achieve higher qualities in those activities that they tend to be more comfortable with (Blackstone, 2003). This means that men are typically expected to perform more 'manly' activities that often require personal strength, such as renovation and maintenance activities, and women are expected to perform more 'womanly' tasks such as chore housework activities.
However, findings from the regression differ from the respondents' views on the likelihood of gender impacting on the quality of unpaid work, as presented in Table 5.22, where the results showed a balanced view between likely and unlikely.

Nevertheless, the regression findings explained above suggest that gender may also be a major determinant of the quality of unpaid work. This statement is supported by the above discussion about the impact of the variable *genderB* and the regression results presented in Table 6.28 as well as the wider literature on time allocation and multitasking. For five of the seven *questionnaire activity groups* gender showed a significant impact on the quality of unpaid work. This justifies the statement that *genderB* may be a major determinant.
This is almost in line with the literature supporting the view that gender is a key factor for all unpaid work activities (Gimenez-Nadal & Molina, 2020; Hunady et al., 2014; Shelton, 2006). Gender is also a significant factor impacting on multitasking but it is uncertain to what extent (Floro & Miles, 2003).

6.11.2.5 Variable *maritalB*

For all seven *questionnaire activity groups* the findings reveal that living with a partner, married or cohabiting, has a positive impact on the quality of unpaid household work compared to people who live alone. This finding is significant for the quality in the *questionnaire activity groups* '*food*', '*cleaning*' and '*gardening*', but not significant for the remaining four groups.
A possible explanation of the significant findings is suggested as follows. People living together may want to enjoy lunch or dinner time together, and may even prepare the meals and do the cleaning together. They may have a higher tendency to increase the quality of food because they want others to have a tasty and good quality meal. Also important to mention here would be the healthier food argument. An argument from another perspective could be that people who live alone may not want to focus on a high quality of food; for example, because they tend to eat more

takeaway food. This way, they spend less time on meal preparation and can focus more on enjoying their single life.
The impact of the marital status on the *questionnaire activity group* '*gardening*' was significant at the $p < 0.01$ level and thus appears to have a very strong impact. People living with a partner may tend to achieve a higher quality for gardening related activities because they enjoy doing those activities and value having a nice garden that children or other family members can all use. An important factor worth mentioning is the availability of a garden in which gardening activities can be performed. There may be a higher chance for couples than singles to meet this criterion.
The significant finding of the regression results is not in line with the results of Table 5.22, and thus the view of respondents on how likely they thought marital status would impact on the quality of unpaid household work. Almost one in two respondents in the questionnaire believed that marital status is unlikely or even very unlikely impacting on the quality of unpaid work, which leaves the impression that this variable may not be significant, but the regression results show otherwise.

The findings of the regression analysis explained above suggest that the marital status may also be a major determinant of the quality of unpaid work, but it may not be as strong as the other major determinants discussed in this Section 6.11. This conclusion is based on the above discussion about the impact of the variable *maritalB* and the regression results presented in Table 6.28. From a total of seven regressions considered, a significant impact could only be detected for three dependent variables (*food*, *cleaning* and *gardening*), whereas no significant impact could be identified for the other four *questionnaire activity groups*. Three out of seven allows to conclude that *maritalB* may be a major but less strong determinant.
This result finds support in the wider literature on the impact of age on the allocation of time and multitasking. Previous research by Bloemen and Stancanelli (2014), Destatis (2015), and Zaiceva and Zimmermann (2011) found some impact of the marital status on time allocated to unpaid work and multitasking but its effect was referred to as rather influencing than impacting, underpinning the findings in this research.

6.11.2.6 Variable *educatB*

The results indicated that respondents holding a university, college degree or higher tend to achieve a lower quality of unpaid work in all seven *questionnaire activity groups* compared to respondents with a lower education level. The findings were significant for the activity groups *food*, *gardening* and *renovation*. They were further significant at the $p < 0.1$ level for the groups *laundry* and *vehicle*, but not significant for the remaining two *questionnaire activity groups* '*cleaning*' and '*pet*'.
Those findings are interesting because a common opinion assumes that a higher education is often associated with better skills, while better skills could lead to a better quality. Apparently, the results of this research show a different picture to that common opinion.
It is complicated to suggest a plausible explanation for the lower quality for higher educated people compared to ones with a lower level of education.
One explanation is that people with a higher education may not focus as strongly on the quality of unpaid household work compared to less educated people. Another possible explanation could be that people with a higher education tend not to be good at 'practical' work. A third explanation might be that better educated people possess more money and use money to buy a good quality in the market, rather than improving the quality themselves by performing unpaid household work activities. This may be particularly the case for the *questionnaire activity groups* that showed a highly significant relationship, which included *food* (people may eat in a restaurant), *gardening* (buy quality service in the market) and *renovation* (get companies or professionals to do the work).
Those findings differ from the respondents' views on the likelihood of the level of education impacting on the quality of unpaid work, as presented in Table 5.22. Those results showed a balanced view between likely and unlikely.

The findings of the regression analysis explained above suggest that the level of education may also be a key determinant of the quality of unpaid work, but had a negative relationship which was hard to explain.
This conclusion is also supported by the regression results presented in Table 6.28 and finds support in the wider literature. According to Bloemen and Stancanelli (2014), Guryan et al. (2008), Ruuskanen (2004), and Shelton and John (1996) a higher level of education significantly impacts on the time spent on unpaid household

work. Floro and Miles (2003) also revealed a significant relationship between the level of education and multitasking. This view was supported by Kalenkoski and Foster (2008) and Zaiceva and Zimmermann (2011). Another study also suggests that a higher level of education may impact on the productivity of men and women (Dollahite & Rommel, 1993). In line with that literature and the fact that the education level in the current study had a significant impact on five of the seven *questionnaire activity groups* it supports the statement that *educatB* may be a major determinant.

6.11.2.7 Variable *healthB*

A good or very good level of health compared to a fair, poor or very poor health status was positively related to the quality of unpaid household work for all seven *questionnaire activity groups*. Apart from pet care, this positive impact was significant and, apart from *renovation* ($p<0.05$), the effect was significant at the $p<0.01$ level. The findings suggest that better health positively affects quality.

This is in line with the results of Table 5.22, where 81.5% of respondents indicated that the personal health level likely or very likely impacts on the quality of unpaid work.

Different to the previous six variables discussed above, the variable *healthB* was the only variable which was used in a previous study on investigating the impact of health on quality directly. In their study, Zhang et al. (2011) focused on productivity loss of work as a result of a poor health level, but also investigated the quality of unpaid work. They found that illness, sickness or bad health influences productivity and reduces the quality and quantity of unpaid work (Zhang et al., 2011). They stated that the quality of unpaid work is also reduced because sick people make more mistakes or do not work as concentratedly as healthy individuals (Zhang et al., 2011).

This previous study by Zhang et al. (2011) and the findings from Table 5.22 support the results of the regression that the personal level of health is a major determinant of the quality of unpaid household work. It may even be suggested that it could be the most important determinant of the seven investigated in this study. This conclusion is also supported by the regression results presented in Table 6.28 and the wider literature in the field of multitasking and time allocation. The health level had a significant impact on six of the seven *questionnaire activity groups* which clearly supports the statement that *healthB* may be a major determinant. According to Gimenez-Nadal and Molina (2015) and Podor and Halliday (2012) a good level of health impacts on the time allocated to unpaid household work, and as research by Endrayana Dharmowijoyo et al. (2021) suggests, it also affects the time spent on multitasking. In addition, health also has an impact on the level of productivity of people (De Vaus et al., 2003; Zhang et al., 2011). The literature supports the conclusion that the level of health may also be a major determinant of the quality of unpaid household work.

Overall, the predictor variable showing the highest impact was *healthB*, followed by *childB* and *genderB*. Lower impacts appeared to be caused by *maritalB*, *educatB* and *ageB*.

6.12 Chapter Conclusion

This chapter presented the VoL results in line with the different models introduced in Chapter 5. Furthermore, the magnitudes of the impact of gender differences on the VoL were shown. An in-depth discussion of those results covers a large part of this chapter. The results of the regression analysis showed whether selected demographics impact on the quality of unpaid work. The chapter ended with the discussion of the regression results.

Chapter 7

Conclusion

7.1 Introduction to Chapter

The purpose of this chapter is to conclude this thesis by providing an overview of the research, summarising the main findings of this research and discussing them in the context of the research aim and the research questions, as well as explaining how the research objectives are met. In addition to this, the contribution of this study to knowledge is presented and possible implications are considered. An explanation of this study's strengths and limitations is followed by suggestions for future research.

7.2 Overview of this Study

The aim of this research is to modify the currently dominating approach on valuing unpaid household work by taking consideration of simultaneous activities, quality and productivity.

The opening chapter of this thesis set the context of this research study by looking at how to put an economic value on unpaid household work. The research problem was identified from the existing approaches that seem to estimate the VoL inadequately, because either some important factors of the valuation were overlooked or some subjective assumptions were made in the estimations. Although these problems have been known for decades and suggestions for solutions are debated, there is still no agreement on how to best improve the existing approaches. This study attempts to modify the dominating approach that is used to estimate the VoL and focused on the methods of improvement. Three main gaps in current research were

identified by the literature review, which this study hopes to contribute towards. The first is the missing consideration of multitasking by valuing just one, the primary activity. The second is the lack of adjusting specialist wage rates for quality differences between paid workers in the market and unpaid household members. The third gap involves the missing adjustment of specialist wage rates for productivity differences also between the market and households. Based on those identified gaps, this study develops and applies modifications to the dominating approach that allow for including those three missing parts into the valuation approach. This is the original contribution of this research. It is the first time three modifications have been implemented in a single approach. Moreover, the research investigates whether gender has an influence on the three modifications and thus on the VoL, and how selected demographics impact on the quality of unpaid work.
The magnitudes of the modifications were derived by calculating the VoL using the different types of adjustments and comparing the results with the dominating approach without those improvements.

The secondary data from the ASHE and the UKTUS were used to carry out and investigate the improvements of the dominating approach for the valuation of unpaid household work. In order to answer the research questions of this study, a self-administered online questionnaire from a sample of 406 people aged 18 years and older living in the UK was used to collect additional data for the proposed adjustments, gender effects, and for a regression analysis on the impacts of demographics on the quality of unpaid work.
The implementation of the modifications to the dominating approach was developed step by step and explained in Chapter 5, showing each individual adjustment separately. In addition, a regression model was built to investigate impacts of demographic factors on the quality of unpaid work.
The results of the different VoL calculations, their comparison with the dominating approach and the evaluation of the magnitudes of the modifications were shown in Chapter 6. Furthermore, the results of the regression analysis were presented. Also, the main findings of the VoL calculations and the regression were discussed in detail.

The current chapter concludes this thesis by assessing whether the aim of this research study has been met.
This aim is achieved by answering the following research questions.

1. What is the currently dominating approach for the valuation of unpaid household work?

2. How can the currently dominating approach on valuing unpaid household work be modified to consider simultaneous activities and adjust for quality and productivity, taking gender differences into account?

3. What are the magnitudes of the modifications compared to the dominating approach based on relevant UK data?

4. How is the quality of unpaid household work affected by selected demographics?

5. What recommendations can be made to policy makers and practitioners on the implementation of splits and adjustments, and the development of a harmonised approach for valuing unpaid household work?

The research questions are addressed through meeting the following five research objectives.

1. to evaluate the existing and identify the currently dominating approaches on valuing unpaid household work.

2. to modify the currently dominating approach on valuing unpaid household work by assigning splits for simultaneous activities and weights to adjust for quality and productivity, also taking gender differences into consideration.

3. to validate the outcome of the modifications by comparing the results based on the modified approach with the dominating approach using relevant UK data.

4. to evaluate the demographic factors and their impact on the quality of unpaid household work.

5. to make suggestions to policy makers and practitioners towards developing a harmonised approach for valuing unpaid household work, and make recommendations for the implementation of splits and adjustments.

Objective 1 is met by an in-depth literature review on the existing valuation approaches for unpaid work. This helped to identify the traditional approach as being the currently dominating approach for the VoL. The traditional approach has been applied for unpaid household work as well as for all other unpaid work activities.

Objective 2 is met by modifying the dominating approach in various steps, to account for multitasking and to adjust for quality and productivity differences, as outlined in the model building sections in Chapter 5. The modifications further allow multitasking splits, quality and productivity adjustments to be applied on a gender basis, for both genders, men and women.

Objective 3 is met by applying the modified approach in its various steps identified through research objective 2 to the secondary UKTUS and ASHE wage data, and the primary data collected through the questionnaire with 406 returns. The results and magnitudes of the different modifications are validated, compared and discussed in Chapter 6.

Objective 4 is met by identifying the demographic factors that are investigated, and applying them in seven different linear regression analyses, using the primary data. The regressions were used to identify a relationship between the demographics and the quality of unpaid household work.

Objective 5 is met by providing suggestions to policy makers and practitioners as regards to how the modified model may be used for more accurately estimating the VoL. All the suggestions are based on the evaluation of the research findings and the discussion of results from this research.

7.3 Main Research Findings

The main findings of this thesis are summarised as follows.

7.3.1 Findings Relating to the Research Objectives

First, according to this research, the suggestion of previous researchers to apply an equal split of time for simultaneous activities could not be supported as a general recommendation. Depending on the number of simultaneous activities, the splits found in this study differed up to 9 percentage points from the equal $\frac{1}{n}$ assumption proposed in literature, which is a significant difference.

Second, the levels of quality and productivity adjustments (weights) found in this study were not to be as high as the previous researchers suggested. The current research shows that the level of adjustments depends on the type of activity done and the gender performing that activity. The often arbitrarily chosen adjustment levels, proposed in previous studies, found partial support only in the case where the quality and productivity adjustments are combined. Apart from the quality adjustment levels for women in the *questionnaire activity groups* '*food*', '*cleaning*' and '*laundry*', and apart from the productivity adjustment levels for women in the activity group '*pet*', the results support the view that specialist wages require downward adjustments.

Third, in all seven *questionnaire activity groups* women reported a far higher productivity level than men. This unexpected finding may be explained by the fact that women are still more proficient in household work than men.

Fourth, an application of primary data adjustment levels for quality and productivity by gender compared to using the adjustment levels for both genders combined would increase the VoL for women but not for men. It was found that the adjustment levels for men, women and both genders combined differ for each of the seven *questionnaire activity groups* investigated.

Fifth, the presence of children aged 0-7 years, gender, marital status, education level and personal health were found to be relevant demographics impacting on the quality of unpaid household work. The demographics of age and the level of employment seem to have no or insignificant impact on the quality of unpaid household work.

Sixth, the findings of this study could not support the view that the traditional approach using the housekeeper wage rate acts as a lower boundary of the approaches generally applied. When illustrating all scenarios, the application of two or three adjustments pushed the VoL below the one that uses the housekeeper wage. In some instances, this lower VoL was even reached with a single adjustment, for quality, productivity or the consideration of multitasking. This suggests that the housekeeper approach may not act as a lower boundary, which is different to what is widely claimed in the literature.

Seventh, depending on the step and scenario applied, the magnitude of the modifications compared to the traditional approach using specialist wage rates would be up to 5.29% of UK's annual GDP. This is quite a large difference from an economy's perspective and clearly shows that a more accurate VoL calculation compared to the traditional approaches might significantly lower the monetary value of unpaid household work; in other words, the currently dominating approach without modifications is found to present a VoL that may be overestimated.

7.3.2 Additional Findings

This research has gained three additional findings that are not covered by the research objectives.
First, the primary data suggests that multitasking is likely or very likely caused by time pressure.
Second, the primary data analysis led to the finding that respondents believed multitasking may rather reduce their productivity than reduce their quality.
Third, based on the 406 respondents, it was found that 55.1% of women but only 35.9% of men prefer multitasking.

7.4 Implications and Recommendations

The findings of this study have some important implications from both the theoretical and empirical perspectives.

7.4.1 Theoretical Implications

Becker's theory of the allocation of time was identified in the literature review as the key theory of this research (Becker, 1965; Heckman, 2015). The strong connection of that theory is based on the use of TUS data of which the concepts rest on the theoretical foundation of Becker's theory (Ironmonger, 1995). The following theoretical implications are highlighted.

Firstly, the outcomes of this research support the theoretical proposition in TUS and VoL literature that the replacement cost approach is superior to the opportunity cost approach in terms of accurately measuring the economic contribution of unpaid household work, as suggested by Salamon et al. (2011) and Schreyer and Diewert (2014). It contradicts the critical voices of earlier work by Kiker and de Oliveira (1990) who believed that neither the replacement cost approach nor the opportunity cost approach can be firmly anchored in the theory of the allocation of time. Furthermore, the outcome of this study supports the extension of Becker's original theory of the allocation of time by Schreyer and Diewert (2014) who included the replacement cost approach into their model, allowing a theoretical justification of its suitability for the VoL.

Secondly, the findings of this research strengthen the theoretical discussion on a suitable way to include multitasking activities in the VoL by justifying that their inclusion is possible without violating the 24 hours time budget constraint, a restriction of the theory of the allocation of time, for example, as shown by Philp and Wheatley (2011). While theory advocates the correct treatment of these simultaneous activities, research publications, for example, Bianchi (2000), Budlender and Brathaug (2010), Kalenkoski et al. (2007, 2009), and Zaiceva and Zimmermann (2011) often ignore this call. They refer to the 24 hour restriction as being a strong argument for disregarding those activities, as highlighted by Stinson (1999). Moreover, the data and results of this research study provide additional support for the justification of including simultaneous activities in the valuation approach and confirm the theoretical proposal by Sanchis (2013, 2016) who allowed for an extension of Becker's theory of the allocation of time by accounting for multitasking. This could lead to a consistent application of a more accurate valuation approach.

Thirdly, while the above theoretical implication concerns the treatment of multitasking in general, this research also allows a more detailed view on appropriate splits. The newly developed questions in the questionnaire used for this research, as suggested by the United Nations (2013), supplement the theoretical assumption that valid data on up to four different activities can be collected from TUS respondents without violating the 24 hour time budget restriction. From a theoretical perspective this supports the view that respondents should provide their individual splits rather than TUS coders, interviewers or researchers estimating them.

The findings of this research fail to generally support the theoretical propositions of an equal split of multitasking activities, for example, by Williams and Donath (1994). While in case of two simultaneous activities the data almost confirmed an equal split, it showed a different result of unequal splits to be more appropriate if more than two activities are done simultaneously.

Fourthly, similar to the multitasking adjustment, the findings of this research partially support the theoretical propositions regarding quality and productivity adjustments in the VoL. The data – collected by newly developed questions – and the results showed that the inclusion of adjustments improved the VoL estimates. The findings show significant differences in the magnitude of the adjustments compared to the theoretical proposition of arbitrary assumptions used in previous studies. Furthermore, the outcome of this study supports the extension of Becker's original theory of the allocation of time by Ruuskanen (2004) who introduced productivity parameters for men and women into his model.

Fifthly, this research study extends the existing theoretical propositions by introducing gender as a main factor into the VoL approach. While previous research studies focus on gender differences in time allocation and wage rates, this study allows the introduction of gender based splits for multitasking and adjustments for quality and productivity. This allows to better assess differences between both genders.

Lastly, the findings of this study fail to support the theoretical assumption of the housekeeper wage acting as a lower boundary. This seems to be an assumption firmly anchored in the literature but, according to the author's knowledge, has not been tested widely apart from arbitrary assumptions. This should encourage researchers to test the theoretical assumption in literature on its general validity, and, if confirmed by other researchers, it could lead to a new view on the treatment of the housekeeper wage.

7.4.2 Empirical and Practical Implications

The major implication of this study is the improvement made in this research to increase the accuracy of the VoL by considering multitasking splits and using adjustments to the specialist wage rate. Although this research was not designed to identify one of the modifications as the most suitable VoL approach, it was found that the magnitudes of adjustments were quite large and showed that even small adjustments might have a significant impact on the accuracy of the VoL. An inaccurate VoL would provide a wrong picture of the size and economic contribution of unpaid household work towards the economy. Hence, it is important to have estimates as accurate as possible.

Based on the UKTUS, the ASHE and the primary data used in this research, the commonly applied housekeeper wage rate does not act as a lower boundary for the VoL. Recognising this finding may change the current view on the application and role of the housekeeper wage rate in the VoL estimates and support the use of the specialist wage rates.

This study shows that it is possible, even on a gender basis, to collect necessary data from people to consider multitasking and make adjustments for quality and productivity in the VoL. The data needed for calculating multitasking splits could be collected by adding one question to the individual or household questionnaire of a TUS asking about general splits of multitasking activities. It is hoped that policy makers pick up this suggestion for future TUSs, in particular for those TUSs that collect multitasking activities. Valuing just the primary activity in unpaid work in the existing literature or practice is often a result of the problem of not knowing how to split the activities, although the relevant time data is available. That existing data might be utilised to its full potential by adding the above-mentioned question to the TUS diary or questionnaire. This research offers suggestions for multitasking splits of up to four simultaneous activities, which also may be tested or used as a starting point in other studies.

Collecting data for quality and productivity adjustments may be more complex than collecting data on multitasking splits, and therefore, it is assumed this might increase the respondent burden. Nevertheless, the findings of this study showed that the collection of this information is a necessary step towards more accurate and less arbitrary estimates of the VoL.

It is hoped that this research will contribute to the ongoing discussions on how to improve the current valuation approaches on unpaid work by proposing a new harmonised approach that could be used by policy makers and practitioners, not necessarily as the leading, but as a comparison approach. It might even be included as a potential option in practitioners' guidelines for future TUS and VoL calculations. This could increase awareness of its existence and allow various countries to test the approach and evaluate how it would hold up against the dominant approaches.

7.4.3 Recommendations to Policy Makers and Practitioners

Based on the above implications, the following suggestions and recommendations can be provided to policy makers and practitioners.

It is pointed out several times in this study that using the housekeeper wage is believed to provide reasonable but not accurate results of the VoL and, apart from the option of having it for comparison reasons, this wage rate is not recommended to be used for the VoL by the author of this study. Arguments for using the housekeeper wage rate as a lower boundary should, according to the findings of this research, be treated with care.
Other than the specialist wage rate, the housekeeper wage rate does not require adjustments for quality or productivity differences. Nevertheless, the findings of this research support the view of at least considering multitasking and applying splits for the time spent on simultaneous activities, when using the housekeeper wage.

In line with the current literature, this research suggests that the traditional approach using specialist wages should be applied for estimating the VoL, because specialist wages are found to be the more suitable wage rates for the valuation. However, to achieve more robust and accurate VoL estimates, it is highly recommended to adjust the specialist wage rate, at least for either quality or productivity, and additionally apply splits for multitasking.

Furthermore, rather than applying equal splits for simultaneous activities, the

findings of this research study suggest using splits for two simultaneous activities, with 56.9% for the primary and 43.1% for the secondary activity. For three activities, a split of 42.0% for the primary, 32.1% for the secondary and 25.9% for the tertiary activity would be recommended. Four activities might best be split 33.3% for the primary, 26.4% for the secondary, 21.6% for the tertiary and 18.7% for the quaternary activity. Based on the results in this study, applying those splits by gender, separately for men and women, may not necessarily improve the VoL, as shown in the discussion in Chapter 6.
It would also be recommended, as mentioned above, to include one question, either to the TUS diary or the individual questionnaire, that allows respondents to report their view on how, in general, they would split multitasking activities. Although this increases respondent burden, it would allow a more accurate VoL estimate. For those not in favour of collecting this information, the splits found in this research might provide a good alternative to the current, whereby an artificial split is often assigned.

In the case that it is the intention of a researcher to use splits and adjustment levels that might be in the vicinity of the arbitrary adjustments suggested by prior literature, the findings of this study support proposing the application of either of the following two VoL modifications.
The first one is adjusting the specialist wage for the average of quality and productivity (Step4Scen3 in Chapter 6). The second one is adjusting for the product of quality and productivity (Step4Scen4 in Chapter 6). Both approaches incorporate multitasking.
It is further recommended to take gender differences into account for any of the four scenarios applied, but it needs to be acknowledged that this may benefit the VoL for women but not for men.

The above recommendations might help to pave the way for a more accurate, harmonised approach to the VoL.

7.5 Contribution to Knowledge

The overall significant original contribution to knowledge of this study is the modification of the dominating approach of the VoL by integrating three individual adjustments, one for multitasking, one for quality and a third for productivity in one valuation approach.

The key strength of this study is the investigation of how each of those three adjustments can be implemented, the evaluation of their impact and, building on this, the enhancement of the VoL approach allowing researchers to obtain a higher accuracy of their VoL estimates. Responding to the call from the United Nations and Statistical Organisations this study provides the urgently required answers to the three research gaps (lack of accurate adjustments for multitasking, quality and productivity) identified in the literature review. Being the first study of its kind, it is hoped to pave the way to move from currently used arbitrary adjustments to a more data-based approach. The present study demonstrates, for the first time, that all three adjustments can be supported by primary data, specifically collected for the purpose of evaluating the modifications.
In addition, this study provides a deeper insight whether selected demographics impact on one of the adjustments, the quality of unpaid household work. This is also considered unique and, by breaking new ground, this contributes to knowledge.

An in-depth explanation of the major contribution is summarised in the following paragraphs.

Firstly, this study contributes to knowledge by a significant improvement of the methodology of the VoL. Acknowledging by an extensive review of the literature that disregarding simultaneous activities is inappropriate, this research enriches the literature by offering potential splits for multitasking activities and providing insights into how those split data can be collected using the unique questionnaire particularly designed for these purposes.
As highlighted by Budlender (2007) and Hunter (2010), the currently used VoL approaches do not allow accurate VoL estimates because they completely disregard simultaneous activities from their calculations. The treatment of multitasking in the VoL is an issue with ongoing debates over decades. Quah (1989) pointed out that a

correct treatment of simultaneous activities is required but did not offer a solution for that problem. A review of the current literature revealed that decades later there is still no consensus on how this should be done (Błaszczak-Przybycińska & Marszałek, 2019; Ironmonger, 2003; Nordhaus, 2006; United Nations, 2017; Williams & Donath, 1994).

A common proposition on how to include multitasking in the VoL is by splitting the time on those activities (Budlender & Brathaug, 2010; Drago, 2011; Stinson, 1999; Williams & Donath, 1994; Zaiceva & Zimmermann, 2011). However, it is uncertain what appropriate splits would look like. The major advantage of applying splits ensures that the time constraint of 24 hours per day will not be violated, and thus is in line with Becker's theory of the allocation of time (Becker, 1965).

Despite the fact that previous studies regularly point out that disregarding multitasking in the VoL calculation is not accurate, apart from highlighting the known problems, little has been done on potential improvements. Although multiple surveys had already collected data of multitasking activities, without knowing appropriate splits, this data cannot be used to its full extent, as pointed out by Kitterød (2001) and Stinson (1999).

Stinson (1999) recommended that one way of finding proper splits is by asking respondents to assign weights when filling in their diary, but due to an increase in the respondent burden this has not been applied. The United Nations (2013) also suggested developing new questions and adding them to future TUSs. This research study provides a unique way that allows for collecting data on those splits for up to four simultaneous activities. The implementation of the novel approach demonstrated in this research closed a gap in this less explored field.

Secondly, this study contributes to knowledge by presenting a unique way of collecting data on quality adjustments, suggesting adjustment levels (weights) for quality and evaluating the magnitudes of the quality adjustments compared to the traditional approach. Although the results may suffer from some limitations, it is believed that the adjustments identified in this research should be of higher accuracy than the commonly applied arbitrary adjustments chosen by other researchers.

The European Commission et al. (2009), Folbre (2015), Landefeld et al. (2009), National Research Council (2005), Poissonnier and Roy (2017), Schreyer and Diewert (2014), and Varjonen et al. (2014) pointed out the importance and necessity to adjust the specialist wage rates for the differences in quality between paid work in the

market and unpaid work in households. Nonetheless, the size of those adjustments is uncertain (Schreyer & Diewert, 2014).
As stated by Fitzgerald and Wicks (1990), it is not clear whether professionals or unpaid household workers would achieve a higher quality. While Fitzgerald and Wicks (1990) believe that household members are able to achieve higher quality levels than market specialists, the general opinion is that household members would only achieve a lower quality level than market specialists (National Research Council, 2005; United Nations, 2017).
As a downside, TUSs do not collect data on the quality of household production, so this information is not available (Varjonen & Aalto, 2006) and requires this data to be collected somewhere else. This research answers that call by developing new questions that allow to collect data on quality levels, which could become part of the TUSs in the future.
However, the lack of information on the quality level of unpaid work and the uncertainty of the size of adjustments often has led researchers either to use no adjustments at all (Schreyer & Diewert, 2014; Varjonen et al., 2014), or to choose arbitrary adjustments (Landefeld et al., 2009). It is hoped that the results of the quality adjustments presented in this research encourage further development in this field of research.

Thirdly, by presenting a unique way of collecting data on productivity adjustments, suggesting productivity adjustment levels (weights) and evaluating the magnitudes of the productivity adjustment compared to the traditional approach, this study contributes to knowledge. Although the results may suffer from some limitations, it is believed the proposed adjustments should be of higher accuracy than the often used arbitrary adjustments.
Similar to the quality adjustment, Blades (2000), Fischer (1994), Lowen and Sicilian (2015), National Research Council (2005), and van de Ven and Zwijnenburg (2016) highlighted the need that specialist wage rates require to be adjusted for a different level of productivity between market professionals and household workers. The adjustments are essential to avoid an overestimation of the VoL (Lowen & Sicilian, 2015). However, analogous with quality adjustments, Salamon et al. (2011) claimed that the magnitude of those adjustments is uncertain. An extensive review of the literature revealed that no consensus on appropriate adjustments has been reached so far (United Nations, 2020), and further research is required.

This research demonstrates that newly developed questions can be used to collect accurate data on productivity adjustments and thus answers the call from the United Nations (2013) by designing new questions to shed light on less explored areas.

Fourthly, this study contributes to knowledge by analysing the impacts of selected demographic factors on the quality of unpaid household work for seven *questionnaire activity groups*. To the knowledge of the author, it is the first study of its kind that did those investigations at this level of detail in a VoL study. The unique results from the current study identified five of the seven demographic factors as main determinants affecting the quality of unpaid household work, which is found to be in line with the wider literature on time allocation and demographics.
The thorough review of the literature uncovered a scarcity of research on the impact of demographics on the quality of unpaid household work and it is hoped that this study fills the void of literature with an additional contribution.

Finally, a significant contribution is also seen in the recommendations to policy makers and practitioners, based on the finding of this study, on how the dominating approach of the VoL can be modified to consider multitasking and adjusting for quality and productivity. The adjustments and splits proposed in this research may help to create a harmonised and more accurate approach of the VoL that practitioners may adopt.
The benefit of a higher accuracy is hoped to be clearly visible when looking at the evaluation of the VoL magnitudes. Although some adjustment levels (weights) seem to be very small, they still may have a significant impact on the overall VoL estimates.
While it is well known that the traditional approaches do not provide accurate estimates, the deviations of up to 5.29% of the annual GDP in the UK from the traditional approach, shown in Chapter 6 of this study, signify the significance of improving the accuracy of the VoL estimates.

7.6 Limitations of this Research Study

Although the research design and the methodological choices were made in the best effort of answering the research questions and meeting the aim of this study, the research does have some limitations and shortcomings. This section summarises the main limitations of this study to highlight what could be done better if the study were replicated.

The first limitation is based on the design and methodologies of the primary data collection. The chosen non-probability sampling design comes with a lack of representativeness of the sample and does not allow generalisability of findings. However, it is believed that the sufficient sample size of 406 respondents, which is more than the required 385 respondents, as outlined in Chapter 4, may have achieved a degree of representativeness that allows the generalisability of the results to some extent. Furthermore, for primary data collection, this study used the services of SurveyMonkey and its UK panel, which consists of people living in the UK. This way, the access was only given to registered users with SurveyMonkey, which may exclude certain groups of people and thus their views. This is seen as a major limitation and may have caused some bias in responses. However, SurveyMonkey claims that its UK panel achieves a high representativeness of people from all walks of life.

The second limitation may be seen in the matching of various classifications and different types of datasets used. In multiple steps of this research, the codes for wage rates (SOC2010) were assigned to UKTUS activity codes, and *questionnaire activity groups* were also matched to UKTUS data activity codes. The detailed methods on how this was done were described in Chapters 4 and 5. Matching of different classifications is common in TUS research but may be prone to errors or bias. Although each matching step was thoroughly undertaken and adapted in line with suggestions from previous research studies – for example Budlender and Brathaug (2010), Egerton and Mullan (2008), Lowen and Sicilian (2015), Poissonnier and Roy (2017), and Statistics New Zealand (2001) – steps like these offer points for critique, because matching is often connected to a certain degree of subjectivity of the researcher. It can therefore not be ruled out that other researchers would come to a different matching result, which may lead to a divergent VoL estimate.
Furthermore, the UKTUS, the wages and the primary data are based on different samples and were collected at different points in time. The researcher did not have the capacity, due to the complexity and variety of the required data, to collect all necessary information from the same sample. For example, UKTUS respondents, who filled in the diaries in 2014/2015, may have responded differently to the primary data questionnaire filled in by the respondents of the SurveyMonkey UK panel in

2021. This may be seen as a big limitation but mixing different types of data is common in the VoL field of research. Nevertheless, the best choice available was used for this study by selecting the respondents from the UK providing the necessary data.

The third limitation is seen in the secondary data that itself comes with adherent limitations. The collection of TUS data rests on many assumptions and limitations outlined in the methodology paper from Morris et al. (2016) and discussed in detail in Chapter 5 of this thesis. The TUSs heavily rely on respondents' views, their willingness to respond accurately, and their enthusiasm to share their thoughts. It therefore may not be astonishing that the list of assumptions and limitations in TUS research can be quite long. It is important to find a suitable compromise between what is aimed for, in terms of data collection, and what is realistic, doable and achievable. This thesis reviewed coded activities, written down by the respondents in their UKTUS diaries. In their technical report, Morris et al. (2016) provided an example of what had happened in the UKTUS, if a respondent had forgotten to complete a large or whole section of the time use diary. According to Morris et al. (2016), the interviewers were asked to encourage participants to use any information from their memories or any other sources to reconstruct their day and complete the missing diary information. This is seen as a limitation because days later it may be difficult to precisely remember all activities and their durations.
Similar to the TUS data, the methodology paper for the ASHE (ONS, 2018a) pointed out the potential shortcomings and limitations of the ASHE data. Due to a high variation of the hourly wage rates of every published year, it was decided to use the 5-year average rates for the VoL calculations. The use of 5-year mean wages may have influenced the monetary VoL estimates to some extent. However, it is believed that these effects should be very small.

The final limitation may be seen in the productivity adjustments applied in this study. For reasons outlined in Chapter 2, the collection of detailed output data on household production, which would allow estimating productivity more accurately, is complicated. This study estimated productivity from a different perspective, offering a fresh view, by deriving productivity from time input and a constant output. This idea is based on the work of Fitzgerald and Wicks (1990), who asked respondents in their business survey to report time duration for producing a given output.
This may not have been as accurate as it was hoped for, because the responses

provided for the relevant questions may be biased to some extent. The sources of the bias (for example, the social desirability bias, or the effort of men to provide answers fitting their bread-earner role, or the aspiration of both genders not to look weak in particular activities) were discussed in previous chapters. Therefore, the results of the productivity adjustments, despite having shown robustness in the data analysis part, should be treated with care.

7.7 Suggestions for Future Research

Based on the limitations outlined above and the findings of this study that were not directly related to the research questions posed in this study, the possible areas for future study may be suggested as below.

Firstly, this research focused on the UK and used time use, wage and primary data collected in the UK. Since the findings of this research may be country-specific, it may be suggested to replicate this study in other countries in order to enable a comparison and classification of the results with the findings in this thesis. In the case where the collection of similar, primary data in other countries is not possible for any reason, it might be a good start to estimate the VoL in another country using the adjustments proposed in this study.

Secondly, this study investigated a limited number of 31 UKTUS activity codes on a 4-digit level from code 3000 to 3590. These were aggregated into six 2-digit UKTUS activity codes from 30 to 35. The activity classification used for the UKTUS shows that unpaid work is also represented by additional codes; for example, code 37 'household management', code 38 'childcare of own household members', or code 42 'informal help to other households' (CTUR, 2016). It may be suggested that future work can extend the number of activities and test how adjustments would work for those additional activities. Particularly, this could be important for childcare activities, including 'being available for care' activities, and unpaid work done outside one's own household, either for friends, neighbours or through non-profit organisations.

Thirdly, one finding of this study was that the housekeeper wage may not necessarily act as a general lower boundary for the VoL, as suggested by Bridgman et al. (2012), Chadeau (1992), and Landefeld and McCulla (2000). Potential further studies may investigate the reason for this finding in greater detail, or may apply the minimum wage, mentioned by Poissonnier and Roy (2017) and van de Ven and Zwijnenburg (2016), which is believed to be lower than the housekeeper wage. Further research may put the minimum wage to the test of whether it would rather hold as a lower boundary than the housekeeper wage.

Fourthly, adding questions to future TUSs to collect data about possible splits for multitasking, quality or productivity adjustments, provides the opportunity of gathering information that allows a more detailed and less arbitrary estimate of the VoL. Future researchers are encouraged to use this study's questionnaire as a basis to develop more suitable questions that can be implemented into the diary, or as general questions into the TUS personal questionnaire. Although it is known that filling in TUSs is time-consuming and may put a high burden on respondents, this additional data would help to increase the accuracy of the VoL calculations. A reduction of the respondent burden may be possible by asking those questions in the piloting stage of a TUS, and applying the acquired data to the full TUS later. In this way, the data for the time allocation on activities and the adjustments would be collected from the same sample.

Fifthly, future studies may be concentrated in exploring the determinants of multitasking, quality and productivity.

Lastly, future research may want to focus on the gender-based differences regarding the adjustments that were found in this thesis and may investigate whether the higher productivity rates for women compared to men are unique to this study or may appear elsewhere to a similar extent.

7.8 Chapter Conclusion

This chapter provides the reader with the main research findings and how they contribute to knowledge in the field including their practical implications. Furthermore, it outlines the limitations of the research and offers suggestions for future research. Overall, the aim of the thesis was to modify the currently dominating approach on valuing unpaid household work by taking consideration of simultaneous activities, quality and productivity. It can be concluded with confidence that this study has accomplished its aim and objectives. It is hoped that the findings of this study will inspire future researchers, policy makers and practitioners and contribute to the ongoing discussions about possible improvements of the VoL estimates. It is also to be hoped that the point of view and the findings presented in this thesis could contribute to finding a harmonised approach for the VoL.

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Appendix A

UKTUS Activity Codes

The following Table A.1 provides a list of selected 2014/2015 UKTUS activity codes based on CTUR (2016). In their report they provide a list of all 274 UKTUS activity codes.

Table A.1: UKTUS activity code list - selected codes

3 HOUSEHOLD AND FAMILY CARE	
	3000 Unspecified household and family care
31 FOOD MANAGEMENT	
	3100 Unspecified food management
	3110 Food preparation and baking
	3130 Dish washing
	3140 Preserving
	3190 Other specified food management
32 HOUSEHOLD UPKEEP	
	3200 Unspecified household upkeep
	3210 Cleaning dwelling
	3220 Cleaning yard
	3230 Heating and water
	3240 Arranging household goods and materials
	3250 Disposal of waste
	3290 Other or unspecified household upkeep
33 MAKING AND CARE FOR TEXTILES	
	3300 Unspecified making and care for textiles
	3310 Laundry
	3320 Ironing
	3330 Handicraft and producing textiles
	3390 Other specified making and care for textiles
34 GARDENING AND PET CARE	
	3410 Gardening
	3420 Tending domestic animals
	3430 Caring for pets
	3440 Walking the dog
	3490 Other specified gardening and pet care
35 CONSTRUCTION AND REPAIRS	
	3500 Unspecified construction and repairs
	3510 House construction and renovation
	3520 Repairs of dwelling

3530 Making repairing and maintaining equipment
3531 Woodcraft metalcraft sculpture and pottery
3539 Other specified making repairing and maintaining equipment
3540 Vehicle maintenance
3590 Other specified construction and repairs

36 SHOPPING AND SERVICES

3600 Unspecified shopping and services
3610 Unspecified shopping
3611 Shopping mainly for food
3612 Shopping mainly for clothing
3613 Shopping mainly related to accommodation
3614 Shopping or browsing at car boot sales or antique fairs
3615 Window shopping or other shopping as leisure
3619 Other specified shopping
3620 Commercial and administrative services
3630 Personal services
3690 Other specified shopping and services

37 HOUSEHOLD MANAGEMENT

3710 Household management not using the internet
3713 Shopping for and ordering clothing via the internet
3720 Unspecified household management using the internet
3721 Shopping for and ordering unspecified goods and services via the internet
3722 Shopping for and ordering food via the internet
3724 Shopping for and ordering goods and services related to accommodation via the internet
3725 Shopping for and ordering mass media via the internet
3726 Shopping for and ordering entertainment via the internet
3727 Banking and bill paying via the internet
3729 Other specified household management using the internet

38 CHILDCARE OF OWN HOUSEHOLD MEMBERS

3800 Unspecified childcare
3810 Unspecified physical care & supervision of a child
3811 Feeding the child
3819 Other and unspecified physical care & supervision of a child
3820 Teaching the child
3830 Reading playing and talking with child
3840 Accompanying child
3890 Other or unspecified childcare

39 HELP TO AN ADULT HOUSEHOLD MEMBER

3910 Unspecified help to a non-dependent e.g. injured adult household member
3911 Physical care of a non-dependent e.g. injured adult household member
3914 Accompanying a non-dependent adult household member e.g. to hospital
3919 Other specified help to a non-dependent adult household member
3920 Unspecified help to a dependent adult household member
3921 Physical care of a dependent adult household member e.g. Alzheimic parent
3924 Accompanying a dependent adult household member e.g. Alzheimic
3929 Other specified help to a dependent adult household member

4 VOLUNTEER WORK AND MEETING

4000 Unspecified volunteer work and meetings

41 ORGANISATIONAL WORK

4100 Unspecified organisational work
4110 Work for an organisation
4120 Volunteer work through an organisation
4190 Other specified organisational work

42 INFORMAL HELP TO OTHER HOUSEHOLDS

4200 Unspecified informal help to other households
4210 Food management as help to other households
4220 Household upkeep as help to other households
4230 Gardening and pet care as help to other households
4240 Construction and repairs as help to other households
4250 Shopping and services as help to other households
4260 Help to other households in employment and farming
4270 Unspecified childcare as help to other households
4271 Physical care and supervision of child as help to other household
4272 Teaching non-coresident child

4273 Reading playing & talking to non-coresident child
4274 Accompanying non-coresident child
4275 Physical care and supervision of own child as help to other household
4277 Reading playing & talking to own non-coresident child
4278 Accompanying own non-coresident child
4279 Other specified childcare as help to other household
4280 Unspecified help to an adult of another household
4281 Physical care and supervision of an adult as help to another household
4282 Accompanying an adult as help to another household
4283 Other specified help to an adult member of another household
4289 Other specified informal help to another household
4290 Other specified informal help

Source: CTUR (2016)

Appendix B

Questionnaire Applied in this Study

This Appendix presents the questionnaire, developed by the researcher, which was answered by 406 respondents. It is important to note that the slider questions (Q10-Q16 and Q18-Q24) show a starting point on the left hand side although the online survey correctly provided a starting point of the slider in the middle of the bar, reflecting the professional worker. It is believed this problem has been caused by exporting the online questionnaire to a PDF as the online version still showed the correct position.

Questionnaire on unpaid work

Welcome to my questionnaire on unpaid work

Dear participant,

my research focuses on the time people spend on activities in their own household that they do not get paid for, so called unpaid work activities. Those include household chores, gardening, repair work and many more.

I am interested in your views on this topic and with your help, you will make a valuable contribution to current and future time use research.

In this questionnaire you will be asked questions about activities that are done simultaneously within the same time period. This is commonly known as multitasking.
Further questions help to investigate the differences between people performing unpaid work and paid market professionals. Those questions focus on the quality of work and time duration to complete certain tasks. The differences may be caused by different levels of skills, experience and less professional equipment.

You may have the feeling that some questions seem very subjective. In those cases, please provide your answers based on your life experience and personal judgement.

Many thanks for your participation!

Please note that your participation is voluntary, and you have the right to withdraw at any time prior to final submission of the questionnaire. In addition to SurveyMonkey's regulations, the researcher respects principles of anonymity, confidentiality, data protection and research ethics.

1

Questionnaire on unpaid work

* 1. Did you do any of the following activities in your own household without getting paid for within the past six months? Please tick **all** that apply.

- ☐ Food preparation including cooking and baking
- ☐ Cleaning and waste disposal
- ☐ Laundry and ironing
- ☐ Gardening
- ☐ Pet and animal care including dog walking
- ☐ House renovation, construction, repair, maintenance
- ☐ Vehicle maintenance
- ☐ None of the above
- ☐ Do not know / prefer not to say

2

Questionnaire on unpaid work

* 2. Do you see yourself as a specialist in one of the following activities because you either currently have or previously had a paid job in that area? Please tick **all** that apply.

- ☐ Food preparation including cooking and baking
- ☐ Cleaning and waste disposal
- ☐ Laundry and ironing
- ☐ Gardening
- ☐ Pet and animal care including dog walking
- ☐ House renovation, construction, repair, maintenance
- ☐ Vehicle maintenance
- ☐ None of the above
- ☐ Do not know / prefer not to say

Questionnaire on unpaid work

* 3. Multitasking means that you do multiple activities simultaneously within the same time period. Do you prefer to multitask or rather complete tasks one after the other?

- Prefer to multitask
- Prefer to do one task after the other
- Do not know / prefer not to say

4

Questionnaire on unpaid work

* 4. How likely do you think multitasking is caused by time pressure?

- Very likely
- Likely
- Neither likely nor unlikely
- Unlikely
- Very unlikely

5

Questionnaire on unpaid work

* 5. This question looks at how multitasking impacts on time duration of activities. Please look at the list of activities given below and think about the following situation.
The listed activities are done together with a typical household chore activity. How likely do you think the listed activity will extend the time required to finish the household chore activity?

	Very likely	Likely	Neither likely nor unlikely	Unlikely	Very unlikely
Phone conversation	○	○	○	○	○
Socialising with family	○	○	○	○	○
Listening to radio, sports or news	○	○	○	○	○

6

Questionnaire on unpaid work

* 6. Think about a situation where **two** different activities of your choice are done simultaneously within a time period of 12 minutes.
How would you split the 12 minutes on those **two** activities?

	Select split that most reflects your opinion
Split for 2 activities	

* 7. Think about a situation where **three** different activities of your choice are done simultaneously within a time period of 12 minutes.
How would you split the 12 minutes on those **three** activities?

	Select split that most reflects your opinion
Split for 3 activities	

* 8. Think about a situation where **four** different activities of your choice are done simultaneously within a time period of 12 minutes.
How would you split the 12 minutes on those **four** activities?

	Select split that most reflects your opinion
Split for 4 activities	

7

Questionnaire on unpaid work

* 9. How likely do you think the following factors have an impact on multitasking?

	Very likely	Likely	Neither likely nor unlikely	Unlikely	Very unlikely
Health	◯	◯	◯	◯	◯
Age	◯	◯	◯	◯	◯
Gender	◯	◯	◯	◯	◯
Level of education	◯	◯	◯	◯	◯
Marital status	◯	◯	◯	◯	◯
Number of children living in own household	◯	◯	◯	◯	◯

8

Questionnaire on unpaid work

Question text for the following 7 activities regarding quality:

For the following set of questions, try to compare yourself with a paid market professional for each unpaid household activity A) to G) listed below.
Consider the professional worker achieves a quality level of 100 % for the completed tasks. If you would do the same work try to estimate the level of quality you would be able to achieve?

Please select the quality using the sliders below for each of the seven activities listed.
Note that sliding to the left means you achieve a lower quality than the expert, sliding to the right means you achieve a higher quality.

* 10. A) Food preparation including cooking and baking

1 % — 100 % quality (equal to market professional) — 200 %

* 11. B) Cleaning and waste disposal

1 % — 100 % quality (equal to market professional) — 200 %

* 12. C) Laundry and ironing

1 % — 100 % quality (equal to market professional) — 200 %

* 13. D) Gardening

1 % — 100 % quality (equal to market professional) — 200 %

* 14. E) Pet and animal care including dog walking

1 % — 100 % quality (equal to market professional) — 200 %

9

* 15. F) House renovation, construction, repair, maintenance

1 % | 100 % quality (equal to market professional) | 200 %

* 16. G) Vehicle maintenance

1 % | 100 % quality (equal to market professional) | 200 %

Questionnaire on unpaid work

* 17. How likely do you think ...

	Very likely	Likely	Neither likely nor unlikely	Unlikely	Very unlikely
... you tend to overestimate your skills when you are asked to compare yourself with a paid market professional?	◯	◯	◯	◯	◯
... the quality of your work would improve in case you would receive a payment for the tasks you normally perform without pay?	◯	◯	◯	◯	◯
... you work as productive in unpaid work activities as you would if you would get paid for it?	◯	◯	◯	◯	◯
... doing two or more activities at the same time reduces the quality of your work?	◯	◯	◯	◯	◯
... doing two or more activities at the same time reduces your productivity?	◯	◯	◯	◯	◯

Questionnaire on unpaid work

Question text for the following 7 activities regarding time duration:

For the following set of questions, try to compare yourself with a paid market professional for each unpaid household activity A) to G) listed below.
Consider the professional worker performs one typical task in each of the activity groups listed below and requires 60 minutes to complete each task.
If you would do the same work try to estimate how many minutes you would require to complete the same task as the paid market professional?

Please select the time using the sliders below for each of the seven activities listed.
Note that sliding to the left means you need fewer minutes than the expert to complete the task (you work faster). Sliding to the right means you need more minutes than the expert (you work slower).

* 18. A) Food preparation including cooking and baking

1 minute | 60 minutes (equal to market professional) | 120 minutes

* 19. B) Cleaning and waste disposal

1 minute | 60 minutes (equal to market professional) | 120 minutes

* 20. C) Laundry and ironing

1 minute | 60 minutes (equal to market professional) | 120 minutes

* 21. D) Gardening

1 minute | 60 minutes (equal to market professional) | 120 minutes

* 22. E) Pet and animal care including dog walking

1 minute | 60 minutes (equal to market professional) | 120 minutes

12

* 23. F) House renovation, construction, repair, maintenance

1 minute	60 minutes (equal to market professional)	120 minutes

* 24. G) Vehicle maintenance

1 minute	60 minutes (equal to market professional)	120 minutes

13

Questionnaire on unpaid work

* 25. How likely do you think the following factors impact on the quality of work and the time required to complete a task?

	Impact on quality of work	Impact on time required to complete a task
Health		
Age		
Gender		
Level of education		
Marital status		
Number of children living in own household		

Questionnaire on unpaid work

* 26. What is your age?

- Under 18 years
- 18 - 29 years
- 30 - 41 years
- 42 - 53 years
- 54 - 65 years
- 66 years and over
- Do not know / prefer not to say

Questionnaire on unpaid work

* 27. How many people of the following age groups live in your household including yourself?

	Number of people
Adults (18 years and older)	
Children (8 - 17 years old)	
Children (0 - 7 years old)	

Questionnaire on unpaid work

* 28. What is your employment status?

- ◯ Self employed
- ◯ In paid employment (full time)
- ◯ In paid employment (part-time)
- ◯ Unemployed
- ◯ Retired
- ◯ Full-time student
- ◯ Long-term sick
- ◯ Something else
- ◯ Do not know / prefer not to say

Questionnaire on unpaid work

* 29. What was your gender at birth?

- Female
- Male
- Do not know / prefer not to say

Questionnaire on unpaid work

* 30. What is your marital status?

- ◯ Single, never married
- ◯ Living with a partner but not married (cohabiting)
- ◯ Married and partner lives in household
- ◯ Married but separated
- ◯ Divorced
- ◯ Widowed
- ◯ Do not know / prefer not to say

Questionnaire on unpaid work

* 31. What is your highest level of education or training completed?

- ◯ No qualification
- ◯ Primary school
- ◯ Secondary school up to 16 years
- ◯ Higher or secondary or further education (A-levels, BTEC, etc.)
- ◯ Vocational training, apprenticeship, professional training
- ◯ University or college degree (Bachelor or similar)
- ◯ Post-graduate degree
- ◯ Other
- ◯ Do not know / prefer not to say

Questionnaire on unpaid work

* 32. How would you rate your current health status?

- Very good
- Good
- Fair
- Poor
- Very poor
- Do not know / prefer not to say

Appendix C

UK Population Estimates

Table C.1 presents the UK total population and the UK population aged 18 years and over for the years 2010-2021. Values marked with * are estimated numbers.

Table C.1: Total UK population and UK population aged 18 years and older

Year	**UK total resident population**	**UK total 18 years and over**
2010	62,676,579	* 49,872,985
2011	63,197,998	* 50,287,889
2012	63,669,605	* 50,600,112
2013	64,104,446	* 50,922,714
2014	64,573,836	* 51,284,254
2015	65,062,586	* 51,771,578
2016	65,560,782	* 52,168,003
2017	65,983,049	* 52,438,674
2018	66,380,723	* 52,730,922
2019	66,740,857	* 53,005,293
2020	67,055,339	* 53,266,817
2021	67,153,670	* 53,344,928

Source: The author's calculations based on OECD (2022b), ONS (2021c), and United Nations (2022b)

Appendix D

Regression Assumption Testing

This appendix presents the assumption testing for the OLS regression analysis and provides the graphs and plots to support that the assumptions are met and have not been violated.

Multicollinearity - Additional Information

In addition to the multicollinearity explanations in Section 6.10 the following information is provided. The correlation between two variables can be estimated by using an appropriate correlation test, which is dependent on whether the variables are continuous or categorical. Table D.1 lists common tests for different types of variables. In line with Bryman (2008), Bryman and Bell (2015), Cohen and Cohen (1983), Field (2009), Khamis (2008), and Mitchell and Jolley (2010) the Phi coefficient was identified as being most suitable for the data used in this study.

Table D.1: Overview of correlation tests

Type of variables	Correlation test
Two metric variables	Pearson's r
Two ordinal variables	Kendall's tau Spearman's r
Two nominal variables	Phi coefficient Cramer's V

Source: The author based on Cohen and Cohen (1983), Field (2009), Schendera (2008), and von Eye and Schuster (1998)

In addition to the Phi correlation coefficient and the VIF which are outlined in the main body of the thesis, it should be mentioned that multicollinearity can also be detected by looking at the condition index of the collinearity statistics (Schendera, 2008). No or weak multicollinearity is assumed for values between 0 and 15 of the condition index, for values between 15 and 30 the relationship is considered moderate, and values above 30 signal a strong multicollinearity (Schendera, 2008; Shrestha, 2020). The highest condition index of the data used in this study shows a value of 8.913 and thus is well below the threshold of 15, also – in line with the Phi coefficient and the VIF results – indicating that there is no issue of multicollinearity in the data.

Linearity

This assumption requires a linear relationship between the dependent and independent variables (Backhaus et al., 2016; Field, 2009; Frost, 2019; Schendera, 2008; Urban & Mayerl, 2006). Although this sounds simple to test, checking for linearity is not trivial. It depends on the type of variables and has a certain degree of subjectivity, particularly when a graphical analysis is the basis for the decision (Pardoe, 2006). Usually the linearity check is done graphically by looking at the scatter plot of the dependent and the independent variable, and this scatter plot should show a linear relationship between both variables (Field, 2009; Moosbrugger, 2002; Pardoe, 2006; Schendera, 2008). However, as all the independent variables used in the regression are binary variables, from a mathematical and statistical perspective a scatterplot would show meaningless results, and therefore, it is not recommended to test linearity for binary variables. This view is supported by Cohen and Cohen (1983) and Moosbrugger (2002) who claim that dummy or binary coded variables can generally be used as predictors in a multiple regression model as they meet the linearity assumption by definition. Therefore, the linearity assumption is met.

Heteroscedasticity

Another assumptions is that there is no heteroscedasticity in the data. To meet the requirement of homoscedasticity the variance of errors (σ^2) needs to be constant, otherwise there would be heteroscedasticity (Field, 2009). According to the literature, there are different ways to test this assumption. One is the Breusch-Pagan test that can be applied to confirm that there is no heteroscedasticity in the data (Breusch & Pagan, 1979). Depending on the p-level, the statistical tests suggests heteroscedasticity for $p \leq 0.05$ and allows to assume homoscedasticity for $p > 0.05$. In all seven cases (*food*, *clean*, *laund*, *gard*, *pet*, *reno* and *vehi*), the statistical test showed a p-value of greater than 0.05 in SPSS, signalling that there is no homoscedasticity in the data. Table D.2 shows the p-values.

Table D.2: Results of Breusch-Pagen test

	p-value
food	.480
clean	.099
laund	.412
gard	.262
pet	.149
reno	.215
vehi	.349

Source: The author

Another and also more preferred way to check this assumption is using residual plots. Pardoe (2006) recommends to test this assumption by "visually divide the residual plot into 5-6 vertical slices, but [...] consider the spread of the residuals in each slice; variation should be approximately the same within each slice" (p. 56). Similar to other graphical interpretations, Pardoe (2006) states that researchers "should only seriously question the constant variance assumption if there are clear changes in the variation between some of the slices" (Pardoe, 2006, p. 56). The residual plots are presented in Figures D.1 to D.7 and support the Breusch-Pagen test results that there is no heteroscedasticity problem in the data.

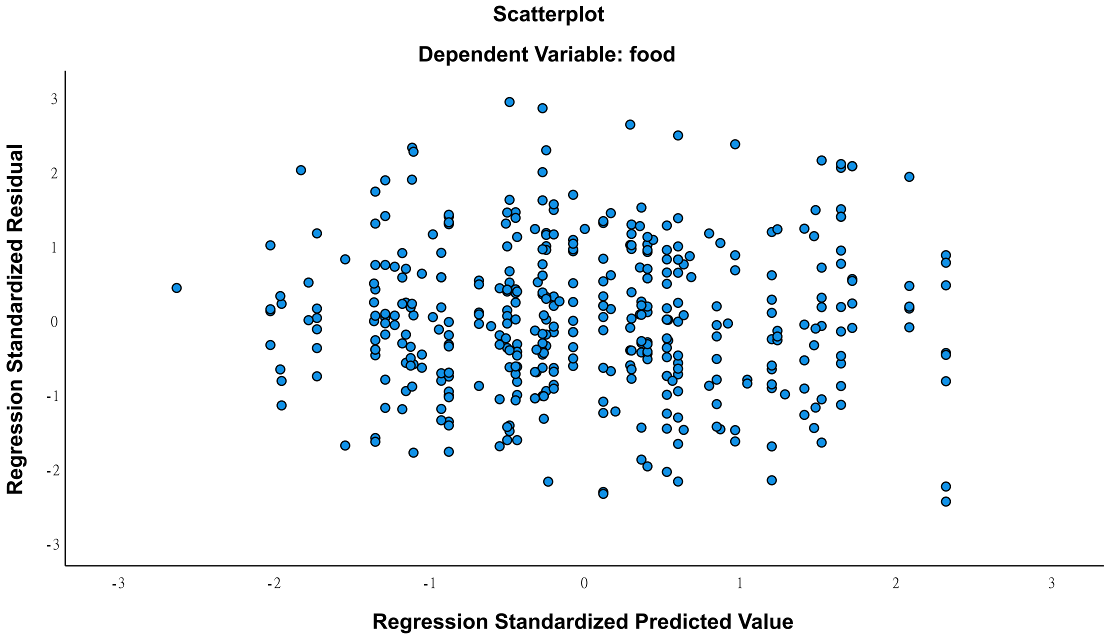

Figure D.1: Homoscedasticity, DV=food

Source: The author

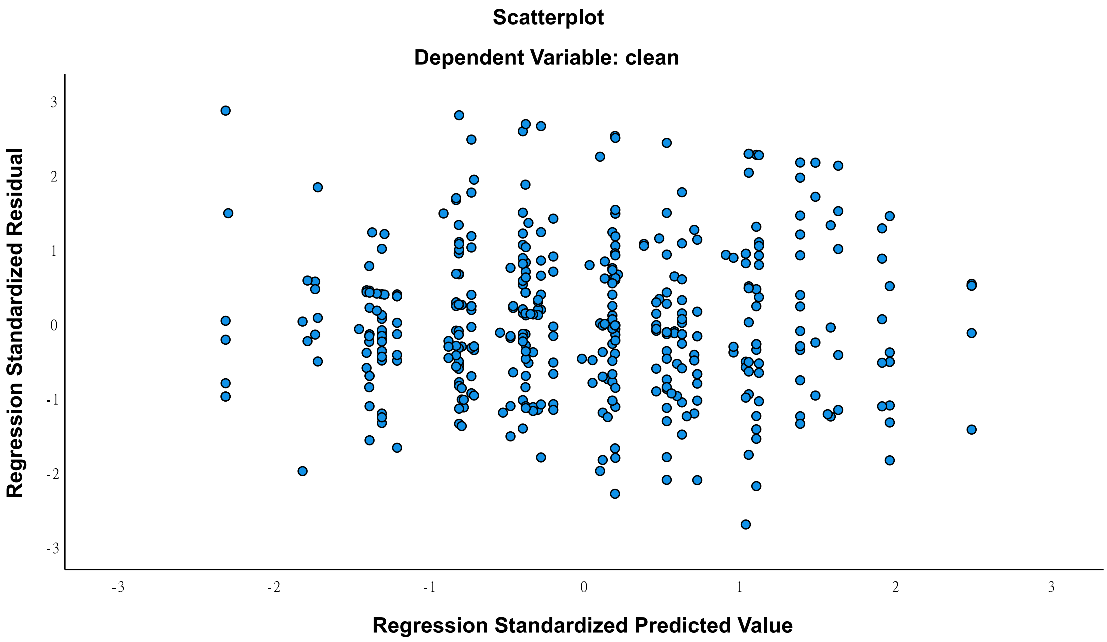

Figure D.2: Homoscedasticity, DV=clean

Source: The author

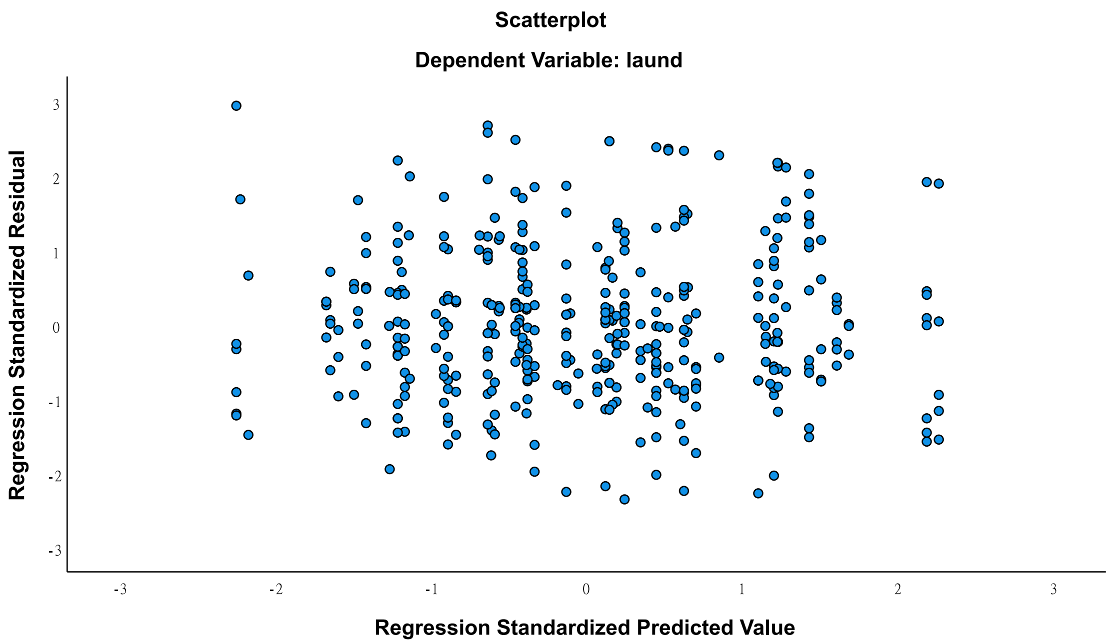

Figure D.3: Homoscedasticity, DV=laund

Source: The author

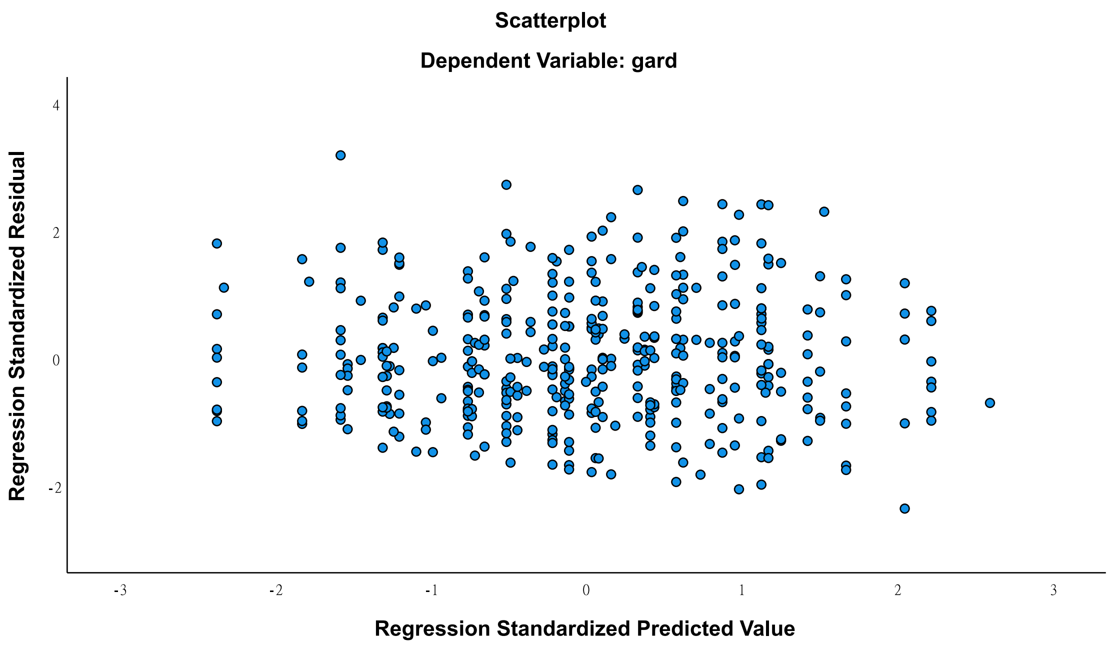

Figure D.4: Homoscedasticity, DV=gard

Source: The author

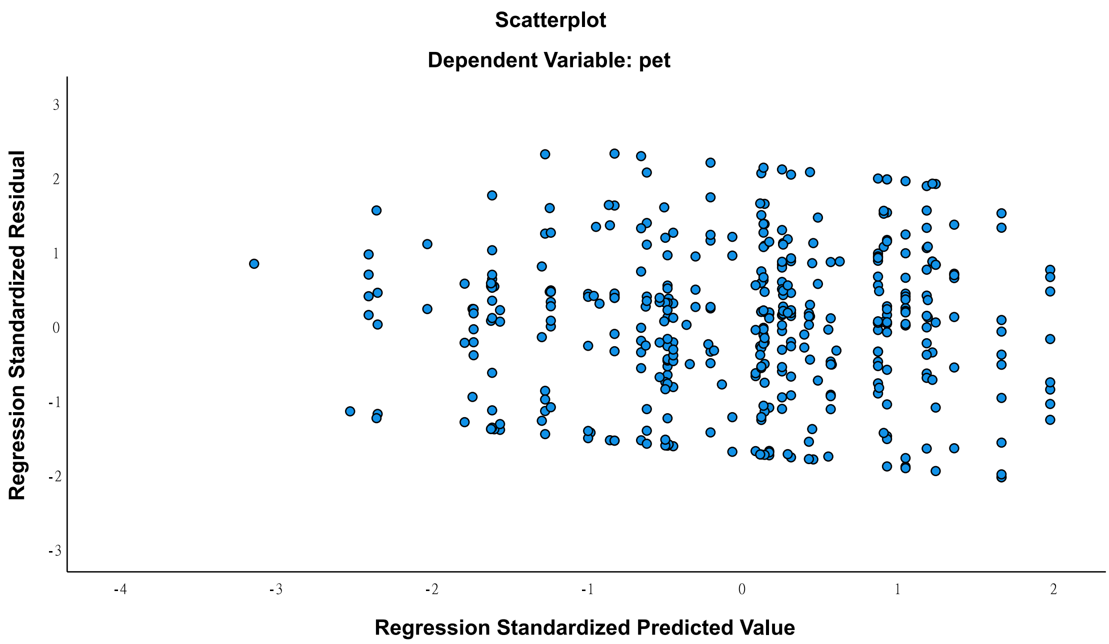

Figure D.5: Homoscedasticity, DV=pet

Source: The author

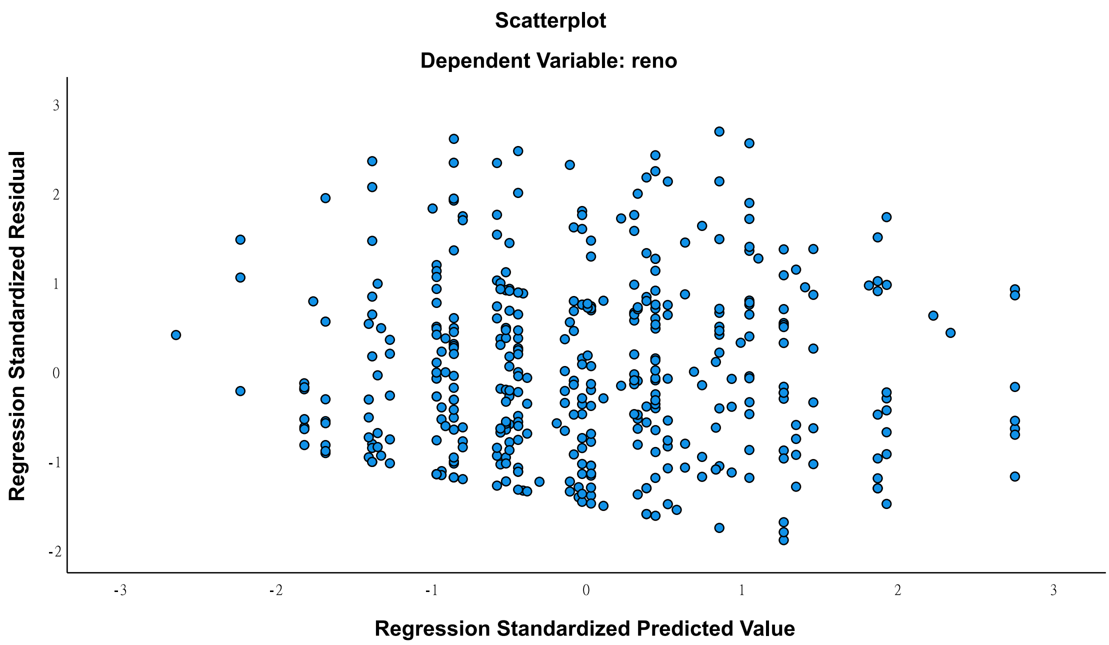

Figure D.6: Homoscedasticity, DV=reno

Source: The author

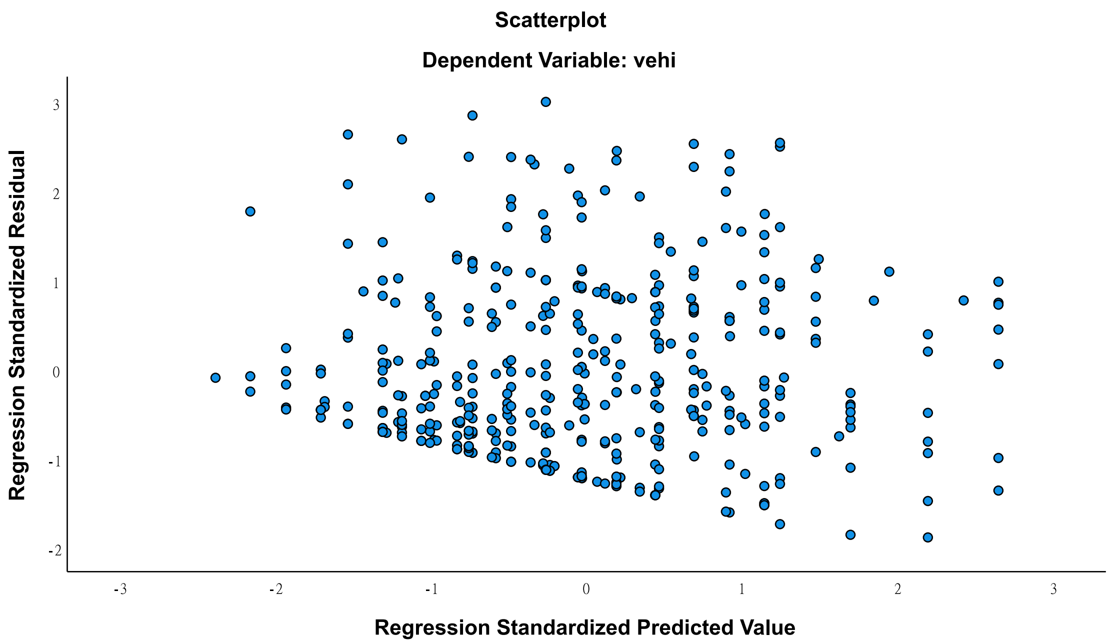

Figure D.7: Homoscedasticity, DV=vehi

Source: The author

Mean Error is Zero

Another assumption of OLS regression is that the expected mean error of the regression model has a value of zero $E(u_i) = 0$ (Backhaus et al., 2016; Field, 2009; Frost, 2019). This assumption has been tested for all seven regressions using SPSS by calculating the mean of the residuals in line with Schendera (2008). For all seven cases that mean showed a value of 0.0000 which allows to confirm that this assumption has been met. It was decided not to present all 2842 residual values $(406 * 7 = 2842)$ in the Appendix as it would not add a significant value.

Also, a visual test of this assumption, based on the residual plots, is possible (Pardoe, 2006). He recommends to "visually divide the residual plot into 5-6 vertical slices and consider the approximate average value of the residuals in each slice; within-slice averages should be "close" to zero. [...] but the variation is small relative to overall variation of the individual residuals" (Pardoe, 2006, p. 55). Moreover, he states that this might be a "somewhat subjective technique" (p. 55) and that researchers "should only seriously question the zero mean assumption if there are clear differences from zero for some of the within-slice averages" (Pardoe, 2006, p. 55).

Normality of Errors

This assumption requires the residuals to be approximately normally distributed (Backhaus et al., 2016; Field, 2009; Frost, 2019; Schendera, 2008).
The researcher "can visually assess whether residuals seem to be approximately normally distributed over the entire residual plot" (Pardoe, 2006, p. 57). This means that "the residuals follow the straight line" (p. 205) of the normal probability plot (Frost, 2019). Another way to test this assumption are histograms or Q-Q plots (Pardoe, 2006). Due to some subjectivity in interpreting graphs or plots, Pardoe (2006) recommends to "only seriously question the normality assumption if the distribution of residuals is clearly different from normal" (p. 57).
The relevant plots are presented in Figures D.8 to D.28 and none of them has a shape that seriously questions the normality distribution assumption. Assistance in interpreting the graphs was found in the publication by Pardoe (2006) where detailed explanations and multiple visualisations helped to conclude that the assumption of normally distributed errors was met. Further guidance was found in the work from Field (2009), Frost (2019), Schendera (2008), and von Eye and Schuster (1998).
In addition to the graphical view, the literature also offers two statistical tests, the Kolmogorow-Smirnow and the Shapiro-Wilk test. Although it finds support in literature for smaller samples, it is criticised and not recommended for larger samples. Field (2009) even mentions a warning: "In large samples these tests can be significant even when the scores are only slightly different from a normal distribution" (p. 148). For larger samples, the visual interpretation of P-P or Q-Q plots and histograms is the preferred way to check this assumptions (Field, 2009; Pardoe, 2006; Schendera, 2008). This recommendation was followed in this study.

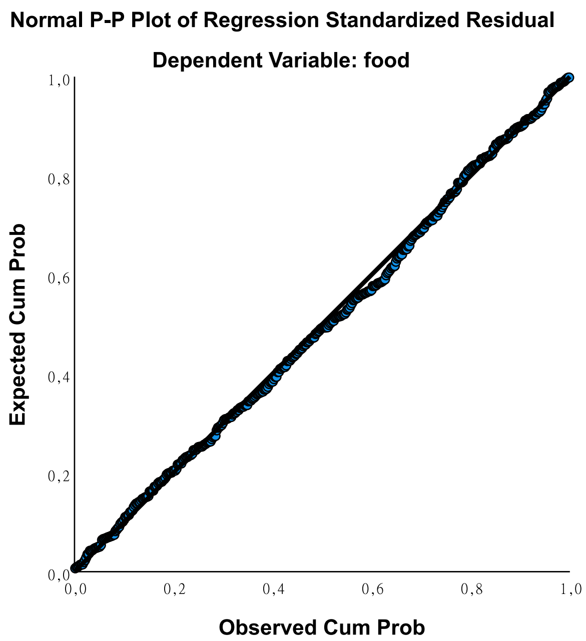

Figure D.8: P-P plot, DV=food

Source: The author

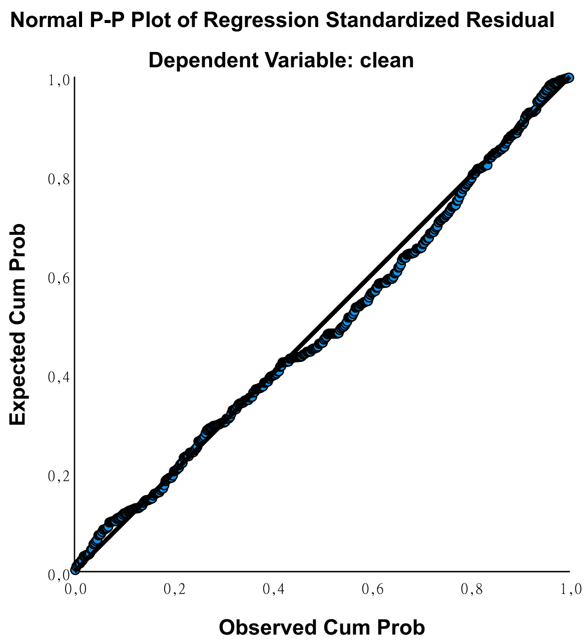

Figure D.9: P-P plot, DV=clean

Source: The author

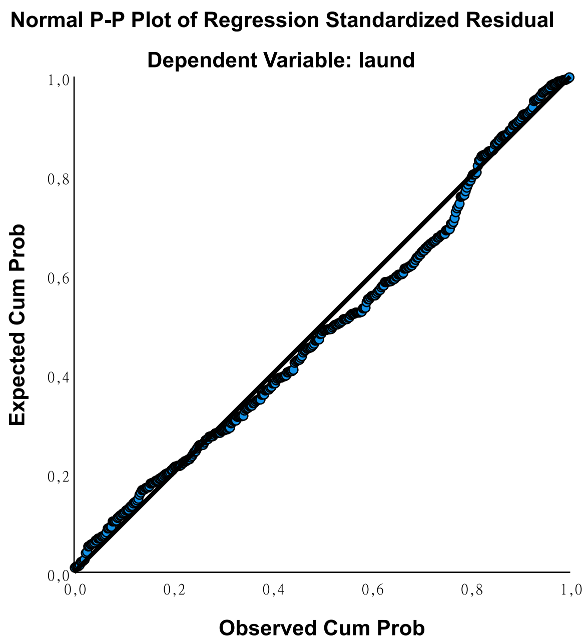

Figure D.10: P-P plot, DV=laund

Source: The author

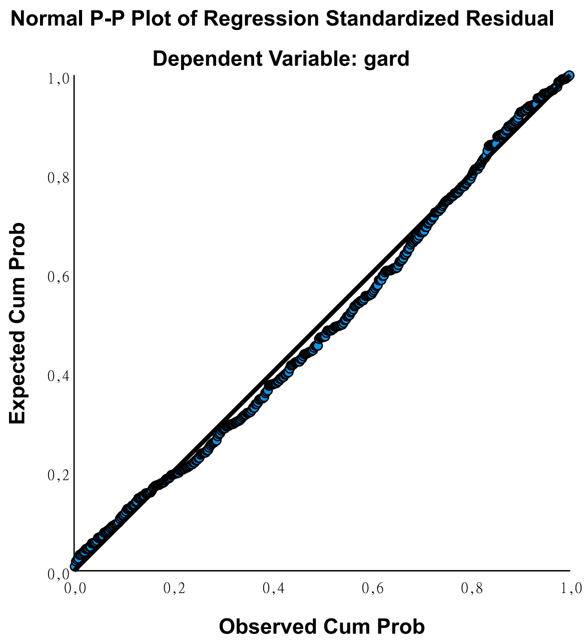

Figure D.11: P-P plot, DV=gard

Source: The author

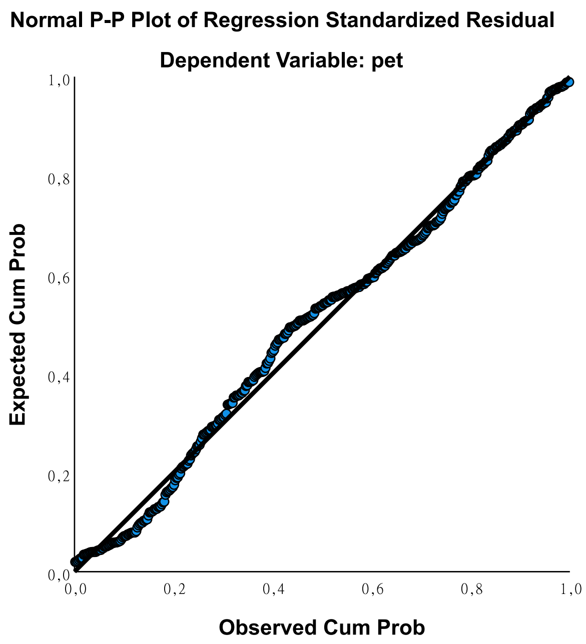

Figure D.12: P-P plot, DV=pet

Source: The author

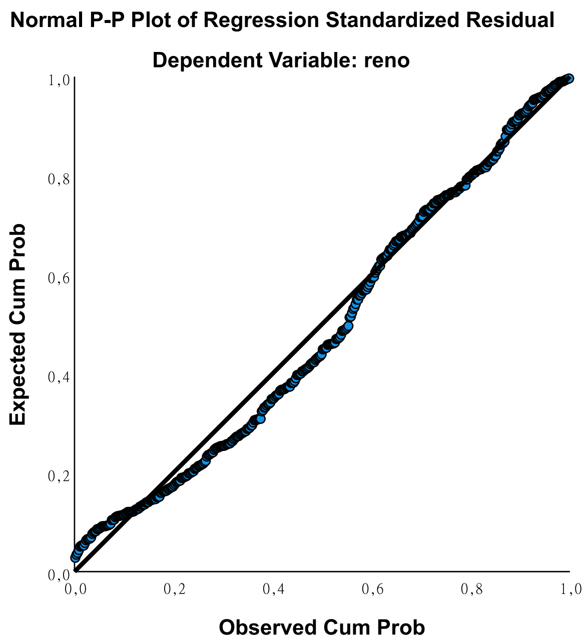

Figure D.13: P-P plot, DV=reno

Source: The author

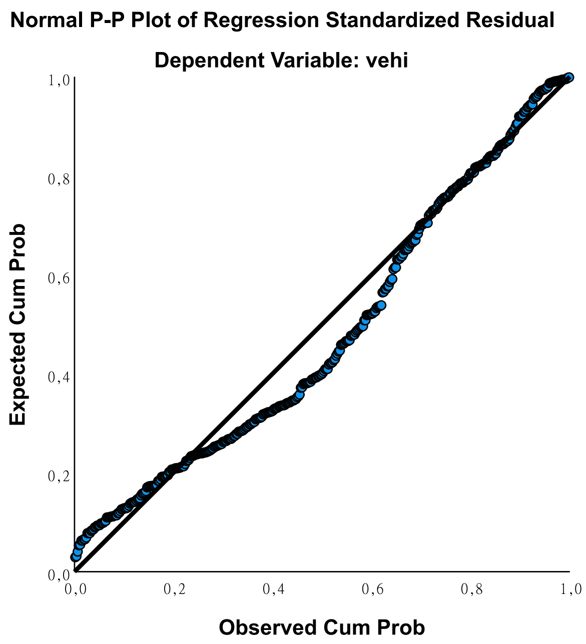

Figure D.14: P-P plot, DV=vehi

Source: The author

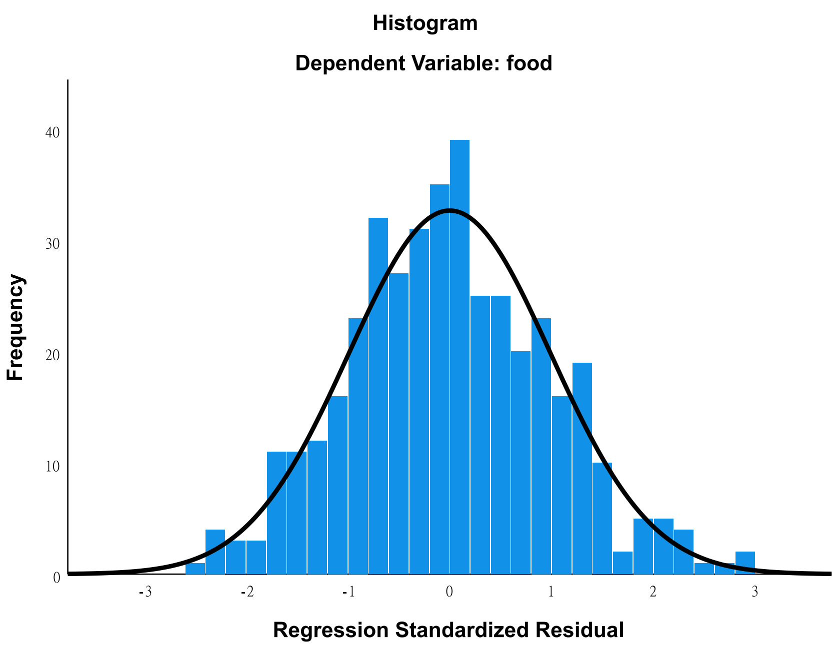

Figure D.15: Histogram, DV=food

Source: The author

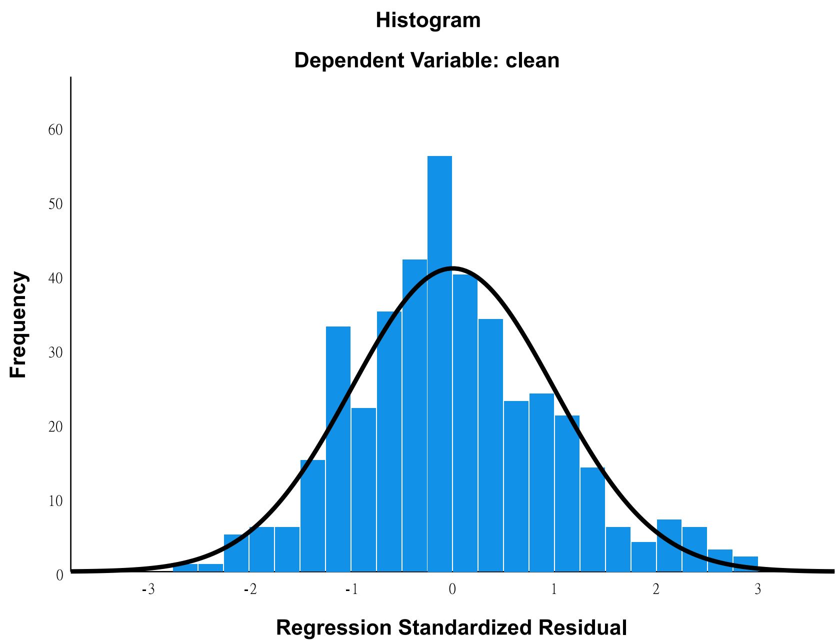

Figure D.16: Histogram, DV=clean

Source: The author

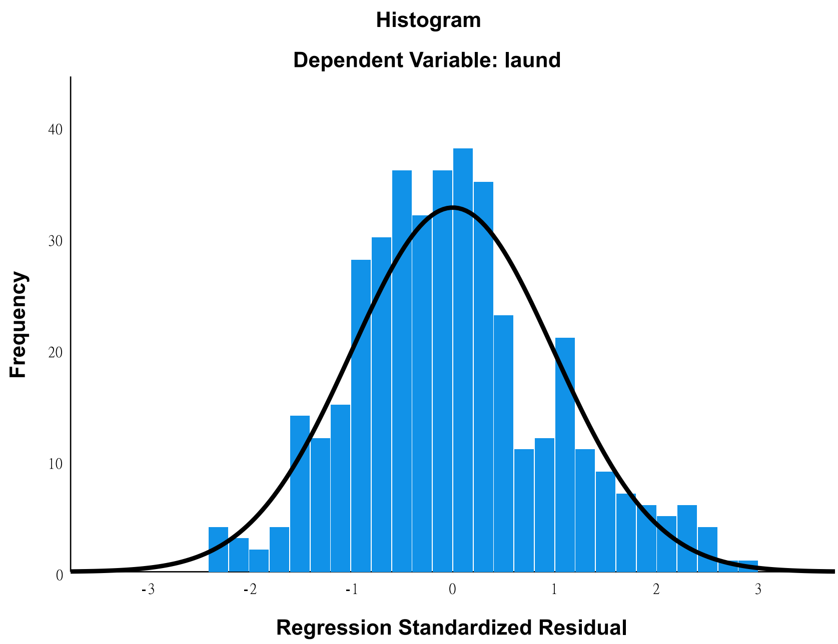

Figure D.17: Histogram, DV=laund

Source: The author

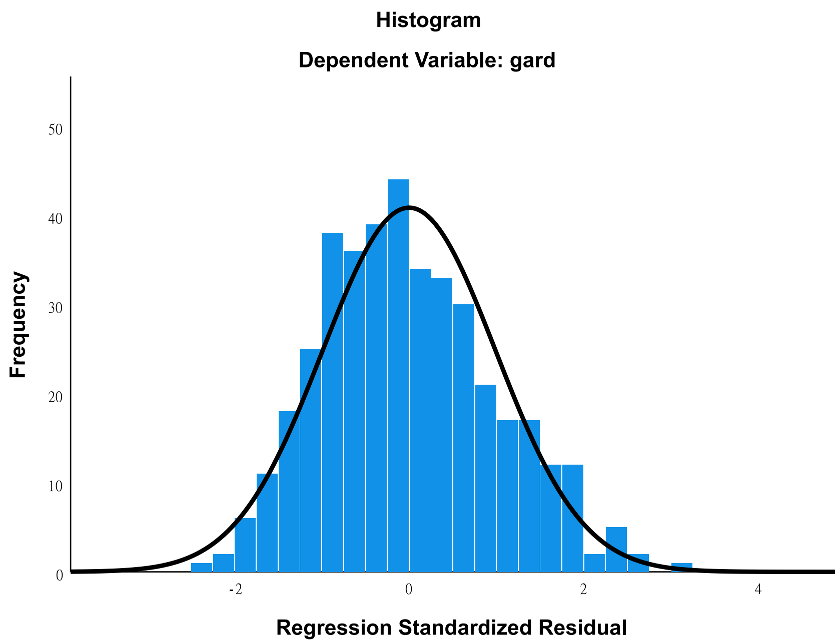

Figure D.18: Histogram, DV=gard

Source: The author

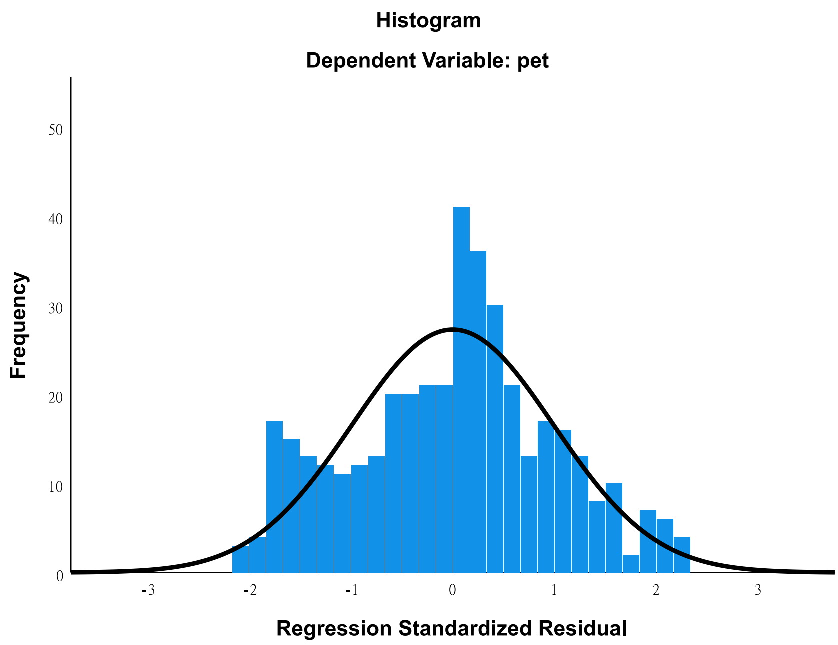

Figure D.19: Histogram, DV=pet

Source: The author

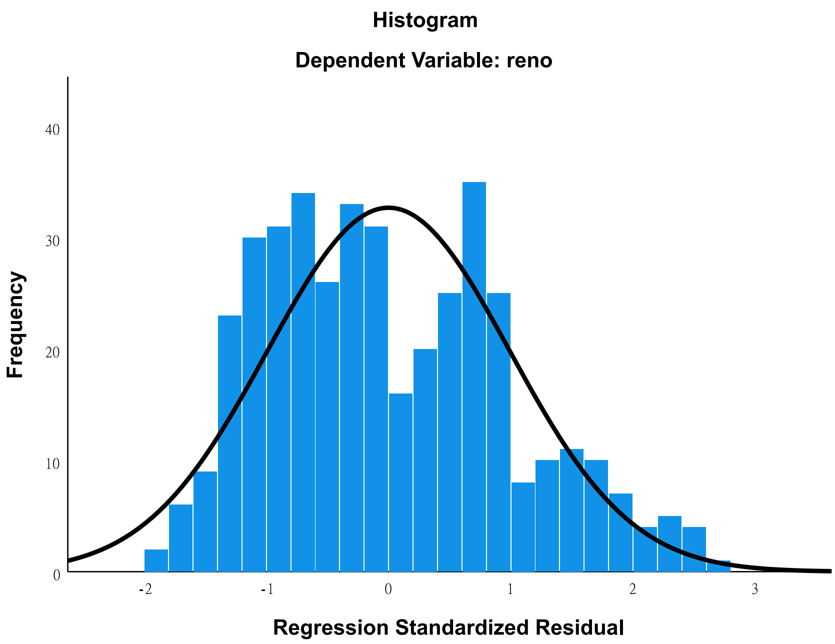

Figure D.20: Histogram, DV=reno

Source: The author

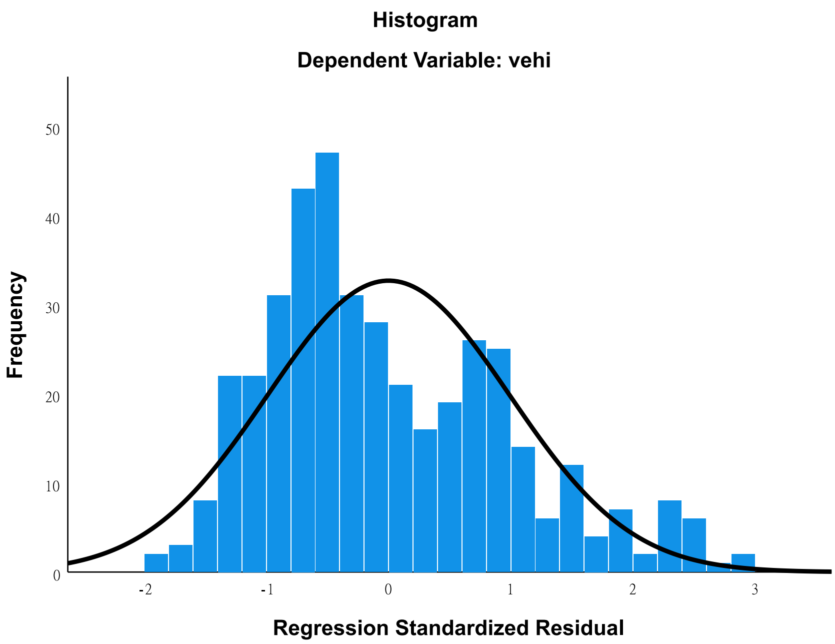

Figure D.21: Histogram, DV=vehi

Source: The author

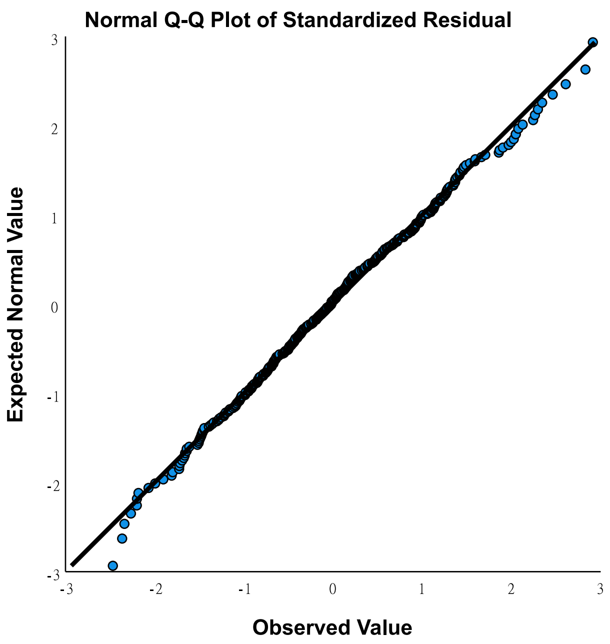

Figure D.22: Q-Q plot, DV=food

Source: The author

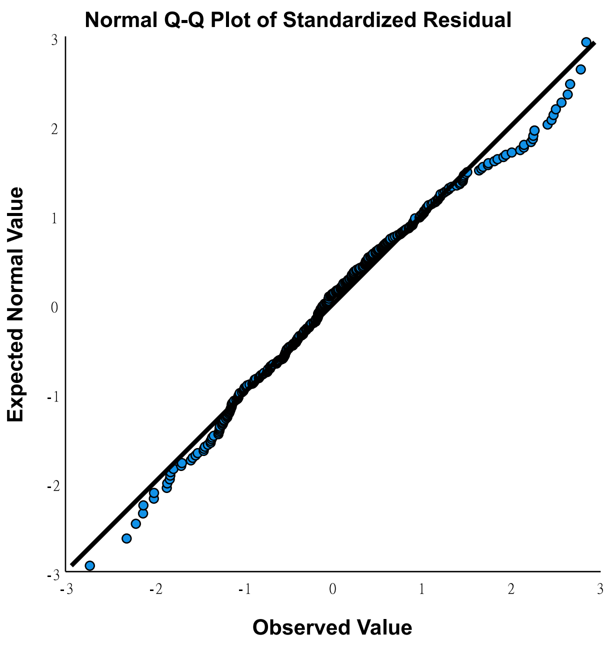

Figure D.23: Q-Q plot, DV=clean

Source: The author

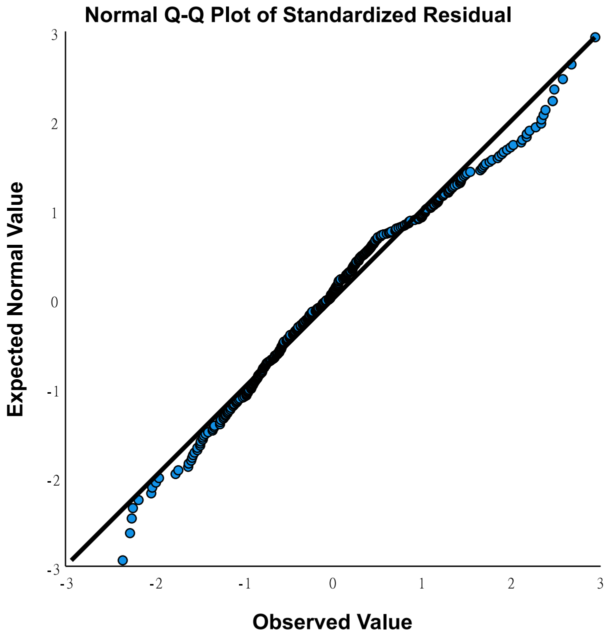

Figure D.24: Q-Q plot, DV=laund

Source: The author

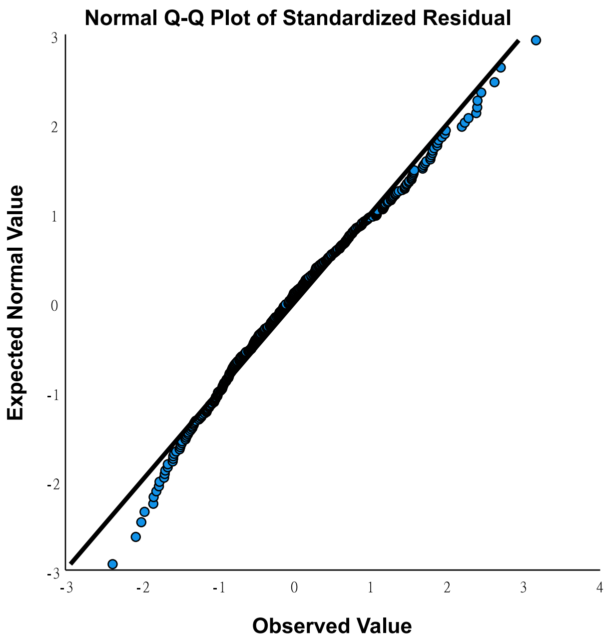

Figure D.25: Q-Q plot, DV=gard

Source: The author

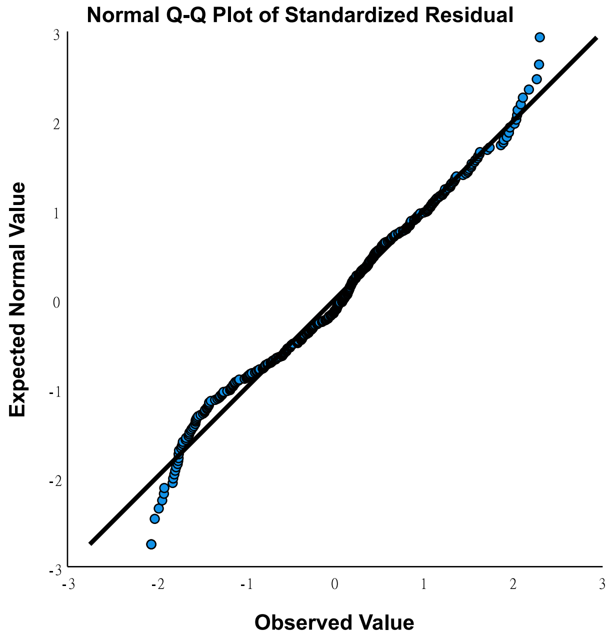

Figure D.26: Q-Q plot, DV=pet

Source: The author

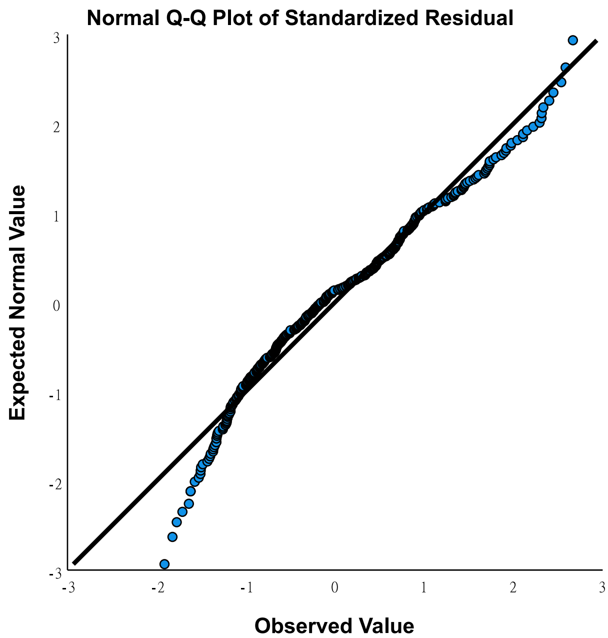

Figure D.27: Q-Q plot, DV=reno

Source: The author

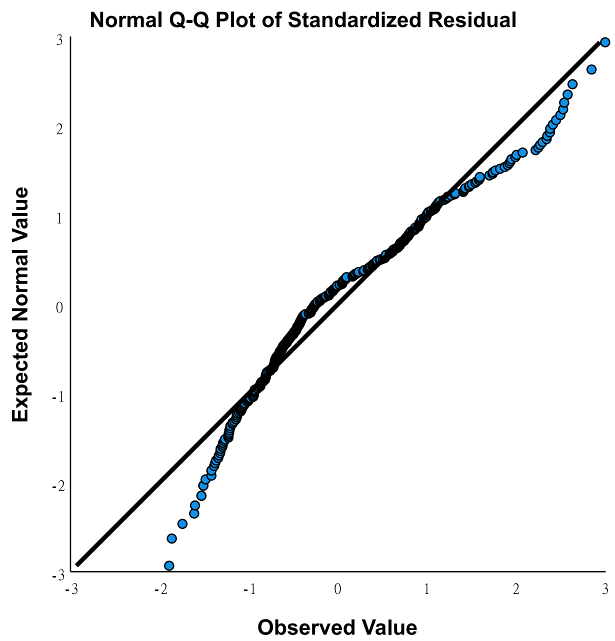

Figure D.28: Q-Q plot, DV=vehi

Source: The author

Autocorrelation

This assumption means that the observations of the error term should be uncorrelated with each other so that no autocorrelation is found in the data. This can be tested using the Durbin-Watson test (Field, 2009). According to Field (2009) a Durbin Watson value of 2 means that the residuals are not correlated and values between 1 and 3 are acceptable. Although this is one of the main assumptions of OLS regression, autocorrelation is relevant for time series data but not for cross sectional data which is used in this study (Schendera, 2008). Therefore, this assumption has not been tested.

Sample Size

The sample size is also important to ensure meaningful results of the regression analysis. The literature offers two general equations that can be applied as a rule of thumb (Green, 1991; Memon et al., 2020; Stoetzer, 2017). If N is the sample size and k the number of independent variables, either equation $N \geq 50 + 8(k)$ or $N \geq 104 + k$ can be suitable. With $k = 7$ predictor variables, the minimum sample size for a multiple regression should be either $N \geq 106$ or $N \geq 111$ (Green, 1991; Memon et al., 2020). This study uses a sample size of $N = 406$ and therefore meets the minimum sample size requirement.