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Visa for competitiveness: foreign workforce and Italian dairy farms' performance

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Abstract

This paper studies the impact of foreign labour on the competitiveness of Italian dairy farms relying on the theory of foreign labour in profit functions. Application of an endogenous switching regression model identifies the drivers of adoption of the immigrant workforce. A counterfactual analysis performed on unit labour costs between farms employing and non-employing immigrants suggests the essential role of foreign farmworkers on dairy farms' competitiveness, which provide a cheaper source of labour. The lower unit labour cost for immigrant workers resembles staunch support to the newly introduced 'social conditionality', for a CAP delivering also for farmworkers.

Keywords: CAP conditionality, farm competitiveness, immigrant workers, endogenous switching regression, labour costs

JEL classification: J43, J61, C34

1. Introduction

The 'globalization of the countryside' shaped the last decades of the agricultural sector, increasing the competition and upstream and downstream pressure on European Union (EU) farms (Corrado, 2015). Among agricultural inputs, labour is a flexible production factor that farm businesses can adjust internally

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in order to widen margins and improve profitability. However, factors such as the seasonality of the farming operations and, consequently, of the labour markets, the low agricultural wages and the hard labour conditions reduce the incentives for domestic workers to engage in agriculture, downsizing the overall offer of domestic EU agricultural labour (Devadoss and Luckstead, 2008; Corrado, 2015). Agri-food systems in high-income countries make up only 10 per cent of the workforce, with the majority of jobs in food processing and services. Urbanised countries rely upon longer food supply chains with marginal roles for agricultural employers, with older, more wage- and immigrant-oriented farms' workforce (Christiaensen, Rutledge and Taylor, 2020). As a result, foreign workers become a necessary source of labour to supply the domestic shortages in many EU Member States (MS), providing flexible and adaptable labour, often at a lower cost (Baldoni, Coderoni and Esposti, 2017; Malchow-Møller *et al.*, 2013; Barham, Melo and Hertz, 2020; Peri and Rutledge, 2020). In the case of Italy, the labour market hosted 11 per cent of foreign workers in 2018, while for the EU-28, the share shrinks to 8 per cent (data from EUROSTAT). According to ISTAT (Italy National Statistical Institute), more than 5 million foreigners were registered in Italy in 2018, which corresponds to about 9 per cent of the total population. About 50 per cent of Italian immigrants are from Europe (30 per cent from the EU-28), 25 per cent from Africa, 20 per cent from Asia and 7 per cent from America. Concerning the Italian agricultural sector, the latest official report points to more than one-third – around 350,000 workers – of farmworkers being foreigners (CREA, 2019). The United Nations Special Rapporteur[1], in January 2020, estimates approximately half a million migrants employed in the farming sector, representing nearly half of the total workforce, of which 40 per cent is estimated to be irregular.

Despite the important economic, social and political implications of foreign workers entering the EU agricultural labour markets, the literature studying their effects on farm's competitiveness is still under development and not clear cut. Indeed, employing foreigners may influence the farm performance through several complex ways. In their empirical application, Baldoni, Coderoni and Esposti (2021) unveil how the cultural diversity of farmworkers affects farm productivity through an inverted U-shaped curve – hence carrying a positive effect up to a certain point, after which the effect turns negative. Overall, this suggests that the net impact depends on a number of factors, including economic, technical and managerial ones. Indeed, our results describe the impact on the competitiveness via lower labour costs, confirming the variety of channels through which immigrant workforce can affect farms' performance. Therefore, micro-level analyses for a thorough understanding are needed (Baldoni, Coderoni and Esposti, 2021), while empirical studies so far widely rely on aggregate data (Devadoss and Luckstead, 2008;

1 See the statement of the UN Special Rapporteur Hilal Elver at: https://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=25512&LangID=E.

Partridge, Rickman and Ali, 2008). Malchow-Møller *et al.* (2013) investigate the role of immigrants on Danish farms' performance, finding that farms employing immigrants are generally larger (in terms of the number of employees, value added and revenues) and not less productive than those who do not hire foreigners. Explanations rely on the fact that migrants may either constitute a cheaper source of labour or bring in specific skills fostering productivity. Baldoni, Coderoni and Esposti (2017) study the role of the immigrant labour force in the Italian agricultural sector, finding that immigrants tend to be concentrated in larger farms with higher productivity levels. However, the authors stress that when a positive correlation exists between foreign labourers and productivity levels, this may stem from model misspecifications as the positive relationship disappears when the dynamic nature of labour productivity is accounted for.

Baldoni, Coderoni and Esposti (2021) focus on the link between immigrant workforce and productivity mimicking constant-wage conditions by controlling for wage differentials. Nevertheless, both anecdotal (Augère-Granier, 2021) and scientific evidence (Malchow-Møller, Munch and Skaksen, 2012; Malchow-Møller *et al.*, 2013) recognise that the immigrant workforce represents an opportunity to reduce farms' labour costs, thus enhancing farms' competitiveness (OECD, 2019). Nevertheless, much of the research efforts applied to the US context: Barham, Melo and Hertz (2020) offer recent evidence of lower wages for agricultural immigrant workers in the United States than nationals. Peri and Rutledge (2020) study the wage gaps between immigrant and national workers, finding that agriculture displays the highest wage differential of up to 55 per cent with a slow rate of convergence among different economic sectors. Martin and Taylor (2003) show a circular relation between farm employment and immigration, which, in turn, during the 90s, fuelled the poverty rate in rural America, suggesting that low-skilled farm jobs are taken up by migrants, who transfer poverty from their country of origin to the United States.

Overall, there is a paucity of empirical works investigating the role of the immigrant workforce within the EU agricultural sector, especially from the microeconomics perspective. The existing literature mainly focuses on the relationship between immigrants and the farm's productivity, with no contribution assessing whether differentials exist between national and foreign workers' labour cost, the latter being a significant leverage for farms' competitiveness. Therefore, the present case study contributes to fill these gaps, providing fresh insights on the linkages between immigrant farmworkers and farm competitiveness in Italy, one of the most emblematic EU agricultural sectors. From a microeconomic perspective, the present study concludes that the immigrant workforce is a resource for enhancing farm competitiveness, lightening the economic burden of labour costs. Moreover, we give first inputs on which farms' and farmers' characteristics, including different Common Agricultural Policy (CAP) instruments, explain the adoption of migrant labour force. The recent open letter[2] signed by many influential people and organisations in both agricultural and labour sectors utterly heated up the socio-political debate on working conditions in the EU agricultural sector. The signatories explicitly call for the inclusion of a social conditionality in the upcoming CAP: beyond the ethical considerations, it will ensure protection to those farmers respecting workers' rights but suffering from unfair competition from those farmers that do not. Eventually, the agreement on the CAP 2023–2027, reached in June 2021, includes the social conditionality as a requisite for receiving public EU subsidies (European Parliament, 2021). Therefore, violating labour rights (e.g. poor wages) is an explicit strategy for increasing the farm's competitiveness, and the COVID-19 pandemic exposed the pivotal role of immigrants for much of the EU agricultural sectors (European Commission, 2020).

Our analysis is rooted in literature, from which the following scenarios can be derived: (i) according to neoclassical growth models, immigration constitutes a simple upwards shift of the labour supply, with no effects on competitiveness per se (e.g. labour productivity grows because of the growth of total factor productivity); (ii) foreign workers can entail negative impacts due to the lack of integration, communication problems with co-workers and managers (Baldoni, Coderoni and Esposti, 2021) and lack of experience and expertise in agricultural duties (Peri, 2012); (iii) foreign workers may receive lower wages than their national counterparts, generating cost-efficient, positive effects on farm performance and hence competitiveness (Malchow-Møller *et al.*, 2013); (iv) employing immigrants may bear some fixed costs that only some farms with specific characteristics are more likely to sustain (Malchow-Møller *et al.*, 2013).

The present study provides policy-relevant pieces of empirical evidences. First, foreign labour force exerts a generally positive impact on farms' labour costs by reducing unit labour costs (ULC), entailing positive feedback for competitiveness. Second, there are factors related to the farm, such as the farm size and its location, the farmers' characteristics, such as education, but also specific CAP measures that are correlated with the use of immigrant workers. Results offer support to policymakers for the design of interventions aimed at smoothing the inclusion of migrant workers in the farm sector, besides giving insights on the role of CAP instruments, particularly useful for the recently agreed social conditionality on which the upcoming EU agricultural policy will hinge on.

The Endogenous Switching Regression (ESR) model resembles a powerful tool to study the determinants of employing/non-employing foreign workers and perform a counterfactual analysis while correcting for potential endogeneity bias. The empirical analysis focuses on the Italian dairy sector using a panel dataset of 10,138 observations for dairy farms covering the period 2008–2018.

2 'The New Cap Needs Social Conditionality. End exploitation and raise labour standards in European agriculture'. For the full text, please visit: https://effat.org/wp-content/uploads/2021/02/Open-Letter-The-new-CAP-needs-Social-Conditionality-With-signatories-1.pdf.

We focus on the Italian dairy sector as in last decades it showed a significant substitution of national workers with foreigners and, due to its non-seasonal nature and requiring a certain degree of specialisation, the farmworkers' turnover is usually lower than other agricultural sectors. These characteristics may better capture the influence of immigrant workers on farm performances in spite of potential data limitations such as under-recording of working hours.

The paper is structured as follows: the next section describes the current situation regarding the use of foreign labour in the Italian farming and dairy sector. Section 3 presents the theoretical background informing the econometric strategy developed in Section 4. Section 5 reports the data used and describes the econometric specification of the applied model. Section 6 discusses the results, while the last section concludes, developing policy considerations and implications.

2. Foreign labour in the Italian dairy sector

Currently, immigrant employees are an irreplaceable source of labour for many agricultural sectors in Italy.[3] This is due not only to the low attractiveness of agricultural jobs for the national workers but also to structural dynamics typical of the Italian agricultural systems that constrain the availability of labour: the large number of people exiting the sector; the ageing of farms owners and the lack of successors (Coopmans *et al.*, 2021); hence the decreasing amount of unpaid and family labour (see Christiaensen, Rutledge and Taylor (2020) for more details on the global trends). The *Statistical Report on Immigration* (Idos, and Confronti, 2002) highlights that farming is the sector where newly arrived migrant workers start their job search. The latest official report on foreign workers in Italian agriculture (CREA, 2019) calculates that in 2017 more than one-third of the total agricultural employees were foreigners.[4,5] In terms of internal distribution, the *Italian Ministry of Labour and Social Policies* reports that in 2017 most of the migrant workers were located in the Italian North-Eastern regions (27 per cent), followed by South (24 per cent), Centre (21 per cent), North-West (18 per cent) and, finally, Islands (10 per cent) (Ministero del Lavoro e delle Politiche Sociali, 2018).

The uncertain contractual conditions and the urgency of migrants to obtain a source of income to sustain their families and their own living, lead to the proliferation of illicit practices such as the *caporalato*, an informal system of recruit-and-control of farmworkers, especially migrants, characterised by

3 On the total legal immigrants on the Italian territory, CREA (2019) details 9 per cent works in agriculture, 17 per cent in the manufactural sector, 10 per cent in the building sector, 21 per cent in restaurants, hotels, and other commercial activities, while 46 per cent in other services (e.g. caring).

4 In the present study, the terms *immigrant, foreign*, and *migrant* are used to designate persons who are not Italian. On the contrary, *national* is an Italian person.

5 See Table A2 in the Appendix for more details on how the immigrant workforce is distributed among different agricultural sectors in 2018 according to the Italian FADN.

exploitation (Fanizza and Omizziolo, 2019; Salvia, 2020). This creates a network of 'under-the-table' intermediaries who play a pivotal role in the current equilibrium of the agricultural labour market in some Italian regions. Moreover, it creates problems of under- and mis-reporting – that is, declaring a lower amount of time worked to what was carried out or when workers perform activities that are different from what the signed contract refers to – representing the most common example of illegal work practices (INEA, 2013).[6] Corrado (2015) reports that only 43 per cent of agricultural foreign work situations are entirely legal, while 29 per cent are partially lawful (i.e. under-reporting) and 28 per cent fully unlawful. Because of the lack of complete information regarding immigrant labour, it is difficult to evaluate the actual impact on the agricultural sector and its competitiveness. The informal contractual relationships and the illegally low wages can significantly reduce the production costs providing biased pictures of the cost-effectiveness.

The dairy sector requires specific skills and specialisation – cow husbandry, milking, milk processing and cheese production – and hard work conditions such as large amounts of early working hours. These factors make this job less attractive for national workers, being substituted by the immigrant workforce (Fondazione FAI, and CISL, 2017; Nori and Farinella, 2020b). Moreover, milk production is not as seasonal as the fruit and vegetable sectors and requires a stable workforce hired via permanent contracts and specialising on specific phases of the production processes (Huffman and Evenson, 2001; Nori and Farinella, 2020a). In value terms, the production of cow milk accounts for 9 per cent of the whole agricultural production (32 billion euro in 2018), while the transformation phase around 12 per cent of the total food production. With approximately 27,000 dairy farms, more than 50 per cent are small farms (i.e. <30 heads), producing 4 per cent of total production only; while big dairy units (i.e. >150 heads) represent less than one-fourth of total agricultural units, although producing almost 80 per cent of the total raw milk. The weight of labour on total costs range from 11 per cent to 19 per cent, depending on the farm size and production (e.g. Protected Designation of Origins (PDOs) cheese or raw fluid milk) (ISMEA, 2019).

Figure 1 describes the labour trends in the sample of Italian dairies used in the present study, highlighting the increasing role of migrants in dairy farm employees, together with the negative trend of domestic labour and the stagnant-to-decreasing role of unpaid (family) worked hours.

The qualitative analysis of the dataset used in the present study also reveals interesting patterns regarding wages between immigrant and national farmworkers. Analysing farms that solely employ either nationals or immigrants permits to obtain crystal-clear data concerning their hourly retribution.

6 See also the statement of Hilal Elver, United Nations Special Rapporteur, on the right to food in Italy in January 2020 at: https://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=25512&LangID=E.

Figure 2 illustrates how immigrant farmworkers generally receive lower per-hour wages than nationals.[7] Specifically, when we compare the hourly wage by contract typologies (i.e. seasonal and non-seasonal), such differential is sharper: foreigners employed as seasonal workers receive 1.10 Euro less per hour worked than the national counterparts, while for non-seasonal working contracts such difference rises to 1.85 Euro per working hour.

3. Theoretical background

The contribution of foreign labour to a dairy farm's profit is described by the general profit function developed by Malchow-Møller *et al.*, (2013), defined as a production function of national and immigrant labour inputs, L_i^N, L_i^I, respectively, minus the costs related to each of the two inputs (C^N and C_i^I, respectively):

$$\pi_i = f_i\left(L_i^N, L_i^I\right) - C^N\left(L_i^N\right) - C_i^I\left(L_i^I\right) \quad (1)$$

The costs associated with national labour are assumed to be equal for all dairy units[8], while immigrant labour costs are farm specific, depending on farms' characteristics and experience. Therefore, each farm is characterised by

7 The statistic retrieved is the median value to avoid misleading outliers effects. The non-seasonal category refers to farmworkers with either permanent or fixed-term contracts.

8 Despite this assumption as per Malchow-Møller *et al.,* (2013), the cost of hiring national farmworkers may also be farm specific (C_i^N), for instance, because of local-specific supply conditions. Please note that such assumptions do not change the theoretical background. Due to the specific focus the present study devotes to immigrant workers and farm-specific factors shaping their employment, we prefer to assume homogeneous cross-farms hiring costs.

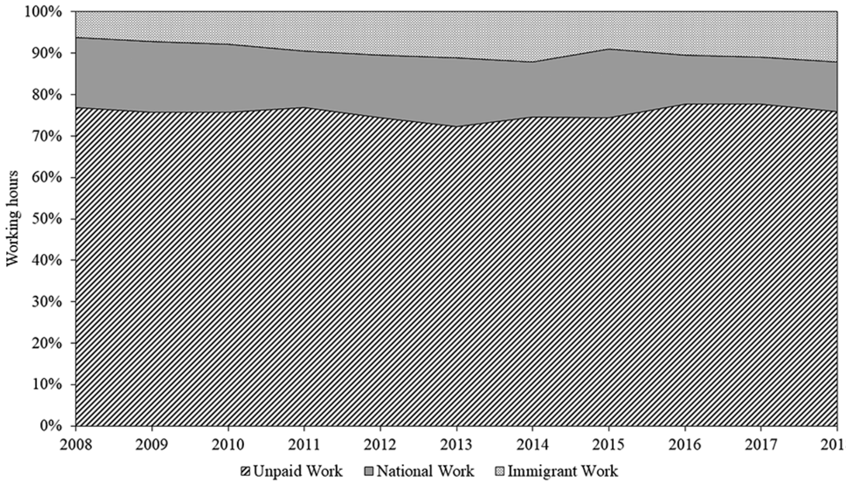

Fig. 1. Average working hours per type of workforce: unpaid, national and immigrant. Italian dairy sector, 2008–2018.
Source: Authors' elaboration on the Italian FADN.

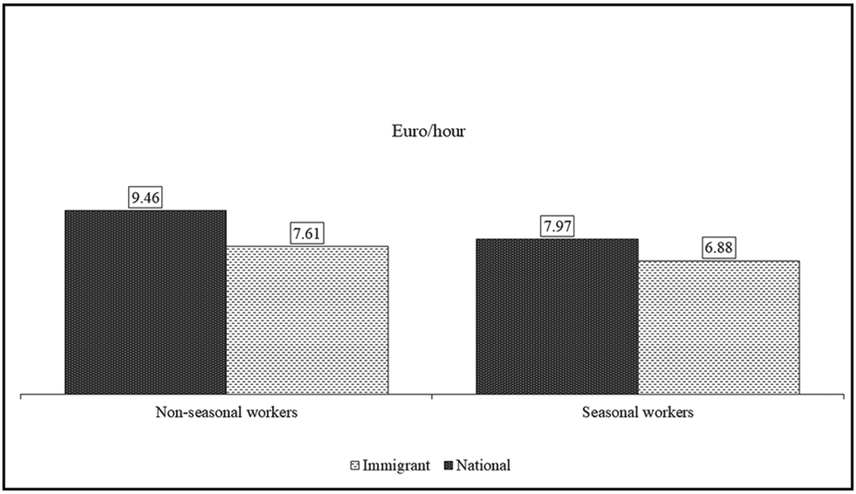

Fig. 2. Median hourly retribution per type of contract (seasonal and non-seasonal) and farmworkers' origin in the Italian dairy sector, 2008–2018.
Source: Authors' elaboration on the Italian FADN.

farm-specific foreign workers' wage and fixed costs (e.g. search and administrative costs and costs related to the integration of the farmworker), with the latter characterised by increasing marginal costs whenever the local labour supply is limited. By defining L_i^* and L_i^{I*} as the optimal amounts of national and immigrant farm labour, and L_i as the total amount of labour, there are three potential scenarios:

$$(a) : \pi_i = f_i(L_i) - C(L_i), as\ C^N(L_i^N) = C_i^I(L_i^I); \tag{2}$$

$$(b) : C^N\left(L_i^*\right) > C_i^I\left(L_i^{I*}\right) + C^N\left(L_i^* - L_i^I\right); L_i^I \in \left(0, L_i^*\right] \tag{3}$$

$$(c) : \pi_i = f_i\left(L_i^N, L_i^I\right) - C^N\left(L_i^N\right) - C_i^I\left(L_i^I\right) - fc_0 * I\left(L_i^I > 0\right) \tag{4}$$

In scenario (a), national and immigrant labour inputs are perfect substitutes with the same cost; therefore, the farmer is indifferent to hiring nationals or immigrant workers and one may expect no effects on farm performances. In this scenario, foreigners are just an increase in total agricultural labour offer.

In scenario (b), the cost of immigrant labour is lower than national cost; therefore, the adoption of foreign labour minimizes the dairy farm's total labour cost, $C_i^I\left(L_i^{I*}\right) + C^N\left(L_i^* - L_i^I\right)$. The lower cost of immigrant labour can be due to lower wages or to the higher productivity of immigrants producing the same output but at a lower cost.

Finally, in scenario (c), the access (or cost) to immigrant labour is farm specific because of factors such as farm location and the availability of immigrant workers in the local labour market (e.g. certain areas may attract more immigrants because of the presence of ethnic enclaves), the farmer's attitude towards foreigners or a different marginal cost of employing migrants. In this scenario, the adoption of foreign labour can affect the farms' performance in two ways: first, because there are additional strictly positive fixed costs (fc_0) of adopting foreign labour increasing the total production costs, activated only when immigrant farmworkers are employed ($fc_0 * I(L_i^I > 0)$). Such fixed costs can be, for example, costs of integration depending on the farm's experience in dealing with foreign workers. This can raise self-selection issues as only the already competitive farms, or the largest ones relying on economies of scale, can sustain the additional fixed costs. As assumed by Malchow-Møller *et al.* (2013), the adoption of foreign workers can be a consequence of the insufficient offer of national workers, resulting in negative effects of immigrants on the dairy farm's competitiveness when more expensive or less skilled. In addition, lower competitiveness can be due to the farm's location: in marginal and less developed rural areas with lower availability of domestic labour, less competitive farms have incentives in adopting foreign workers. On the contrary, some dairy farms may have more access to skilled migrant workers, improving the farm's competitiveness.

In summary, based on the Malchow-Møller *et al.,* (2013) theoretical work described above, the main factors influencing the adoption of immigrant labour are: (i) the farm and farmer characteristics and (ii) the impact of immigrant labour on dairy farm's total labour costs. These factors act simultaneously and we formalize them in the following hypothesis, helping in structuring the empirical strategy:

H1: Farms' and farmers' characteristics, including CAP measures, significantly influence the likelihood of employing foreign workers;
H2: The adoption of foreign labour relates to lower total labour costs, improving dairy farms' competitiveness.

4. Econometric strategy

The ESR allows to both identify the drivers of adoption of foreign labour and to execute a counterfactual analysis on the impact of immigrant workers on the farm's ULC. Therefore, it is used to test both hypotheses H1 and H2.

Employing immigrants may be a strategic decision allowing to reduce costs and thus increase the competitiveness, posing a self-selection problem and eliciting an endogeneity bias, as certain (unobserved) characteristics potentially affect the farmers' choice. The ESR allows for bias-corrected estimates via the simultaneous estimation of the choice of hiring immigrant workers and the farms' ULC for employing and non-employing[9] immigrants.

9 Note that the terms 'employing' and 'treated', as well as 'non-employing' and 'untreated', are used to designate farms employing and non-employing immigrants, respectively. Defining the

The ESR generates selection-corrected (expected) ULC estimates for both employing and non-employing, delivering unbiased treatment effects (i.e. the choice of employing immigrants) for both treated and untreated farms (Di Falco, Veronesi and Yesuf, 2011; Di Falco, 2014). The statistically significant difference in ULC between farms employing and not employing immigrants would resemble a test for the substitution effect, answering to the question posed by scenario (a).

The choice of ESR is motivated by the following reasons: (i) simple regression models (i.e. OLS) would not allow controlling for unobserved farms' and farmers characteristics – both potentially correlated with the choice of hiring immigrants and the ULC – leading to a biased treatment effect (Fuglie and Bosch, 1995; Di Falco, Veronesi and Yesuf, 2011); (ii) matching techniques (e.g. propensity score matching) allows to control only for the observed heterogeneity but not for selection bias (Bairagi, Mishra and Durand-Morat, 2020; Läpple, Hennessy and Newman, 2013); (iii) difference-in-differences (D-i-D) approaches require data to be collected for both the treatment and control groups before and after the employment of foreign workers, which would lead to a significant loss of information given the unbalanced panel of Italian farms used for this study (Vigani and Kathage, 2019). The ESR falls into the IV approach, estimating a selection equation based on a probability model (first stage) and two continuous ULC equations, one for each treatment condition (second stage) simultaneously (Fuglie and Bosch, 1995; Di Falco, Veronesi and Yesuf, 2011; Magrini and Vigani, 2016).

The first stage is described by equation (5) and represents a *probit* selection model distinguishing between farms employing and non-employing foreign labour, where farmers choose whether to employ foreigners to minimize costs. We assume that observations are independent of each other and that the choice of employing immigrant workers is a function of exogenous variables Z_i, such as observable farmers' and farms characteristics, and cost-related elements. The latent variable A_i^* captures the different level of ULC, and farms adopt foreign labour ($A_i = 1$) only when such choice minimizes the ULC:

$$A_i^* = Z_i\alpha + \eta_i \; with \; A_i = \begin{cases} 1 & if\, A_i^* > 0 \\ 0 & otherwise \end{cases}, \tag{5}$$

where η_i are *iid* error terms capturing unobservable factors, such as the experience in handling immigrant workers or the attitude towards foreigners. The output of the first stage hence answers H1, revealing the farm's and farmer's characteristics influencing the likelihood of employing immigrants. Moreover, concerning CAP, results will give insights on which policy instruments foster or hinder the choice of employing immigrant workers by farms.

In the second stage, we estimate the effect of employing immigrants on the dairy farm-specific ULC (y_{mi}) under the two regimes m, where $m = 1$ indicates

employment of foreigners as the treatment, treated farms are those that actually employ them. The same applies to the definition of untreated farms.

the adoption of foreign labour and $m = 2$ indicates non-adoption:

$$Regime\ 1 : y_{1i} = X_{1i}\beta_1 + \varepsilon_{1i}\ if\ A_i = 1 \tag{5.1}$$

$$Regime\ 2 : y_{2i} = X_{2i}\beta_2 + \varepsilon_{2i}\ if\ A_i = 0 \tag{5.2}$$

X_{mi} is a vector of exogenous variables influencing the ULC, and ε_i are iid error terms. If the error terms η_i in the selection equation (5), and ε_{mi} in equations (5.1) and (5.2) are correlated, OLS estimates are inconsistent; hence, correction is needed. Therefore, the inverse mills ratio evaluated at $Z_i\alpha$ is included in equations (5.1) and (5.2) to correct for selection bias (Maddala, 1983; Kleemann, Abdulai and Buss, 2014). Through this procedure, and following Heckman, Tobias and Vytlacil (2001), counterfactuals are developed to test H2 through the estimation of the effect of adopting foreign workers (the treatment) on the treated farms (TT) and the effect of the treatment on the untreated farms (TU). Indeed, both TT and TU will provide insights on whether and how the choice of (not)employing immigrant workers affects the ULC, hence the farm's competitiveness (see the Appendix for more details on the ESR).

The full information maximum likelihood estimator ensures the highest efficiency in estimating simultaneously the binary and continuous equations of the ESR, deriving consistent standard errors and estimating the correlation ρ_j between ε_j and η. A significant ρ_j indicates the presence of endogenous switching, hence sample selectivity bias (Lokshin and Sajaia, 2004; Di Falco, Veronesi and Yesuf, 2011; Läpple, Hennessy and Newman, 2013; Ma and Abdulai, 2016; Amadu, McNamara and Miller, 2020).

Finally, for correct identification, vector $Z_i\alpha$ in equation (5) must contain at least one additional variable than those included in the vector $X_{ki}\beta_j$ in equations (5.1) and (5.2). A valid selection instrument would affect the farm decision of employing immigrants only, casting no effect on the ULC. This prevents relying exclusively on the exclusion restrictions automatically generated by the non-linearity of the selection model. Falsification tests are hence conducted to establish the admissibility of these selection instruments (Di Falco, Veronesi and Yesuf, 2011; Di Falco and Veronesi, 2013; Di Falco, 2014; Vigani and Kathage, 2019).

4.1. Instrumental variable strategy

The ESR requires valid identification variable(s) correlated to the choice of hiring immigrants and not to the outcome equations of ULC. According to both sociology and labour economics studies, the so-called 'network effect' provides a significant source of information to prospective migrants (Massey *et al.*, 1993; Munshi, 2003; Bertoli and Ruyssen, 2018). Therefore, immigrants tend to cluster where higher shares of conational already exist (Moreno-Galbis and Tritah, 2016), often looking for employment in the same occupation (Edin, Fredriksson and Aslund, 2003; Beaman, 2012), with employers using these networks as a screening for potential workers (Patel and Vella, 2013). Hoxhaj (2015) recently found significant positive influence of networks on illegal immigrants entering on the Italian territory. In light of these findings, we built a first instrument (i.e. *Networks*) as the share of newly entered immigrants during each year – with a valid permit – over the total immigrant population per province. This allows to proxy the strength of the local immigrant network: the stronger the ability of local networks to attract conational, the higher the share of new entries with respect to the already-existing immigrant population. Hence, farms located within provinces with strong attractiveness for foreign migrants are expected to have higher likelihood of employing immigrants.

The study of Basile *et al.* (2021) recently concludes on the significant displacement effect of immigrant entrants on the mobility of Italians, especially those low skilled, confirming the findings of Mocetti and Porello (2010) at a more disaggregated level. Such dynamics are explained as the 'skating-rink' model: when immigrants bear with the same skill set of domestic workers, particularly low-skilled workers, there may exist more direct competition for jobs. Therefore, foreign workers entering the local economy do not entail any effect on both employment and wages: natives with similar skills usually move out of the local labour markets. (Card and DiNardo, 2000). Therefore, we introduced a second instrument (i.e. *Native Out-Migration Rate*) as the share of Italian nationals exiting the province on the total Italian population at the province level. Such a share wants to mimic the displacement effect of immigrants; hence, we expect that the higher the outflow of natives per province, the more likely farms located in the area employ immigrants.

As argued by Mocetti and Porello (2010), powerful trade unions are traditional traits of the Italian economy, with centralised bargaining and strong regulations of the labour market, restricting adjustments to labour shocks more on the quantity rather than the wage side. In light of this, and adding to the skating-ring model, both instruments[10] do not influence the farm-specific ULC but do have an effect on the decision to employ foreigners. Finally, the recent comprehensive literature review of Edo (2019) on the impact of immigration on developed economies in terms of wage and employment shed more light on the issue. Indeed, the author concludes that, despite being controversial, the overall impact of immigrants on the average native's wage levels is negligible or, at most, positive.

5. Data and econometric specifications

The data used for the analyses are retrieved from the Italian Farm Accountancy Data Network (FADN)[11], extracting the farm category 'specialist milk'[12] for the period 2008–2018. This constitutes an unbalanced panel of 2,888 dairy

10 Both instruments were built relying on data provided by the Italian National Institute of Statistics (ISTAT).

11 The authors are grateful to the CREA-PB of Rome (Italy) for providing the data.

12 This is as the European Commission defines those farms having ¾ of total grazing livestock as dairy cows (see the EC regulation 1242/2008).

farms representatively distributed in all the Italian regions for a total of 10,138 observations.

Concerning the ESR, the selection equation (5) hinges on a binary variable, taking the value 1 if the farm employs migrant workers and 0 otherwise, with above 17 per cent of the sample adopting immigrant workforce (i.e. 503 dairy farms).

The dependent variable of the outcome equations (5.1) and (5.2) is the total labour cost per Euro of output, *ULC*, calculated as: $ULC_{it} = \left[Salary_{Taxes\,it} + \left(hourlyOC_{it} * unpaid\_hours_{it}\right)\right] / TotalOutput$, where $Salary\_Taxes_{it}$ is the total farm's expense in salaries and social security taxes (i.e. including taxes paid on the family labour); $hourlyOC_{it}$ is the farm-specific hourly opportunity costs for unpaid workers[13]; $unpaid\_hours_{it}$ is the total amount of hours worked by family (unpaid) members and *TotalOutput* is the (deflated) economic result of the farm at the end of the year. ULC hence measures the average cost of labour per unit of economic output, representing a valid measure of competitiveness (OECD, 2019).

Covariates in equations (5), (5.1) and (5.2) are a set of farmer and farm characteristics used in the literature related to the attitude towards and drivers of adopting foreign labour and dairies' cost structure. Among the farmers' characteristics, the farm holder's age is expected to negatively affect the choice of hiring foreigners as considered a proxy of conservatism (Semyonov, Raijman and Gorodzeisky, 2006; Hainmueller and Hiscox, 2007; Weber, 2019), besides being a pivotal factor for investment decisions and, consequently, for elaborating strategies that may ameliorate the farm cost-efficiency (e.g. Tauer and Mishra (2006) find old farmers to be less cost efficient); male gender is also a proxy for more conservatism, as females showed more positive attitudes (O'Rourke and Sinnott, 2006; Vecchione *et al.*, 2012). On the contrary, the higher the educational level ('None', 'Secondary School and Professional School', 'High School' and 'University Degree') the more supportive the individual towards immigrants because of a lower level of ethnocentrism and an optimistic view about their economic impacts (Coenders and Scheepers, 2003; Ivarsflaten, 2005; Hanson and Bell, 2007; Hainmueller and Hopkins, 2014). Finally, socioeconomically vulnerable individuals, such as the low-income population, are more prone to negative attitudes towards immigrants (Esses *et al.*, 2001; Scheepers, Gijsberts and Coenders, 2002; Gorodzeisky and Semyonov, 2016); thus, the level of off-farm income ('0 to 2,000 Euro', '2,001 to 10,400 Euro', '10,401 to 15,600 Euro' and 'Over 15,600 Euro') is included, expecting that the higher the income, the more likely is the farm to employ foreigners. Off-farm revenues may also prevent farms in difficult economic conditions from leaving the market (Wieck and Heckelei, 2007).

Among the farms' characteristics, we use both binary and continuous numerical variables. The binary variables are the following: (i) 1 if the farm is located in mountain areas (0 otherwise), a proxy for marginal or

13 This is a ready-to-use variable available from the Italian FADN that is assessed during the survey based on the local characteristics of the labour market.

less-developed areas, associated with higher conservatism (Gorodzeisky and Semyonov, 2016), unfavourable production conditions with higher expenses for variable inputs and machinery (Wieck and Heckelei, 2007) and lacking public services such as infrastructure (Limao and Venables, 2001); similarly, one may expect farms located in lowlands to be more likely to hire immigrants, especially because of the easier access to the farm for immigrants (i.e. 1 if the farm is located in lowland areas and 0 otherwise); (ii) 1 if the farm is diversified[14] (0 otherwise) as high diversification entails a larger volume of tasks to be carried out, hence a potential higher demand of labour; (iii) 1 if the farm falls in the category of large farms[15] (0 otherwise), as farm size may influence the number of hired workers, the cost structure due to diverse animal health and disease management and more efficient use of assets (Dong *et al.*, 2016; Mosheim and Lovell, 2009); in a similar but opposite fashion, one may expect small farms to be less likely to hire immigrant farmworkers (i.e. 1 if the farm is categorised as 'small' and 0 otherwise).

Regarding continuous variables on farms' characteristics, we include: (i) the amount of grassland for their impact on the cost structure (Zimmermann and Heckelei, 2012); (ii) the total value of machinery in the last decades (Dong *et al.*, 2016), which has reduced costs by increasing labour efficiency; (iii) the absolute value of new investments as a proxy for technical innovation, as new investments would face lower marginal costs ameliorating the farm's cost efficiency (Wieck and Heckelei, 2007), and farmers unwilling (or unable) to invest in new technologies are more likely to have lower competitiveness and of exiting the sector (Zimmermann and Heckelei, 2012); (iv) the intensity of contract work per farm as the total expense in contract work and the share of rented land over the total available land (UAA) because of their potential effects on the labour cost structure (Eaton and Shepherd, 2001; Garrone *et al.*, 2019).

An important element affecting the farms' decisions concerning input use and allocation, especially labour, is the CAP support. Empirical evidence shows heterogeneous effects within the CAP portfolio with respect to labour, especially between Pillar I and Pillar II (Olper *et al.*, 2014; Garrone *et al.*, 2019), coupled and decoupled payments (Petrick and Zier, 2011, 2012) and environmental and investments measures (Pufahl and Weiss, 2009). Hence, due to the potential mixed and measure-specific effects, we disaggregate CAP payments received by dairy farms into five groups: (i) Coupled Direct Payments (CDP), coupled to the number of livestock or cropped land hectares; (ii) Decoupled Direct Payments (DDP); (iii) Agri-environmental schemes (AES); (iv) other annual payments from Rural Development Policy (RDP) – such as Less Favoured Areas (LFA); (v) Other Rural Development subsidies, such

14 When diversified, the farm offers further services beyond the typical farming activity (e.g. hospitality services, such as restaurant and/or accommodation).

15 According to the Italian FADN (personal communication), relying upon the economic dimension of the farm, the latter is defined as Small (up to 24,999 Euro), Medium (from 25,000 to 99,999 Euro), and Large (over 99,999 Euro).

as investment aids (see Biagini, Antonioli and Severini (2020) for a more thorough description of CAP implementation in Italy).

Finally, to exploit the panel nature of our dataset, we apply the Mundlak (1978) fixed effects (Wooldridge, 2010; Di Falco and Veronesi, 2013; Vigani and Kathage, 2019), which account for farm-specific heterogeneity.[16] This method consists of plugging the time-varying variables in their average values over the 2008–2018 period, relying on the assumption that unobservable characteristics are a linear function of the averages farm-variant variables (Di Falco and Veronesi, 2013). Furthermore, to control for unobservable region-specific factors, we introduce regional dummy variables. Table 1 illustrates the descriptive statistics concerning all the variables used in our econometric strategy.

6. Results and discussion

Table 2 reports the difference between farms employing and non-employing immigrants. Nearly 70 per cent of the sample's total output is produced by dairies that do employ immigrants, and that, on average, is 1.1 times larger than non-employing (i.e. 113 per cent the percentage difference). Interestingly, Table 2 also highlights the lower on-average total labour cost per unit of output produced that immigrant-employing dairies benefit from, namely a reduction of about one-third – 33 per cent.

The results of the ESR are displayed in Table 3.[17] At the bottom of the table, the estimated coefficients of the correlation terms ($\rho_j; \sigma_i$) indicate that the absence of sample selection bias can be rejected and that in the sample there is endogenous switching and heterogeneity. Moreover, there is a statistically significant difference between the labour cost functions of farms adopting and not adopting immigrants. Accordingly, the likelihood ratio test for joint independence of the three equations is also significant, showing dependency and, thus, selection bias (Asfaw *et al.*, 2012; Kabunga, Dubois and Qaim, 2012). Notably, ρ_0 (i.e. the correlation coefficient between η_i and $\varepsilon_{2,i}$) indicates positive selection bias; thus, farms not employing immigrants incur into higher ULC levels than a random farm – that is, non-employing incurring into above-average ULC are more likely to employ immigrants. On the other hand, although positive, ρ_1 is not significant, indicating that the null of absence of sample selectivity bias for the 'employing' function may not be rejected. All in all, the statistically significant ρ_0 confirms that the ESR is appropriate (Lokshin and Sajaia, 2004; Di Falco, Veronesi and Yesuf, 2011; Läpple, Hennessy and Newman, 2013; Abdulai and Huffman, 2014; Mishra *et al.*, 2018).

16 Methods based on random effects probit could address the issue of individual effects in unbalanced panels with gaps (see Plum, 2014). However, applications in ESR models with simultaneous estimation of selection and outcome equations have not been developed yet. Further research in this direction is still needed and could further the applications of ESR to panel data. We are grateful to an anonymous referee for pointing this out.

17 We use the 'movestay' command in Stata developed by Lokshin and Sajaia (2004).

Table 1. Descriptive statistics of variables used in econometric models estimation

Label	Obs.	Mean	SD	Min	Max
Employing immigrants (1/0)	10,138	0.180	0.390	0.000	1.000
Total labour cost/total output (deflated) (ULC)	10,138	0.500	0.440	0.000	7.360
New investments/total output (deflated)	10,138	0.100	0.300	0.000	9.290
Value of machinery/total output (deflated)	10,138	0.390	0.620	0.000	10.510
Cost of contract work/total output (deflated)	10,138	0.010	0.010	0.000	0.220
CDP	10,138	1,765.350	4,793.570	0.000	239,000.000
DDP	10,138	12,410.340	22,529.020	0.000	476,000.000
AES	10,138	1,882.930	6,389.610	0.000	203,000.000
Other annual RDP payments (RDP annual)	10,138	3,205.82	7,790.700	0.000	270,000.000
Non-annual RDP support (RDP others)	10,138	1,765.350	4,793.570	0.000	239,000.000
Education level of the farm holder	10,138	2.170	0.560	1.000	4.000
Age of the farm holder	10,138	52.120	11.840	20.500	90.000
Presence of female holder (1/0)	10,138	0.958	0.200	0.000	1.000
Off-farm revenues	10,138	1.610	0.890	1.000	4.000
Diversified farm (1/0)	10,138	0.102	0.303	0.000	1.000
Share of rented land on total land as utilised agricultural area	10,138	0.490	0.410	0.000	1.000
Large farm (1/0)	10,138	0.540	0.500	0.000	1.000
Small farm (1/0)	10,138	0.070	0.260	0.000	1.000
Mountain farm (1/0)	10,138	0.450	0.500	0.000	1.000
Lowland farm (1/0)	10,138	0.310	0.460	0.000	1.000
Grassland surface	10,138	20.640	52.840	0.000	944.430
Share of new immigrants on total immigrant population per province	10,112	0.080	0.040	0.020	0.370
Share of native moving out of the province on total native population	10,138	0.020	0.010	0.010	0.040

Note: All monetary variables are standardised for the total farm output.
Table A1 in the Appendix provides descriptive statistics for the two sub-group samples: farms employing and non-employing immigrants, respectively. We thank an anonymous referee for suggesting their inclusion.
Source: own elaboration on the Italian FADN and ISTAT datasets.

Table 2. Percentage differences of sociodemographic and economic indicators per farm employing and non-employing immigrants, group averages, 2008–2018

	Employing	Non-Employing	Difference
Total output	406,172.375	190,274.781	113%
ULC	0.360	0.540	–33%
New investments/total output	0.100	0.100	0%
Value of machinery/total output	0.340	0.400	–15%
Cost of contract work/total output	0.010	0.010	0%
Overall CAP support/total output	0.170	0.150	13%
Large farm	0.790	0.490	61%
Small farm	0.010	0.090	–89%
Lowland farm	0.390	0.290	34%
Mountain farm	0.380	0.460	–17%
Age of the farm holder	51.190	52.330	–2%
Presence of female holder	1.990	1.950	2%
Education level of the farm holder	2.260	2.150	5%
Off-farm revenues	1.590	1.610	–1%
Share of rented land on total land	0.540	0.470	15%
Contract work	126.680	41.210	207%
Grassland surface	43.650	15.530	181%
Diversified farm	1.150	1.090	6%
Productivity of total labour	37.600	29.256	29%
Hours worked total	7,956.362	4,828.836	65%
Hours worked by total paid	3,836.803	760.860	404%
Hours worked by unpaid	4,119.560	4,067.976	1%
Hours worked by paid permanent	1,801.568	321.446	460%
Hours worked by paid seasonal	2,035.235	439.414	363%

Source: Authors' elaboration.

The falsification tests suggest that the two identification variables represent a valid set of instruments.[18] Both coefficients are positive and significant as expected, suggesting the stronger the networks of immigrants existing in a giving area, the higher the likelihood for immigrants to be hired by local farms; and the higher the ratio of native who left the area, the greater the probability of farms employing foreign workforce, since areas experiencing high outflows of natives are probably featuring inflows of immigrants.

18 The probit regression and the X^2 test (26.00) reject the null hypothesis that the variable is equal to 0 at 1 per cent; on the other hand, the OLS regression and the *F*-test (1.35) fails to reject the null hypothesis that the set of identification variables is equal to 0. Results are reported in Table A4 of the Appendix.

Table 3. ESR model results: probit selection and ULC continuous equations

	1	2	3
	Selection equation	Employing immigrants	Not employing immigrants
	Hiring immigrants (1/0)	(Employing = 1)	(Employing = 0)
Educational level	0.056**	−0.011	−0.028**
	(0.023)	(0.009)	(0.011)
Age of the holder	0.001	−0.002**	0.002*
	(0.003)	(0.001)	(0.001)
Off-farm income	−0.054	0.033**	0.023
	(0.037)	(0.014)	(0.019)
Female holder	0.010	0.056	0.031
	(0.084)	(0.047)	(0.030)
Diversified	0.240***	−0.061***	−0.095***
	(0.043)	(0.037)	(0.026)
Investments	0.029	−0.050***	0.005
	(0.031)	(0.018)	(0.011)
Rented land (share)	0.035	−0.005	−0.042**
	(0.034)	(0.016)	(0.016)
Mechanisation	−0.345***	0.107***	0.259
	(0.053)	(0.023)	(0.020)
Contract work	1.642	−0.076	−1.003*
	(1.179)	(0.705)	(0.515)
Grassland	0.003***	−0.000***	−0.001***
	(0.000)	(0.000)	(0.000)
Large farm	0.722***	−0.138***	−0.403***
	(0.036)	(0.018)	(0.015)
Small farm	−1.510***	0.182**	0.631***
	(0.081)	(0.079)	(0.023)
Lowland farm	0.305***	−0.027*	−0.158***
	(0.037)	(0.016)	(0.019)
Mountain farm	−0.150***	0.009	0.048**
	(0.050)	(0.027)	(0.020)
CDP	−3.439***	0.832**	2.085***
	(0.797)	(0.359)	(0.443)
DDP	−7.636***	−0.010	4.934***
	(0.258)	(0.189)	(0.093)
AES	−1.029***	−0.050	0.103
	(0.302)	(0.084)	(0.148)
Rural Development	−0.282	0.875***	0.326**
Program annual	(0.276)	(0.121)	(0.126)
Rural Development	0.158	−0.136**	−0.094
Program others	(0.138)	(0.069)	(0.067)

(continued)

Table 3. (Continued)

	1	2	3
	Selection equation	Employing immigrants	Not employing immigrants
	Hiring immigrants (1/0)	(Employing = 1)	(Employing = 0)
Constant	−1.468***	0.272**	0.542***
	(0.226)	(0.117)	(0.082)
Networks	0.347*		
	(0.180)		
Native Out-Migration Rate	8.453***		
	(3.109)		
Regional dummies FE	Yes	Yes	Yes
σi		0.215***	0.571***
		(0.003)	(0.005)
ρj		0.026	−0.998***
		(0.093)	(0.000)
LR test of independent equations	2311.43***		

Notes: Standard errors in parentheses. σi denotes the square-root of the variance of the error terms εji in the outcome equations (5.1) and (5.2), respectively; ρj denotes the correlation coefficient between the error term ηi of the selection equation (5) and the error term εji of the outcome equations (5.1) and (5.2), respectively. Results are for variables in level; see Table A3 in the Appendix for results of the Mundlak effect. *Significant at the 10 per cent level;
**Significant at the 5 per cent level;
***Significant at the 1 per cent level.
FE, Fixed Effect; LR, Likelihood Ratio.
Source: authors' elaboration.

The first column of Table 3 reports the results for the selection equation (5), explaining the drivers of employing immigrants in Italian dairy farms, testing H1. Among farmers' characteristics (i.e. farmers' age, gender, off-farm income and education), only education seems to play a role for the choice of hiring foreigners, with the expected positive sign – the higher the education attainment, the more likely the farms employ foreigners. The low predictive power of the farmer's characteristics links to the social environment – which the present study cannot control for – that the literature proved already to be a prominent influencer of farmers' behaviour. Family members often exert a significant role in the management of the farm, besides other referents that may drive farmers' decisions (Bechini *et al.*, 2020; Sok *et al.*, 2021), turning individual characteristics not significant. Results hint that higher individual educational attainment may reduce the influence of referents on individual attitude towards foreigners.

Among the farms' characteristics, results show that diversified farms are more likely to employ immigrants, as this generally entails more agricultural tasks to be undertaken, and of different nature, suggesting foreigners are regarded as a non-specialised workforce but highly versatile. Likewise, larger farms show a significant and positive effect on the probability of hiring immigrants: for such farms, the demand for labour is higher because of higher work intensity, surfaces and number of heads, and the limited domestic labour offer steers the hiring of foreigners. The negative and significant coefficient of small farms corroborate such results. Looking back at Table 2, large (small) farms are more (less) concentrated into the 'employing' group, with 65 per cent more the amount of hours worked on average and four times the amount of hours worked by paid farmworkers; moreover, the employing group has twice the average total output, with higher labour productivity – calculated as the total output per hour worked – as well as near-double grassland surfaces. Generally, larger farms may better cope with the additional cost related to hire immigrants, finding it easier to employ them. Similarly, farms located in mountainous areas are less likely to hire immigrants, while the opposite is true for those farms located in lowlands. Regarding the former, the lack of services such as public transport and the significant distances from the immigrant networks – where immigrants usually reside – disincentive the hiring of foreigners; on the contrary, farms located near urban centres, often in lowland areas, are more likely to employ immigrant farmworkers, also because of the easier accessibility of foreigners to the workplace.

Mechanisation intensity elicits significant negative effect, as expected: highly-mechanised farms seem to prefer native farmworkers. Immigrants may lack of skills' signals and deemed as low-skilled workers (Basile *et al.*, 2021). Neither the volume of investments, the share of rented land, nor the intensity of contract work show significant effect on the likelihood of employing migrants. Finally, when farms rely on large grassland areas, they are more prone to employ immigrants; this may relate to the fact that the presence of grasslands mean cows need to be handled to such grazing areas to feed – grasslands have not to be contiguous to the farm where stables are.

Among the different CAP payments, none resemble a pulling factor for the employment of migrants as all significant effects are of negative nature. Although naïve, the first logical explanation relates to the fact that as far as immigrants provide with lower ULC, the smaller the amount of public subsidy the farms receive, the higher the likelihood to hire farmworkers that lighten the cost structure. CAP CDP are coupled to specific productions (e.g. soy hectares and number of bovine heads) and types of animal (e.g. suckler cow). Therefore, although farms in the dataset are specialised in milk production, they may still receive subsidies coupled to field crops or for suckler cows, activities that are less labour-intensive, offering an explanation for the negative coefficient. Likewise, higher CAP DDP reduces the probability of hiring foreigners in line with Petrick and Zier (2012, 2011): DDP allows for releasing labour as such subsidies are distributed independently from the output produced. Therefore, this may negatively affect the dairy-specific demand for labour, either national or foreign. However, the works of Garrone *et al.* (2019) and Olper *et al.* (2014) find a positive effect of DDP in reducing farm labour losses. This may suggest that dairies receiving DDP have no incentives to hire additional labour and can maintain their actual workforce.

Table 4. Average expected ULC levels and treatment effects

	Decision stage		Treatment effects	
	To hire	*Not to hire*	*TT*	*TU*
Farms that hire immigrants	(a) 0.381 [0.284]	(c) –0.405 [0.183]	0.787*** (0.008)	
Farms that do not hire immigrants	(d) 0.729 [0.509]	(b) 0.389 [0.248]		0.339*** (0.006)

Note: Standard deviation and standard errors in squared and rounded parentheses, respectively. Two-sample *t*-test with unequal variances and unpaired sample is applied to test for significance.
***Significant at the 1 per cent level.
Source: Authors' elaboration.

Several authors (Olper *et al.*, 2014; Pufahl and Weiss, 2009; Garrone *et al.*, 2019) show that environmental practices to which AES payments are destined positively affect work creation in the farming sector mainly because they are labour intensive. Nevertheless, the negative coefficient seems to support the strand of literature (Chabé-Ferret and Subervie, 2013; Uthes and Matzdorf, 2013; Bertoni *et al.*, 2020) warning of their windfall effects – that is, paying for practices that would have been adopted anyway, decreasing their efficiency with no enhancement of the labour demand. Others annual RDP payments (e.g. LFA) as well as other RDP measures (e.g. support to farm investments) are not significant. The literature, in this regard, offers controversial results. Garrone *et al.,* (2019) and Petrick and Zier (2012, 2011) find no significant effect for LFA payments on old MS' agricultural employment, while Olper *et al.*'s (2014) result for RDP support show to be quite sensitive to model specifications, with investment aids boosting labour losses and Petrick and Zier (2012) concluding on the positive impact of investment-aid subsidies on agricultural jobs maintenance.

The quantification of the impact of immigrant workers on total labour costs is reported in the counterfactual analysis in Table 4. Values (a) and (b) indicate the average labour cost observed in our sample across farms that actually hire and do not hire migrants, respectively, whereas (c) and (d) represent their counterfactuals. Both the Treatment on the treated (TT) and Treatment on the untreated (TU) effects are calculated as described in the Appendix.

Looking at the TT, the high and positive differentials between the decisions of hiring (a) and non-hiring (c) foreign workers suggest that in the hypothetical scenario in which employing farmers decided to not to do so, their relative labour cost per Euro of output would turn negative – a situation in which either the total labour cost or the total farm output is negative, with the latter representing the only possible outcome, for example, due to high ratios of auto-consumption or a negative variation of farms' stocks. Therefore, if dairies adopting immigrant workforce would employ Italian farm workers instead, they would be forced to operate a profound restructuring of the production process to accommodate potential losses and to avoid exiting the sector. On the other hand, confirming the hypothesis that migrants constitute a resource for reducing labour costs (H2), the effect of the TU shows that the average labour cost of non-employing would decrease more than 45 per cent (i.e. a reduction of about 0.34) if they would decide to adopt foreign labour.

Hence, we can accept H2, as foreign farmworkers allow reducing Italian dairy farms' labour costs. In this regard, foreign workforce seems to represent a non-replaceable factor of production, maintaining farms' competitiveness and preventing their exit from the market.

Results clearly point to a non-perfect substitution between native and immigrant farmworkers in terms of ULC for the considered Italian case study. This opens the floor to four scenarios explaining how the migrant farmworkers represent a more competitive production factor for Italian dairy farms: (i) foreign labour has lower unitary cost than national labour, ceteris paribus. In this scenario, one may wonder whether immigrants are sufficiently rewarded for their professional profile, that is, whether they receive a non-specialised wage despite carrying out highly specialised tasks (e.g. milker); (ii) data are affected by underreporting of working time, with significant shares of the salaries paid 'under-the-table', unlawfully, and preventing the farmworker to gain access to welfare programmes and grants; (iii) a mix of the two scenarios described above; lastly, (iv) immigrants are more productive farmworkers than nationals, capable of producing more output at the same cost as recently found by Baldoni, Coderoni and Esposti (2021) for the Italian agricultural sector.

7. Conclusions and policy implications

The research addresses a new trait of the organisation of labour markets in the EU agriculture, namely the growing importance of immigrant workforce and farm competitiveness.

Overall, immigrants exert a generally positive impact on farm competitiveness and they can represent a solution for the structural shortages of labour in the farm sector. Foreign-born workers are 'essential' resources as formally recognised by the European Commission during the COVID-19 emergency (European Commission, 2020) and largely documented by the media: harvests of fruits and vegetable in Italy, Spain, Germany and the UK have been compromised by the lack of the migrant seasonal workers (The Economist, 2020a, 2020b). Furthermore, the Stockholm Programme of 2009 recognizes that '[…] in the context of the important demographic challenges that will face the Union in the future with an increased demand for labour […] immigration can contribute to increased competitiveness and economic vitality', encouraging '[…] the creation of flexible admission systems [that] enable migrants to take full advantage of their skills and competence'.

The importance of foreign labour for the EU agriculture is already triggering EU social initiatives, particularly the new-born European Labour Authority (ELA) under the new European Pillar of Social Rights (EPSR), the Farm to Fork Strategy and the recently agreed CAP reform. Notably, the latter envisages to '[…] promote employment, growth, social inclusion and local development in rural areas'; the ELA aims to 'guarantee the effectiveness and implementation of EU rules on labour mobility, and ensuring that fair social security rules are enforced and coordinated throughout the Single Market' (Schuh *et al.*, 2019); and the Farm to Fork, particularly after the COVID-19 pandemic, recognizes the importance of EPSR principles '[…] especially when it comes to precarious, seasonal and undeclared workers. The considerations of workers' social protection, working and housing conditions as well as protection of health and safety will play a major role in building fair, strong and sustainable food systems'.

Despite the relevance of the topic, empirical evidences investigating the role of immigrant workers on farm competitiveness are scant. We address this issue using the theory developed by Malchow-Møller *et al.,* (2013) and focusing on the case study of Italian dairy farms. We first explore the factors explaining the probability of hiring foreigner workers. Education as well as farm size and location are important drivers. Results emphasise the important role of CAP payments, with an overall negative effect on the probability of employing immigrants, especially concerning coupled, decoupled and agri-environmental instruments. Results of the counterfactual analysis show that, on average, farms' employing immigrants benefit from lower ULC, thus fostering their competitiveness.

The scenarios we described for explaining the positive role of immigrants employed in the farming sector need policy interventions. If foreign workers are more productive than nationals, a healthy and well-functioning labour market should reward such productivity with salary levels at least equal to those of Italians as declared in the above-mentioned Stockholm Programme: 'The Union must ensure fair treatment of third country nationals who reside legally on the territory of its Member States […] granting them rights and obligations comparable to those of citizens of the Union'. On the contrary, if under-reporting, black labour markets and unfair salaries are the reasons explaining lower costs, indicating severe exploitation issues needing urgent policy interventions to cut off unlawful behaviour.

This issue is at the heart of the inclusion of the social conditionality within the CAP 2023–2027. Indeed, it explicitly communicates the societal demand for policy interventions aimed at the lawful and smooth integration of immigrants into the agricultural sector, demanding stricter controls to tackle unfair treatments, enhancing the competitiveness of the farming sector at no detriment of basic social and work rights. This will cover diverse areas, from working time to housing, for all agricultural workers, thus including immigrant labourers. Besides ethical reasons, it aims at preventing unfair competition by granting more resources to lawful farmers respecting workers' rights. Therefore, conditionality on workers' conditions may ensure that EU taxpayers – funding the CAP – contribute to improving working and living conditions, avoiding, or at least reducing, welfare losses for the entire society.

Finally, limitations of the research hopefully ignite further research efforts in this field of study. Future research efforts should focus on the policy trade-off between societal gains and farm losses: raising immigrants' wages may entail detrimental effects for some farms as they may exit the market, while improving the market position of those suffering from unfair competition.[19] As suggested by an anonymous referee, it is crucial to deepen the understanding on the dynamic perspective of immigrant employment, exploiting the panel nature of the data. Whether farm's wage levels actually shifted after employing immigrants could be unveiled via dynamic models, accounting for both endogeneity and autocorrelation. Furthermore, both the geographical and sectorial coverages should be expanded for cementing the results presented. The current study does not discern among farms in which the immigrant working hours may widely vary. Therefore, whether and how the farms' cost structure change according to the amount of hours actually worked by immigrant employees may be empirically investigate by future research. Similarly, differentiating the analysis by farm size may deliver additional insights on the role of immigrant labour on farm competitiveness. Moreover, further characteristics, such as the specific tasks performed by the farmworker and the country of origin, besides other personal elements as the educational attainment, age and agriculture-related skills and experience, may deepen the understanding of their role on the farm performance, providing further insights for the political debate and policy design.

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Appendix: The endogenous switching regression model: further statistical details

Referring to equations (5), (5.1) and (5.2), η_i and ε_{mi} are assumed to have a trivariate normal distribution with mean zero and non-singular covariance matrix such that:

$$\Psi = \mathrm{cov}(\varepsilon_{1i}, \varepsilon_{2i}, \eta_i)' = \begin{bmatrix} \sigma^2_{\varepsilon 1} & . & \sigma_{\varepsilon 1\eta} \\ . & \sigma^2_{\varepsilon 2} & \sigma_{\varepsilon 2\eta} \\ . & . & \sigma^2_{\eta} \end{bmatrix},$$

where σ^2_η is the variance of η_i in equation (5), assumed to be equal to 1 since the coefficients are estimable only up to a scale factor (Abdulai and Huffman, 2014; Di Falco, Veronesi and Yesuf, 2011; Mishra *et al.,* 2017); $\sigma^2_{\varepsilon 1}$ and $\sigma^2_{\varepsilon 2}$ are the variances of $\varepsilon_{1i}, \varepsilon_{2i}$ in equations (5.1) and (5.2), respectively; $\sigma_{\varepsilon 1\eta}$ and $\sigma_{\varepsilon 2\eta}$ are the covariances between η_i and ε_{mi}. Since y_{1i} and y_{2i} are not observed simultaneously, the covariance between ε_{1i}, ε_{2i} is not defined (corresponding to the dots in Ψ) (Di Falco, 2014). Because of the correlation between η_i and ε_{mi}, the expected values of ε_{1i} and ε_{2i} conditional on the sample-selection are non-zero:

$$E[\varepsilon_{1i}|A_i = 1] = \sigma_{1\eta}\frac{\emptyset(Z_i\alpha)}{\Phi(Z_i\alpha)} = \sigma_{1\eta}\lambda_{1i}, \text{ and}$$

$$E[\varepsilon_{2i}|A_i = 0] = -\sigma_{2\eta}\frac{\emptyset(Z_i\alpha)}{1-\Phi(Z_i\alpha)} = \sigma_{2\eta}\lambda_{2i},$$

where $\sigma_{\varepsilon 1\eta}$ and $\sigma_{\varepsilon 2\eta}$ are the covariances between η_i and ε_{mi}, $\emptyset(.)$ is a standard normal probability density function, $\Phi(.)$ a standard normal cumulative density function, and $\lambda_{1i} = \frac{\emptyset(Z_i\alpha)}{\Phi(Z_i\alpha)}$ and $\lambda_{2i} = -\frac{\emptyset(Z_i\alpha)}{1-\Phi(Z_i\alpha)}$ are the inverse mills ratios evaluated at $Z_i\alpha$ and included in equations (5.1) and (5.2) to correct for selection bias (Maddala, 1983; Kleemann, Abdulai and Buss, 2014). The estimated covariances $\sigma_{\varepsilon 1\eta}$ and $\sigma_{\varepsilon 2\eta}$, if statistically significant, suggest that the decision to hire migrants and the total labour cost are correlated, confirming the evidence of endogenous-switching and rejecting the null of absence of sample selectivity bias (Di Falco, Veronesi and Yesuf, 2011).

The application of the ESR allows to compare the expected ULC of farms that hire migrants (a) to those that do not hire migrants (b), besides investigating the expected ULC of hypothetical counterfactual cases, that is, farms employing migrants as they would not hire any foreign workers (c), and those not employing immigrants as they would do (d):

a. Adopters of migrant labour deciding to adopt (hire) migrants (real):

$$E(y_{1i}|A_i = 1) = X_{1i}\beta_1 + \sigma_{\varepsilon 1\eta}\lambda_{1i}$$

b. Non-adopters of migrant labour deciding to not adopt (hire) migrants (real):

$$E(y_{2i}|A_i = 0) = X_{2i}\beta_2 + \sigma_{\varepsilon 2\eta}\lambda_{2i}$$

c. Adopters of migrant labour deciding not to adopt (hire) migrants (hypothetical):

$$E(y_{2i}|A_i = 1) = X_{1i}\beta_2 + \sigma_{\varepsilon 2\eta}\lambda_{1i}$$

d. Non-adopters of migrant labour deciding to adopt (hire) migrants (hypothetical):

$$E(y_{1i}|A_i = 0) = X_{2i}\beta_1 + \sigma_{\varepsilon 1\eta}\lambda_{2i}.$$

According to Heckman, Tobias and Vytlacil (2001), we compare the effect of the treatment 'employing migrants' on the treated farms (TT) by calculating the difference between (a) and (c), representing the effect of hiring immigrants on the TLC of farmers who hire migrants:

$$TT : E(y_{1i}|A_i = 1) - E(y_{2i}|A_i = 1) = X_{1i}(\beta_1 - \beta_2) + \lambda_{1i}(\sigma_{\varepsilon 1\eta} - \sigma_{\varepsilon 2\eta}). \quad \text{(A1)}$$

In the same fashion, we calculate the effect of the treatment on the untreated farms (TU), that is, those farms that do not employ any foreign workers, as the difference between (d) and (b), describing the effect of hiring immigrants on the TLC of those farmers who do not employ immigrants:

$$TU : E(y_{1i}|A_i = 0) - E(y_{2i}|A_i = 0) = X_{2i}(\beta_1 - \beta_2) + \lambda_{2i}(\sigma_{\varepsilon 1\eta} - \sigma_{\varepsilon 2\eta}). \quad \text{(A2)}$$

Table A1. Descriptive statistics of variables used in econometric models estimation. Sub-samples of farms employing and not employing immigrants

Label	Obs.	Mean	SD	Min	Max
Farms employing immigrants					
Total labour cost/total output (deflated) (ULC)	1,843	0.360	0.290	0.050	1.850
New investments/total output (deflated)	1,843	0.100	0.210	0.000	2.550
Value of machinery/total output (deflated)	1,843	0.340	0.500	0.000	5.220
Cost of contract work/total output (deflated)	1,843	0.010	0.010	0.000	0.130
CDP	1,843	2,990.620	6,021.600	0.000	51,006.000
DDP	1,843	17,922.600	34,758.520	0.000	476,000.000
AES	1,843	4,243.690	11,676.490	0.000	203,000.000
Other annual RDP payments (RDP annual)	1,843	6,676.170	12,784.660	0.000	270,000.000
Non-annual RDP support (RDP others)	1,843	2,352.460	23,892.600	0.000	530,000.000
Education level of the farm holder	1,843	2.260	0.590	1.000	4.000
Age of the farm holder	1,843	51.190	11.870	21.500	86.500
Presence of female holder (1/0)	1,843	1.990	0.120	1.000	2.000
Off-farm revenues	1,843	1.590	0.920	1.000	4.000
Diversified farm (1/0)	1,843	1.150	0.360	1.000	2.000
Share of rented land on total land as utilised agricultural area	1,843	0.540	0.380	0.000	1.000
Large farm (1/0)	1,843	0.790	0.410	0.000	1.000
Small farm (1/0)	1,843	0.010	0.070	0.000	1.000
Mountain farm (1/0)	1,843	0.380	0.490	0.000	1.000
Lowland farm (1/0)	1,843	0.390	0.490	0.000	1.000
Grassland surface	1,843	43.650	86.570	0.000	944.430
Share of new immigrants on total immigrant population per province	1,843	0.080	0.050	0.020	0.370
Share of native moving out of the province on total native population	1,843	0.030	0.010	0.010	0.040

(continued)

Table A1. (Continued)

Label	Obs.	Mean	SD	Min	Max
Farms not employing immigrants					
Total labour cost/total output (deflated) (ULC)	8,295	0.540	0.460	0.000	7.360
New investments/total output (deflated)	8,295	0.100	0.320	0.000	9.290
Value of machinery/total output (deflated)	8,295	0.400	0.640	0.000	10.510
Cost of contract work/total output (deflated)	8,295	0.010	0.010	0.000	0.220
CDP	8,295	1,493.110	4,429.870	0.000	239,000.000
DDP	8,295	11,185.610	18,541.070	0.000	250,000.000
AES	8,295	1,358.410	4,255.120	0.000	141,000.000
Other annual RDP payments (RDP annual)	8,295	2,434.770	5,883.160	0.000	205,000.000
Non-annual RDP support (RDP others)	8,295	843.150	10,126.600	0.000	319,000.000
Education level of the farm holder	8,295	2.150	0.550	1.000	4.000
Age of the farm holder	8,295	52.330	11.820	14.500	90.000
Presence of female holder (1/0)	8,295	1.950	0.210	1.000	2.000
Off-farm revenues	8,295	1.610	0.880	1.000	4.000
Diversified farm (1/0)	8,295	1.090	0.290	1.000	2.000
Share of rented land on total land as utilised agricultural area	8,295	0.470	0.410	0.000	1.000
Large farm (1/0)	8,295	0.490	0.500	0.000	1.000
Small farm (1/0)	8,295	0.090	0.280	0.000	1.000
Mountain farm (1/0)	8,295	0.460	0.500	0.000	1.000
Lowland farm (1/0)	8,295	0.290	0.450	0.000	1.000
Grassland surface	8,295	15.530	40.050	0.000	730.000
Share of new immigrants on total immigrant population per province	8,269	0.070	0.040	0.020	0.370
Share of native moving out of the province on total native population	8,295	0.020	0.010	0.010	0.040

Note: All monetary variables are standardised for the total farm output.
Source: own elaboration on the Italian FADN and ISTAT datasets.

Table A2. Shares of immigrant farmworkers by number of people and working hours per main agricultural sector on the total amount of immigrants, 2018

2018	Share immigrant workers (on the total of immigrant)	Share immigrant working hours (on the total of immigrant)
Dairy	8%	14%
Cereals	1%	1%
Herbivores	3%	6%
Fruits	33%	17%
Granivores	7%	16%
Olives	2%	2%
Horticulture	29%	28%
Crops	6%	7%
Vineyards	11%	9%

Source: Authors' elaboration on the Italian FADN.

Table A3. Mundlak effects estimated coefficients

	1	2	3
	Selection equation	Employing immigrants	Not employing immigrants
Mundlak effect	Hiring immigrants (1/0)	(Employing = 1)	(Employing = 0)
Age of the holder (mean)	–0.005**	0.003***	0.000
	(0.003)	(0.001)	(0.001)
Mechanisation (mean)	0.300***	–0.101***	–0.246***
	(0.065)	(0.028)	(0.024)
Off-farm income (mean)	0.026	–0.020	–0.003
	(0.040)	(0.016)	(0.020)
Investments (mean)	0.121**	–0.026	–0.031
	(0.055)	(0.037)	(0.026)
CDP (mean)	4.799***	1.520***	–1.707**
	(1.333)	(0.505)	(0.714)
DDP (mean)	3.659***	0.576***	–2.414***
	(0.423)	(0.222)	(0.174)
AES (mean)	1.0806**	0.487***	0.221
	(0.490)	(0.173)	(0.241)
RDPO (mean)	0.104	0.593***	–0.030
	(0.236)	(0.182)	(0.093)
RDPA (mean)	–1.246***	0.413**	0.774***
	(0.396)	(0.121)	(0.126)
Contract work (mean)	1.319	–0.444	–0.734
	(1.465)	(0.796)	(0.667)

**Significant at the 5 per cent level;
***Significant at the 1 per cent level.
Source: Authors' elaboration.

Table A4. Probit and OLS regressions and IV falsification test

	Probit Immigrants (1/0)	OLS ULC
Educational level	0.114***	−0.0232***
	(0.033)	(0.006)
Age of the holder	0.00475	−0.00119
	(0.004)	(0.000)
Female holder	0.484***	0.0056
	(0.151)	(0.015)
Mechanisation	−0.145*	0.0260**
	(0.082)	(0.010)
Off-farm income	−0.143**	−0.0012
	(0.060)	(0.009)
Diversified	0.503***	−0.0527***
	(0.060)	(0.010)
Investments	0.0437	0.0124**
	(0.062)	(0.006)
Rented land (share)	−0.130**	−0.0509***
	(0.056)	(0.008)
CDP	−1.635	−0.026
	(1.446)	(0.238)
DDP	−0.768	0.0662
	(0.59)	(0.047)
AES	−0.0521	−0.0909
	(0.457)	(0.069)
RDPA	0.263	0.0129
	(0.474)	(0.065)
RDPO	0.146	−0.027
	(0.367)	(0.034)
Large farm	1.012***	−0.275***
	(0.054)	(0.007)
Small farm	−1.300***	0.492***
	(0.173)	(0.012)
Lowland farm	0.395***	−0.0795***
	(0.058)	(0.009)
Mountain farm	−0.356***	9.78E-05
	(0.078)	(0.010)
Contract work	0.459	−1.149***
	(2.252)	(0.27)
Grassland	0.00239***	−0.000527***
	(0.000)	(0.000)
Networks	2.357***	0.178
	(0.662)	(0.11)
Native Out-Migration Rate	34.16***	0.318
	(9.67)	(1.592)
Age of the holder (mean)	−0.00296	0.00361***
	(0.005)	(0.000)
Mechanisation (mean)	0.158*	0.000319
	(0.095)	(0.012)

(continued)

Table A4. (Continued)

	Probit Immigrants (1/0)	OLS ULC
Off-farm income (mean)	0.183***	0.0217**
	(0.063)	(0.010)
Investments (mean)	0.0785	−0.0497***
	(0.105)	(0.013)
CDP (mean)	6.848***	0.0823
	(1.75)	(0.366)
DDP (mean)	−2.955***	1.704***
	(0.757)	(0.089)
AES (mean)	−0.933	0.536***
	(0.899)	(0.117)
RDPA (mean)	0.423	1.257***
	(0.676)	(0.098)
RDPO (mean)	0.0797	−0.0327
	(0.47)	(0.048)
Contract work (mean)	7.936***	0.565
	(2.544)	(0.345)
Constant	−5.392***	0.487***
	(0.44)	(0.059)
Region dummies	Yes	Yes
		$R^2 = 0.54$
Falsification test		
Networks = 0	X^2 (2) = 26.00	F(2, 10,060) = 1.35
Native Out-Migration Rate = 0	Prob = 0.0000	Prob = 0.2592

*Significant at the 10 per cent level;
**Significant at the 5 per cent level;
***Significant at the 1 per cent level;
RDPA, Rural Development Program annual;
RDPO, Rural Development Program others.
Source: Authors' elaboration on the Italian FADN.