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Thorsoe, Martin, Noe, Egon, Maye, Damian ORCID: 0000-0002-4459-6630, Vigani, Mauro ORCID: 0000-0003-2442-7976, Kirwan, James ORCID: 0000-0002-4626-9940, Chiswell, Hannah Marie ORCID: 0000-0003-4504-1319, Grivins, Mikelis, Adamson-Fiskovica, Anda, Tisenkopfs, Talis, Tsakalou, E, Aubert, Pierre-Marie and Loveluck, William (2020) Responding to change: Farming system resilience in a liberalized and volatile European dairy market. Land Use Policy, 99. Art no 105029. doi:10.1016/j.landusepol.2020.105029

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1 **Responding to change: Farming system resilience in a liberalized**
2 **and volatile European dairy market**

3

4 **Authors:**

5 Martin Thorsøe, AU - Aarhus University, Denmark

6 Egon Noe, SDU - University of Southern Denmark

7 Damian Maye, CCRI – University of Gloucestershire, United Kingdom

8 Mauro Vigani, CCRI – University of Gloucestershire, United Kingdom

9 James Kirwan, CCRI – University of Gloucestershire, United Kingdom

10 Hannah Chiswell, CCRI – University of Gloucestershire, United Kingdom.

11 Mikelis Grivins, BSC – Baltic Studies Centre, Latvia

12 Anda Adamsone-Fiskovica, BSC – Baltic Studies Centre, Latvia

13 Talis Tisenkopfs, BSC – Baltic Studies Centre, Latvia

14 Emi Tsakalou, AUA – Agricultural University of Athens, Greece

15 Pierre-Marie Aubert, IDDRI – Institut du développement durable et des relations internationales, France

16 William Loveluck, IDDRI – Institut du développement durable et des relations internationales, France

17

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20 Responding to change: Farming system resilience in a liberalized 21 and volatile European dairy market

22 Highlights:

- 23 1. Market liberalization and price volatility drive changes in all farming systems.
- 24 2. Price volatility results in poor adaptive capacity of dairy farms.
- 25 3. Strategies for dairy farming systems are conditioned by strategies of processors.
- 26 4. Systems respond with different strategies despite comparable regulatory framework.
- 27 5. Dairy market trends may have long-term impact on land use.

28 **Abstract:** For more than two decades market conditions for European producers have changed significantly
29 due to liberalization and increasing price volatility. The objective of this article is to analyze how farming
30 systems in five European countries (Denmark, Greece, France, Latvia, and the United Kingdom) have
31 reacted to the emerging instability of the milk market. Dairy production is an ideal setting to study how
32 different farming systems respond to changing conditions as a number of policy changes have altered
33 market conditions for producers. Empirically, the analysis draws on statistical data on dairy production and
34 farm structure, and qualitative and quantitative data from case studies in the five countries. During the
35 period under study, dairy farming systems have operated under the same overarching EU regulation, but
36 dairy sectors at the national level followed specific pathways. We found different strategies and
37 institutional arrangements deployed to address price volatility at the national levels. We argue that
38 divergence in the strategies developed to address this disturbance reflects different configurations of value
39 chain organization (particularly dairies), production factors (production facilities and biophysical
40 conditions), and market orientation. Increasing market volatility implies that succession planning and
41 attracting investments is difficult for farming systems across all countries, and thereby to formulate
42 strategies for resilience.

43 **Keywords:** Milk quota; farming systems; food system governance; dairy sector; farmer strategies; market
44 liberalization

45 1. Introduction

46 In order to support sustainable agri-food futures it is important to understand the foundations for farming
47 system resilience. This is increasingly relevant because market, policy, and environmental conditions
48 continuously evolve, becoming less predictable and more interconnected globally (Biggs et al., 2011;
49 Freibauer et al., 2011; Veerman et al., 2016). Furthermore, changing conditions have had profound impacts
50 on farming practices and therefore also on the resulting land use and activities in rural areas (Dervillé and
51 Allaire, 2014; Huettel and Jongeneel, 2011; Mills et al., 2017).

52 Faced with unpredictability farming systems must adopt strategies that increase tolerance to uncertainty
53 and surprise (Biggs et al., 2011; Darnhofer, 2014). Therefore, farming systems must develop resilience,
54 understood as *“the capacity of a system to absorb disturbance and reorganize while undergoing change so
55 as to still retain essentially the same function, structure and feedbacks, and therefore identity, that is, the
56 capacity to change in order to maintain the same identity”* (Walker et al., 2004: 5). Recent Europe-wide
57 disturbances include the 2008 food crisis (Rosin et al., 2012), liberalization of agricultural commodity

58 markets (Dervillé and Allaire, 2014), accelerating climate change and extreme weather events (Nelson et
59 al., 2009), as well as diversifying consumer preferences (Thorsøe, 2015).

60 Hence, it is important to understand what disturbs farming system resilience and to identify strategies to
61 ensure resilience in the light of such disturbance (Darnhofer et al., 2016; Dedieu, 2009; Holling, 2001). The
62 objective of this article is to analyze how farming systems in five European countries (Denmark, Greece,
63 France, Latvia, and the United Kingdom) have responded to liberalization and the emerging volatility of the
64 milk market and to discuss the implications of this development for farming system resilience. The article is
65 based on a comparative case study of the dairy farming systems in the five different countries.

66 Dairy production is an ideal setting to study how farming systems respond to a disturbance as a number of
67 recent policy changes have profoundly changed conditions for primary producers. Moreover, milk is
68 produced in every European country and dairy farming is particularly important in many disadvantaged
69 regions (e.g. areas in danger of abandonment and less-favored areas) (EC, 2014). The size and importance
70 of the dairy sector varies considerably across regions, but dairy is the single most important commodity
71 sector in terms of output value as dairy products accounted for 13.8 % of total agricultural production in
72 the European Union (EU) in 2017 equaling nearly EUR 60 billion (EU, 2018). Generally, dairy products are
73 consumed in local markets while the extent of international trade in dairy products is limited, representing
74 just 7 % of global dairy production (EU, 2018).

75 The article is based on a farming system theoretical perspective. We understand farming systems as socio-
76 technical systems that are assembled by social as well as material factors and organized with a particular
77 purpose in mind (Noe and Alrøe, 2012). A central idea in farming system theory is the distinction between
78 internal factors (such as the farmer, farm workers, and machinery) and external factors that function as the
79 surrounding environment to the system (such as regulation, markets, and processors) (Darnhofer et al.,
80 2012; Ison, 2012). In dairy farming, a combination of factors are mobilized in production, such as pastures,
81 cows, farmers, farm workers, dairies, milking parlors, mortgage providers, etc, thus, each individual farming
82 system is made up of these components.

83 We distinguish between different analytical levels, with farming systems being the lowest and all farms at
84 national level constitute the dairy sector. Furthermore, individual farming systems are part of a value chain
85 along with processors and retailers downstream that are responsible for processing and sale of dairy
86 products. Furthermore, all dairy farming systems as well as related industries within a country comprise the
87 dairy sector. Farming systems are organized around a particular operating logic (Noe and Alrøe, 2012). They
88 not only differ in terms of structure, level of mechanization and size, but also in terms of the strategy for
89 value capture (Porter, 2008). This strategy expresses a choice concerning how to modify parameters such
90 as product quality, business size, marketing, research and development, contracts, etc. The strategy leads
91 to a distinct performance that can be observed in economic, social, or ecological terms.

92 European farming systems are very heterogeneous and differ substantially in size, organization, and the use
93 of technology, thus responding differently to changing conditions (Dedieu, 2009). Besides, a dairy farming
94 system is a multi-layered organization spanning several spatial scales that are subject to their own complex
95 dynamics, and when conditions change all actors have to adjust their position in the system (Darnhofer et
96 al., 2010; Noe and Alrøe, 2006). This also implies that farming systems through their strategic decisions
97 respond differently to changes in their environment (biophysical, economic, social, and institutional) and
98 that the development path of the particular social, structural, and material configuration of the farming

99 system is important for understanding these strategic responses (Noe and Halberg, 2002). In this
100 perspective, resilience of a farming system is understood as the dynamic process of the system to observe
101 crucial changes in its environment and to strategically react accordingly to sustain itself; in other words,
102 resilience is a dynamic feature of the system.

103 The analysis is organized as follows. Firstly, we outline the methodology used in the study (section 2).
104 Secondly, we unfold the changing market and policy conditions in the dairy sector at a European level
105 (section 3). Thirdly, we examine how dairy farming systems in the five countries have reacted to changing
106 dairy policies and the resulting volatile market conditions (section 4). Finally, we discuss the strategic
107 responses by the farming systems observed and the wider implications of the findings in terms of the
108 regional configuration of dairy farming (section 5).

109 **2. Data sources and methods**

110 Dairy farming systems in five European countries¹ were analyzed using in a mixed-method research
111 framework (Creswell, 2014). More specifically, different methodologies were employed, including
112 quantitative and qualitative data, in the context of the EU H2020-funded SUFISA² project (2015-2019). This
113 combination of methods provided different types of information, offering a rich picture of the dairy farming
114 system in each of the five countries.

115 We focus the analysis on the changing European regulatory conditions as these regulations have
116 profoundly altered market conditions for dairy producers (Veerman et al., 2016). To highlight the context of
117 the strategies adopted by the farming systems we initially characterize the European policies that
118 influenced the dairy price since the early 1980s, when milk production quotas were introduced. This
119 characterization was based on a review of European policy documents and academic literature pertaining
120 to the milk market and regulatory interventions.

121 The strategic responses to these changes were then observed at the individual farming system level, the
122 value chain level, and at national level. At the value chain level we uncovered the strategic positions of
123 dairies, while on the farm level we examined how farming systems observed and reacted to these changes.
124 The strategic response of dairy farming systems and value chains was initially observed by comparing the
125 development of dairy prices and production volumes across the EU Member States, as this illustrates the
126 direct effects of the changes. For this characterization we used descriptive statistics, extracted from the
127 EUROSTAT and FAOSTAT databases, as data are collected according to a standardized methodology. These
128 data characterize the performance of the farming systems in the five countries on an aggregate level.

129 Subsequently we used qualitative and quantitative data acquired in the SUFISA project to explore the
130 configuration of the farming systems in the five national settings and the strategic responses of these in
131 more detail. The farm level was our entry point for data collection, but we also included the perspectives of
132 associated stakeholder groups, as these are important to understand interdependencies in relation to food
133 chain governance and institutional arrangements (Martino et al., 2017). The authors of this article were all

¹ The Greek case study concerned goat milk for Feta production, hence, the results of some of the Greek data is not fully comparable to the other cases.

² Sustainable Finance for Sustainable Agriculture and Fisheries.

134 part of the national teams that conducted the analysis and hold intimate knowledge regarding the
135 configuration of the national dairy farming systems.

136 A number of data sources were used to analyze the five case studies (for a full description see Maye et al.
137 (2018a)). For the description of the strategies for resilience applied in this paper we have focused on two
138 sets of data that describe the farming systems and associated value chains. First, a qualitative inquiry
139 containing 20-30 key informant interviews per country with a range of different stakeholders, including
140 policymakers, farmers, NGOs, and representatives from the value chain and supporting industries was
141 carried out. This work was completed in 2016. Following an initial analysis of these data, two or three focus
142 groups were held in 2017 with dairy farmers in one selected region in each of the five countries. The focus
143 groups and interviews were audio-recorded, transcribed verbatim, open coded, with the meaning
144 condensed according to a grounded research methodology (Corbin, 1998). These data were used to unfold
145 the strategic considerations at farming system level (section 4.3). Second, we conducted a phone or face-
146 to-face survey among farmers in the case study regions during the winter of 2017. The number of
147 respondents ranged between 82-200 (for further information on the survey see Vigani et al., 2018). These
148 data are used to characterize the structure and organization of the farming systems and strategic
149 considerations (sections 4.1 and 4.3).

150 All country-level data were synthesized in individual national case study reports that were presented and
151 discussed with stakeholders for verification. The qualitative and quantitative data were collected and
152 analyzed in an iterative process, hence, the qualitative data obtained in the workshops were used to
153 deepen the interpretation of the results from the survey. A detailed account of the methodology adopted
154 in the SUFISA project and the full dataset on which this article is based can be found in the five national
155 case study reports (Aubert et al., 2018; Grivins et al., 2018; Maye et al., 2018b; Thorsøe and Noe, 2018;
156 Tsakalou and Vlahos, 2018).

157 **3. European regulatory and market conditions**

158 European institutions have a profound impact on dairy price formation and are therefore a highly relevant
159 actor for the dairy sector. It is also important to note that dairy farming systems are the result of a long
160 strategic adaptation process. Therefore, to understand current strategies and structuring of dairy farming
161 systems, we briefly introduce the evolution of the regulatory framework and market conditions that shape
162 the surrounding environment of European dairy farming, particularly regulatory conditions introduced by
163 the EU.

164 Historically, the most important instruments in EU dairy policy have included production quotas, direct
165 payments, intervention storage, export refunds, and import duties (see Table 1). The Common Agricultural
166 Policy (CAP) was developed to improve agricultural production, but the early 1980s marked the beginning
167 of a reform era that eventually liberalized commodity markets (Ackrill, 2000). The CAP was reformed in
168 1984, when milk quotas were introduced to control production, and in 1988 when an expenditure ceiling
169 was imposed by the European Council (EC). A more extensive reform of the CAP took place in 1992, with
170 the MacSharry reform beginning a process of liberalization by decoupling income support from production
171 subsidies (although initially not for the dairy sector), thereby setting the direction for further CAP reforms.

172

173

174 *Table 1 Overview of policy instruments applied to regulate conditions on the European dairy market,*
 175 *developed based on (Jongeneel et al., 2011; MMO, 2019).*

Instruments (2000-2019)	Description
Dairy quotas	National quotas for production were in place between 1984 and 2015.
Income support	Dairy premium introduced after reform in 2003, paid per holding and calendar year. Since 2008 implemented in the SFP scheme.
Public and private intervention storage	Developed to balance the milk market and stabilise market price from seasonal fluctuations. As a result of the 2003 reform, butter and SMP intervention prices were reduced step by step over a four-year period, beginning on 1 July 2004. Butter and SMP intervention prices were reduced by 25% and 18% respectively (2004-08).
Export refunds	Developed to enable EU to discharge some of the structural surpluses on the world market where dairy prices were lower. In 2009 export refunds were reintroduced to help support EU market prices in the wake of the sharp decline in world market prices, however, the refund rates and quantities were considerably lower than previously. Since 2009, exports have been carried out without export refunds.
Import duties	Import duty (tariff) has ensured a price-gap between EU and world market prices for dairy products. Import duties' levels have been only slightly adjusted in the period. However, several trade agreements enable preferential imports at reduced or zero duty, mostly on quota basis.
Stimulation of internal consumption	Various subsidy schemes to stimulate internal consumption of dairy products have been in place, such as school milk scheme, the bakery and ice cream schemes for fat, the casein aid and SMP for feed programmes for protein.

176

177 In 1995, dairy market liberalization was again on the agenda, when agriculture became part of the
 178 multilateral GATT (General Agreement on Tariffs and Trade) negotiations, as trade partners were
 179 discontent with the EU's support of its own agricultural sector (Hansen, 2001). An important policy change
 180 occurred with the "Agenda 2000" agreement in 1999 and the "Fischler reform" in 2003 (IPTS, 2009;
 181 Swinbank, 2008). In relation to the dairy sector, prices for market interventions (buying into storage) for
 182 butter and skimmed milk powder (SMP) were lowered in favor of direct support. These instruments were
 183 previously important stabilizing mechanisms of the milk price within the EU that guaranteed producers a
 184 minimum milk price – in effect, the gap between the European and world market prices gradually
 185 decreased (EC, 2018). While in the EU milk prices were 91 % higher than those on the world market in the
 186 period 1997-2003, they decreased to 52 % in 2004-2006, and again in 2007-2008 to just 13 % (Jongeneel et
 187 al., 2011). Milk prices became increasingly volatile, particularly after 2006, due to a production boom on
 188 world markets.

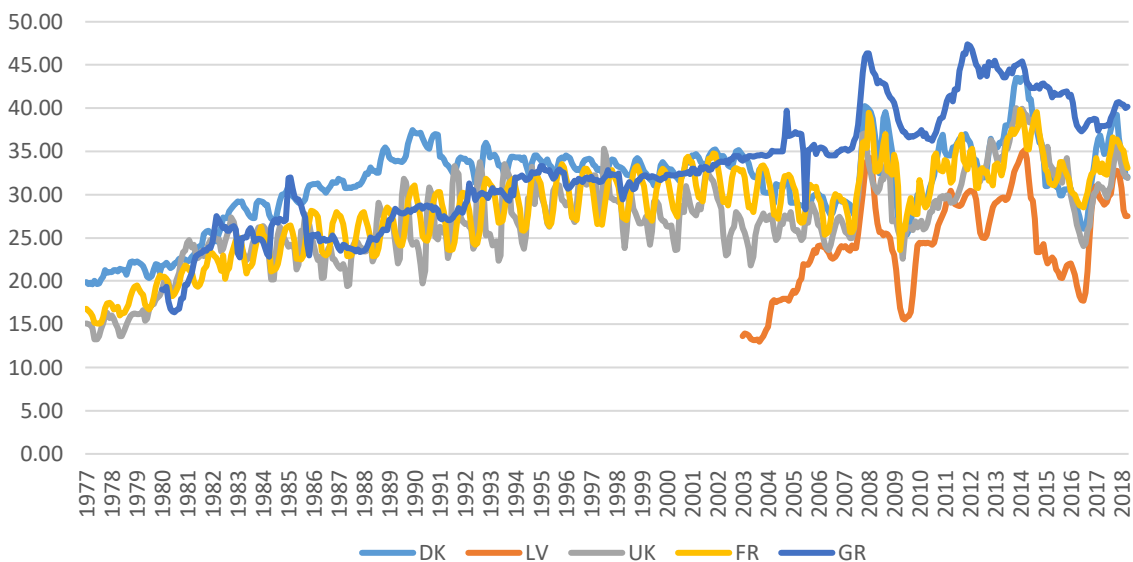
189 The CAP Health Check review in 2008 resulted in a decision to abolish milk quotas in 2015, thus further
 190 liberalizing milk production across Europe (EC, 2008). To ease the transition the EC decided to gradually
 191 increase quotas by 1 % annually in the period 2009-2013. In addition, the "Milk Package" was developed in
 192 2012 to ease the transition for producers. The Milk Package included provisions to support the collective
 193 organization of dairy farmers and improve market transparency. Instruments like contractualization,
 194 support for Producer Organizations (POs) and sustaining quality production were also part of the package
 195 (EC, 2014, 2016). The quota abolition coincided with a number of other factors that influenced the milk
 196 price, including a reduced Chinese SMP market and a trade ban from Russia. To sustain dairy farmers, the

197 EC took a number of initiatives, for instance, extending periods of public and private storage aid, although
198 with little effect on the milk prices within the EU (EC, 2018; OECD, 2017).

199 This liberalization of market policies had a direct influence on the dairy market. The period up until 2006
200 was characterized by a relatively stable commodity price, although with an annual variation (see Figure 1).
201 This was due to the interventionist policies of the CAP (Jongeneel et al., 2011). However, the gradual
202 liberalization of the dairy market was quite evident in the subsequent years, where prices were
203 considerably more volatile. Prices were generally high in the years 2007-2008 and 2013-2014, while they
204 were low in 2009-2010 and 2015-2016. However, there were also remarkable regional variations in the
205 volatility. For instance, the amplitude of milk price cycles ranged between 10-20 EUR per 100 kg of milk
206 reflecting about 50 % of the average commodity price (2006-2018), highest in Latvia (EUR 17-20) and
207 lowest in Greece (EUR 10). However, it is important to note that the EU intervention policies still had an
208 effect in these periods, therefore variations do not reflect an undistorted market.

209 Each of the five countries analyzed has a different history and relationship with the EU. France was one of
210 the founding members of the community and member since 1957, whereas the United Kingdom and
211 Denmark both joined in 1973, and Greece followed in 1981, hence these countries have all experienced the
212 process of policy transformation of the productivist European agricultural policies. The UK has since exited
213 the EU (January 2020), but the regulatory environment for the period of analysis was set by the EU. Latvia is
214 again somewhat different, as it became a Member State of the EU in 2004 along with nine other East
215 European countries, but have followed a comparable trajectory to other European countries since
216 accession. Furthermore, the countries all have different socio-economic and political development
217 trajectories, institutions, and varying biophysical conditions that have given rise to somewhat different
218 dairy farming systems.

219



220
221 *Figure 1 Monthly development in milk price (EUROSTAT, 2019).*

222 In sum, the CAP regime has changed from a production-oriented policy underpinned by price support to a
223 'multifunctional' policy emphasizing environmental protection and rural development. Policy interventions
224 to sustain milk prices have been reduced in favor of provisions to ensure better collective organization of

225 dairy farming systems, quality labelling, and increasing market transparency. This process has gradually
 226 destabilized the agricultural commodity prices increasingly exposing European producers to world price
 227 volatility.

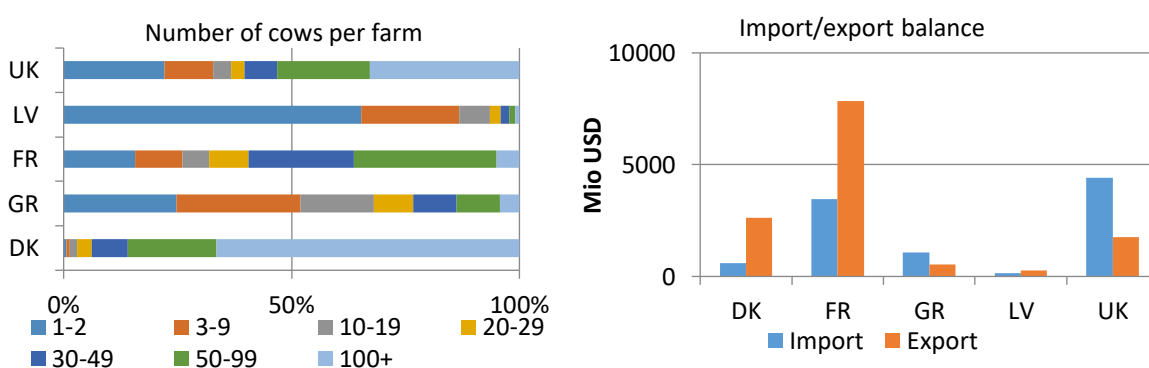
228 4. Results

229 In this section, we compare the strategic responses adopted by farming systems and dairy sectors to
 230 market liberalization and increased price volatility in the five European countries. Initially we describe the
 231 structural characteristics of the dairy sector at the national level. Afterwards we present the effect of the
 232 strategies as reflected in the price levels and production volumes, and examine the strategies that farming
 233 systems and dairies have developed to manage changing market conditions.

234 4.1 Structure and organization of the dairy sector

235 The dairy sectors in the five countries have experienced different developmental pathways in terms of
 236 structure and organization of milk production (see Figure 2). Key differences include characteristics of dairy
 237 farming systems, contractual relationships in the value chain (see Table 2), and the temporality of these
 238 relations.

239 The orientation of the dairy sector varied considerably, – countries like Denmark and France had a large
 240 export share of dairy products, Latvia had a slight dominance of export over import, while Greece and the
 241 United Kingdom were net importers (see Figure 2). The structure of dairy farming systems also differed
 242 notably between the five countries, but there were also variations within each of the countries (see Figure
 243 2). Denmark had the most homogeneous and intensive dairy farming systems, as majority of farms had
 244 more than 100 cows; the Latvian dairy sector was by far dominated by small-scale dairy farming systems
 245 with less than 10 cows, but was also home to large-scale and industrialized production facilities.
 246 Furthermore, there were considerable inter-country variations in the share of organic production ranging
 247 between 2-12 %.



248 *Figure 2 Left: Number of dairy cows per farm in the five countries (EUROSTAT, 2019).*
 249 *Right: Market characteristics, balance between import and export in the five countries (FAOSTAT, 2019).*

250
251

Table 2 General characteristics of the survey participants (Source: SUFISA survey data).

	Number of respondents	Collective agreement	Individual agreement	Size (ha)	Herd size (Cows)	Yield (Ton/year)	Productivity (Ton/cow)
Denmark	82	79	3	203,7	259,9	2543,2	9,8
United Kingdom	200	83	117	183,7	237,6	1855,7	7,8
France	100	84	16	98,5	70,9	524	7,4
Greece	150	25	125	16,3	182,9 ³	31,9	0,2
Latvia	142	65	77	303,2	102,8	709	6,9

252

253 The SUFISA survey explored the relationship between dairy farming systems and processors in one region in
254 each of the countries. These data show that dairy farming systems in Denmark and France are primarily
255 arranged into collective organizations, such as cooperatives that are responsible for processing and selling
256 products. Dairy farming systems in Greece are primarily associated with processors based on individual sales
257 contracts. In the United Kingdom and Latvia there is an almost equal split between individual and collective
258 sales agreements.

259 In cooperatives the added value of milk processing is transferred back to individual farming systems.
260 However, private processors may offer better prices, particularly in periods with high demand for dairy
261 products. The duration of a contract between primary producers and processors is important, as long-term
262 investments are required to establish dairy production. Generally, dairy farming systems in Denmark, France,
263 and the United Kingdom have quite long running contracts, typically lasting for more than a year (see Figure
264 3). This is in contrast to dairy farming systems in Greece that have shorter contract durations, typically less
265 than a year. Dairy farming systems in Latvia are again very heterogeneous, as about 50 % of primary
266 producers have contracts with a duration of less than a year and another 50 % have contracts of more than
267 two years. However, it is important to note that unlike the restricted number of processors in France,
268 Denmark, and the UK, producers in Greece and Latvia have access to a wider range of different processors
269 allowing for more flexibility in choosing bulk buyers of their raw milk.

³ Note: the case study for Greece explored sheep and goat milk production

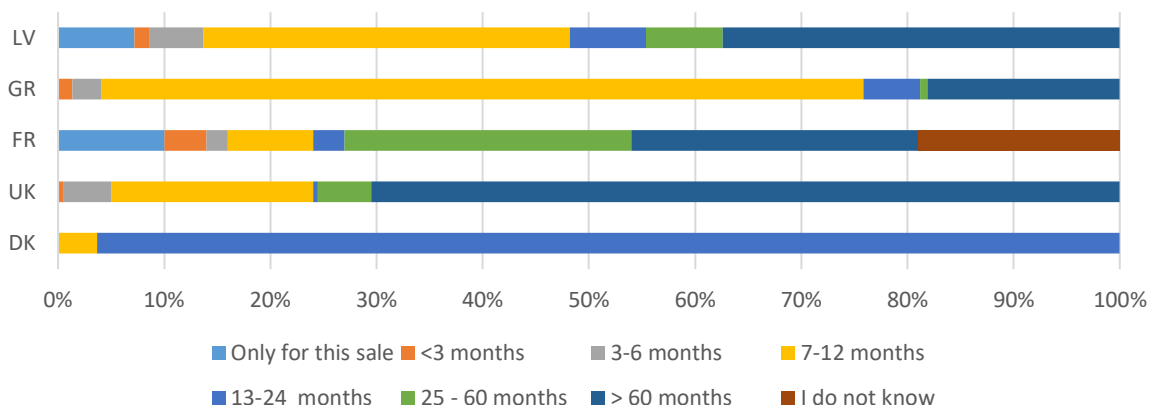


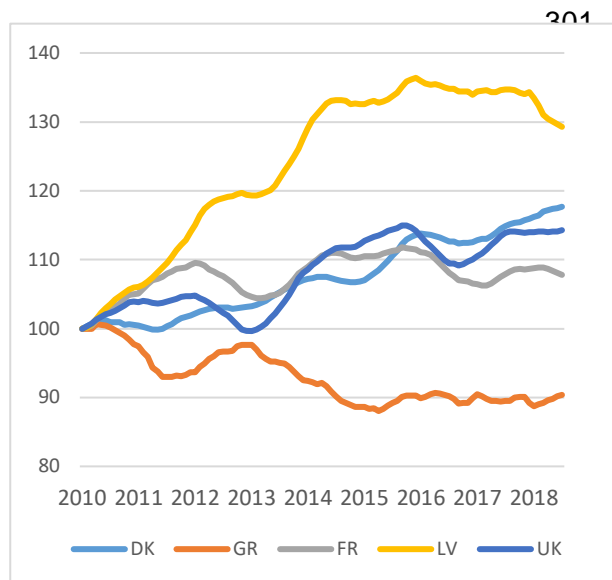
Figure 3 Contract duration of dairy farmers in the five countries. Replies to the question: “What is the duration of this sale agreement or membership in a collective organization?” (Source: SUFISA survey data).

271 4.2 Development of production and price

272 Although the dairy market was gradually liberalized, there was considerable fluctuations in the prices that
 273 dairies offered to producers in the five countries (see Figure 1). In the expert interviews and focus groups,
 274 differences in dairy prices across countries can be explained as variations in the local markets, products,
 275 and degrees of integration in the world market. Besides, there are country-specific variations, as farming
 276 systems in Latvia received prices below world market price, while farming systems in Greece received high
 277 and relatively stable prices. An explanation for this development is Latvia’s stronger reliance on the Russian
 278 food market and therefore a higher market sensitivity to the Russian trade embargo, as well as power
 279 asymmetry in the value chain, where processors have a strong position. In contrast, dairies in Greece are
 280 more focused on the lucrative fresh milk market within Greece, and dairies are therefore less sensitive to
 281 global price volatility. Interestingly, we observed a convergence of the milk prices in all the five countries
 282 since 2010, likely reflecting the increasing world market integration of European dairy farming systems
 283 following the gradual market liberalization.

284 Milk price levels and production volumes have continuously changed in the last decade both on an annual
 285 basis and in a longer-term perspective (see Figure 4). The annual variation is particularly due to changes in
 286 fodder composition, the timing of calving, and access to grazing in the summer period. However, there
 287 were variations across countries as, for instance, farming systems in all the examined countries maintained
 288 continuous production throughout the year, except for Latvia where production varied by about 15 %
 289 points annually. In the long-term perspective, we observed an annual production increase in all countries
 290 since 2010, except for Greece. This increase has been most significant in Denmark and Latvia, although
 291 Latvia came from a low starting point in terms of productivity. Interestingly, the development since the
 292 beginning of 2015 also marks a period of change in the dairy sector, the trends in Greece, Latvia have come
 293 to a halt, and instead we have seen a rapid production increase in Denmark and a slightly declining
 294 production in France. The Greek case is a bit of an outlier because Greek farmers focus on Feta production
 295 based on goat milk, which is generally less volatile because markets are not exposed to international
 296 competition and volatility due to a focus on quality and uniqueness.

297 Expert interviews and focus groups identified three explanations for this development. Firstly, Denmark
 298 was constrained by milk quota, as high productivity and increasing production were seen as an important
 299 objective at both processors' and farming systems' levels. Accordingly, when the quotas were abolished
 300 milk production increased, which was also encouraged by local dairies. Furthermore, the removal of quotas



	Total production (1000 tons)		Development in production
	2010	2018	2010-2018
DK	4.818	5.615	16,56 %
GR	688	620	-9,82 %
FR	23.375	24.583	5,17 %
LV	625	780	24,85 %
UK	13.584	15.180	11,75 %

Figure 4 Left: Raw milk collected at dairies, monthly data, and 12 month running average; normalized based on 2010 (MMO, 2014). Right: Total dairy production and production development in selected European countries in 2010-2018 (EUROSTAT, 2019).

304

305 influenced the wider milk pool and opened the market, particularly at a European level. Secondly, dairies in
 306 France have had no interest in expanding production in times of low prices and have deliberately not
 307 purchased more milk than what they could sell. Therefore, the strategic response by farming systems was
 308 strongly conditioned by the strategic response of the dairies that they supplied. Thirdly, in Latvia the last
 309 decade was also characterized by an internal restructuring of farming systems, as farm sizes, productivity,
 310 and number of cows per farm have increased considerably.

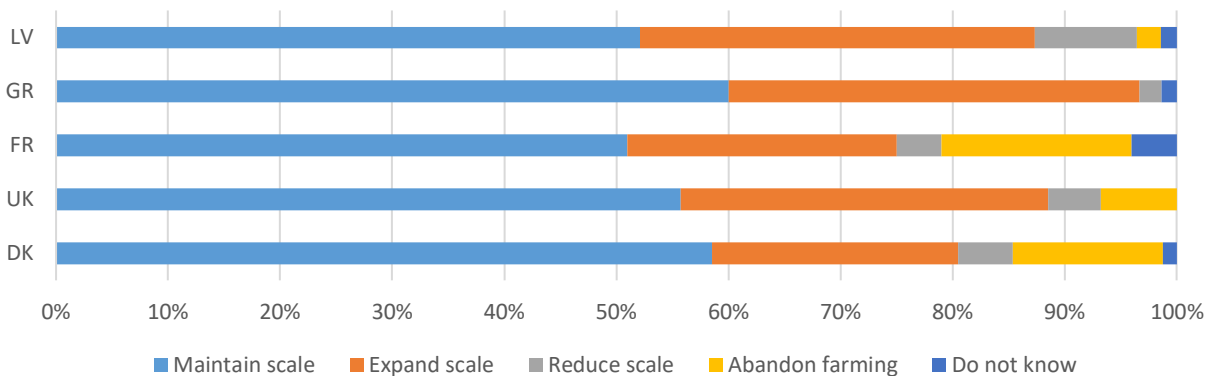
311 4.3 Strategic considerations of the farming systems

312 The development of dairy price and production was quite different across the case study countries.
 313 Nevertheless, we observed the same structural tendencies. Farms keep getting bigger and there was a
 314 tendency for all farming systems to improve the efficiency of their production because of the market
 315 situation (see Table 3). However, the efficiency improvements also reflected an extension of the strategic
 316 orientation at individual farming systems level and the fact that different strategic opportunities were
 317 available due to diverse backgrounds in each country. Based on the case studies it is also clear that it is
 318 challenging for farming systems to formulate resilient strategies, which may lead to a fundamental
 319 restructuring of the European dairy sector.

320 Within each country, farming systems undergo a continuous structural development, but we also see an
 321 emerging regional concentration of dairy production at European level, in Denmark (as well as other

322 countries in North-Western Europe), where conditions for dairy production are favorable and where the
 323 milk quota previously limited production. In all countries, we observed increasing farmer age and issues
 324 with the reproduction of farming systems. Succession is increasingly problematic following market
 325 liberalization as it is difficult for young farmers to see a future as dairy farmers and to attract sufficient
 326 capital for succession due to the increasingly volatile and low-income milk market.

327 In the survey we also explored how farmers observed the disturbances and their views of the future. The
 328 data show little overall variation between the countries regarding the expected strategic response of the
 329 dairy farming systems in the present situation (see Appendix 1). Many dairy farming systems faced income
 330 problems and were left with few strategic options. For instance, a majority (ranging from 50-60 %) of the
 331 survey respondents across the five countries indicated that they planned to “maintain the existing scale of
 332 operation” (see Figure 5). Only a minority of respondents (20-35 %) indicated that they planned to “expand
 333 the existing scale of operation”, most pronounced in Greece, Latvia, and the United Kingdom. Lastly, a
 334 minority of less than 20 % of respondents indicated that they intended to either “abandon farming” or
 335 “reduce the existing scale of operation”, most pronounced in France and Denmark. For the Danish case
 336 study, this may be due to the fact that a large number of dairy farms had already expanded their operations
 337 prior to the quota abolition and because there were a number of older farmers who intend to retire once
 338 property prices increase.



339 *Figure 5 Farmers' strategies. Replies to the question: „What are your strategies for the*
 340 *development of dairy farming within the context of your farm business in the coming 5 years?”*
 341 *(Source: SUFISA survey data).*
 342

343 A number of local issues, such as value chain configuration, market dependence, and local market
 344 characteristics influenced farming systems and their ability to endure in times of crisis. Whereas the
 345 farming systems in the United Kingdom, Greece, and to some extent Latvia were more embedded in local
 346 markets and the production of fresh products, other countries like France and Denmark were more
 347 dependent on export markets, hence, they were more influenced by world market dynamics (see Figure 2).
 348 In effect, we observed that countries like Denmark expanded production whereas other countries,
 349 especially pronounced in Greece, but also Latvia, focused on added-value production like organic
 350 production or engaged in various subsidy schemes to support their economy.

351 To explore the changes farming systems intend to implement to meet their strategic ambitions the survey
 352 included a question addressing the expected changes to the farming system in the coming five years (see
 353 Appendix 1). Between 35-60 % of respondents indicated a plan to invest in production facilities, most

354 pronounced in Greece and Latvia. An ambition to specialize their production further was indicated by 20-40
355 %, most pronounced in France. However, there were also major points of divergence across the countries.
356 For instance, around 50 % of respondents expected to insure against crop or livestock losses in Denmark
357 and Latvia, which was substantially higher than the other countries. 70 % of respondents in Denmark
358 indicated a plan to add value, for instance, by converting to organic production (where prices for organic
359 milk were substantially higher for a long period), which is about 50 percentage points higher than other
360 countries. Furthermore, 45-50 % of respondents in Latvia expected to secure income and develop new
361 partnerships, which is 20 percentage point higher than other countries. Therefore, the strategic response of
362 the farming systems to the changing conditions on the dairy market were associated with the commodity
363 type (and therefore general across the countries) as well as specific and deeply embedded in local
364 contextual features.

365 Survey participants were also asked to indicate what influences their decisions regarding production and
366 farming strategies. A number of factors were highlighted as important drivers across the different cases –
367 particularly, changes of regulations, consumer preferences and behavior, and access to loans and credit
368 (see Appendix 2). Adverse climatic conditions were also highlighted as important drivers, particularly in
369 France and Latvia, but the importance differ across cases. This suggests that the five case studies are
370 influenced by different environmental and biophysical factors influencing milk production.

371 We also examined farming and marketing strategies based on qualitative data obtained in interviews, focus
372 groups, and workshops. Here we observed a pronounced difference in the strategic response of farming
373 systems, on the one hand, and processors, on the other. The strategic response of the processors varied
374 quite a lot across countries, due to many different factors such as their market orientation, size, product
375 output, and technical setup. Each individual processor adopted its own strategic response depending on
376 the market conditions, i. e., the nature of their contracts with specific supermarkets, the market of the
377 specific products they produce, and the processing capacity in the dairies' system. This implies that the
378 strategic opportunities available for the farming systems should also be understood in relation to the
379 corporate strategies in the value chain.

380 Although the different farming systems were vulnerable to price volatility, the specific impacts of this
381 disturbance varied. In countries like Greece, Latvia, the United Kingdom, and France, much of the milk
382 production takes place in relatively old production facilities. Likewise, farming systems are more self-
383 sufficient and have lower debt levels, compared to the Danish case. Hence, when prices are low, farmers
384 are able to either abandon dairy farming altogether or accept a period with low wages or overdraft. In a
385 country like Denmark where dairy production primarily takes place in modern high-tech production
386 facilities the challenge is different. These production facilities demand large investments, implying a high
387 share of fixed costs, and require production at full capacity to service loans. Accordingly, when prices
388 fluctuate these facilities will run with a deficit in some periods (and in some cases quite a large one).
389 Therefore, to endure, different farming systems have adopted different strategies to manage volatility. In
390 Denmark production was expanded to full capacity thereby reducing marginal costs per unit of produce,
391 whereas in France farming systems were restricted by a voluntary quota system coordinated by the dairies,
392 and in the United Kingdom production contracts dominated.

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Table 3 The strategic response of farming systems following market liberalization and increasing price volatility (Aubert et al., 2018; Grivins et al., 2018; Maye et al., 2018; Thorsøe and Noe, 2018; Tsakalou and Vlahos, 2018).

	Configuration of milk production	Strategic response of the processors	Strategic response of the farming systems
Denmark	Large-scale and industrialized production facilities. Milk is processed by several cooperatives (Arla is by far the largest). Historically the Danish dairy industry is very export-oriented as 2/3 of production is exported Denmark.	Gradual increase in production, particularly after the quota abolition. A strategy dominated by an ambition to conquer market shares on the global market.	Crisis response has primarily been to lower production costs per kg of milk, by locally expanding production or converting to organic production to get price premium.
France	Great regional differences in production systems. Two main market channels, either cooperatives or private dairies, each of these have approximately the same size. Most milk is sold as standard milk for processing at the dairies.	Deliberate capacity restrictions in the processing sector to ensure stable production in an attempt to not destroy the local market.	Two strategies are prominent, either extensification via pasture-based production or intensification.
Greece	Small-scale and fragmented dairy sector with few international enterprises. Produce around half of the Greek consumption of cow milk products. 60 % of the Greek dairy sector produce goat and sheep milk.	Producer cooperatives are a dominating institution to ensure competition.	Lacking credit access imply difficulties to formulate a strategic response in the current situation of low prices.
Latvia	High share of small scale farming systems with low productivity and uncoordinated processing system. Traditionally, milk is wholesaled at spot market, hence, no long-term contracts for farmers who have a weak position in the value chain.	Initially low milk prices and reliance on the Russian market. However, the entrance of a few large multi-national companies has increased prices and boosted production.	Emphasis on productivity improvement, implying increasing production. Initially the milk price crisis implied that farmers were forced to sell their milk below the costs of production. Several strategies are, however, available, including selling at spot markets to the highest bidder, surviving on subsidies or including new revenue streams.
United Kingdom	Fragmented dairy sector, a number of different market arrangements exist, both cooperative and private. Supermarkets dominate, particularly the liquid milk market. About 65 % of dairy production in the United Kingdom is sold as liquid milk, with only 25 % turned into cheese and 10 % into powders and butter.	Contracts have become an increasingly important feature of dairy supply chains. A range of different actors employing different strategies dominate the milk market. Some processors have introduced an A and B pricing regime to control supply.	Low milk price is an existential concern, but price stability (stable market) is also essential; farmers receive different prices based on the nature of their contract. However, the crisis has implied an increasing contractualization, diversification of revenue streams and conversion to organic production.

397

398 Thus, dairies also act in a highly competitive market and formulate their own strategic response ensuring
399 the perseverance of their companies, sometimes at the expense of individual farmers. During the period of
400 milk quotas and stable market prices, volatility had not been considered by dairies because prices and
401 production volumes were relatively constant. However, when this changed new institutions were
402 developed to ensure stability for the dairies, but often these meant less flexibility for producers. For
403 instance, in the case of Denmark higher entrance fees to cooperatives were adopted to ensure that farmers
404 do not exit if offered better prices at another dairy. French dairies, in turn, have adopted voluntary
405 production ceilings. Hence, the emerging price volatility was transferred directly onto primary producers.

406 **5. Discussion**

407 As documented in this article, liberalization and the volatile nature of the dairy market has had a profound
408 impact on the conditions of milk producers in Europe. In the following, we discuss the effects of the
409 strategic response of the farming systems with respect to the resilience of the European dairy sector.

410 **5.1 Dairy production in a volatile market**

411 In response to market liberalization the dairy market has become highly volatile in contrast to previously
412 stable dairy market conditions (Veerman et al., 2016). Price stabilization was an important feature of the
413 European dairy market assuring the viability of small-scale farming systems in marginal areas that may not
414 have endured in the absence of market protection (Dervillé et al., 2017; Dillon et al., 2005; McDonald and
415 Macken-Walsh, 2016). European farming systems were adjusted to these market conditions and they were
416 therefore challenged when this protection was abolished.

417 An important effect of liberalization was an increase in the production of milk in the EU, despite low or
418 volatile prices. For the single farmer it was rational to increase production to endure, but for the European
419 dairy sector as a whole it was problematic, because increasing production further lowered the milk price.
420 Consequently, there is a trade-off between the rationality of individual farming systems and of the dairy
421 sector as a whole. On a more aggregate scale, market liberalization has also changed the structural
422 dynamics of land use and milk production within the EU. Milk production is therefore expected to further
423 concentrate in regions with temperate climate and high grass growth as these have a comparative
424 advantage, whereas quotas previously restricted this structural adjustment (Boere et al., 2015; Huettel and
425 Jongeneel, 2011; Läßle and Sirr, 2019). Thus, liberalization threatens dairy farming systems in other
426 regions, particularly in areas with low production density and a low degree of quality differentiation
427 (Dervillé et al., 2017).

428 Like the individual dairy farming systems, the dairy processing sector in most European countries has also
429 experienced pronounced consolidation in the last two decades resulting in a number of multinational
430 companies (Grau et al., 2015). This has implied a strategic reorientation of these companies emphasizing
431 economies of scale, and they have become increasingly distanced from primary producers, although the
432 largest processors are still cooperatives (Juliá-Igual et al., 2012).

433 Today, economic forces encourage more efficient milk production in the EU and further adjustment is
434 expected (Nehring et al., 2016). In this article we have also observed that the changing conditions have
435 accelerated the competition between dairy farming systems within Europe. Particularly, in North-Western

436 Member States' production increases while it stagnates or declines in other regions, as farming in these
437 regions currently is unable to maintain production under the new market conditions. However, the
438 adjustment is gradual as dairy farming systems are slow to adjust to changing conditions due to a high
439 share of sunk costs in the production facilities and because of the strong cultural importance of dairy
440 production. Besides, local policies to reduce manure production is a barrier for this development in regions
441 that already have a high livestock density (Grinsven and Bleeker, 2017).

442 Currently we observe a transition to more extensive and value-based production in some areas of the five
443 countries (mountainous and marginal regions) and his accelerated structural adjustment was also observed
444 in studies from France, Ireland, the Netherlands, and Belgium (see, e. g., Deming et al., 2020; Dervillé and
445 Allaire, 2014; Pinter and Kirner, 2014). Hence, structural adjustment not only concerns individual farming
446 systems, but also the rural areas in which these farming systems are embedded (Darnhofer et al., 2016).
447 This is particularly true for dairy farming because of its historical organization as family farming and a
448 strong cooperative organization in many countries.

449

450 **5.2 Configuration of risks and resilience**

451 Increasing price volatility is a major disturbance, and it is problematic in dairy farming, particularly for
452 industrial systems because relatively long-term investments and a high specialization is required, which
453 lead to a substantial path-dependency (van der Ploeg, 2016). Although specialization offers advantages in
454 terms of productivity gains, on the downside farm income is tied to a single commodity. Such dependence
455 can become a threat as it increases farmers' vulnerability to market shock. Furthermore, farming systems
456 also rely on the world market in relation to input factors, such as feedstuff or fuel, and prices for these
457 commodities have also become increasingly volatile. Accordingly, volatility incurs an increasing complexity
458 of the surrounding environment to the farming systems and inability to manage this complexity results in a
459 poor adaptive capacity (Alrøe and Noe, 2012; Darnhofer et al., 2016). Managing this complexity requires an
460 increasing attention to the timing of investments and risk management as this determines the profitability
461 of farming. Although milk prices are volatile, production is quite inelastic, and it is difficult to adjust
462 production from one month to the next. Hence, the disturbances currently faced by producers are also the
463 result of past strategic decisions and the production system design at a time when market conditions were
464 different.

465 Market liberalization has also accelerated an increasing individualization of market-related risks, as
466 foreseen in several studies (Breustedt et al., 2011; IPTS, 2009; Jongeneel et al., 2010). The milk market
467 liberalization ,thus, also reflects a changing power balance in the commodity chain in favor of downstream
468 actors (Jongeneel et al., 2011). However, as documented in this article, even though farming systems are
469 managed by the same regulatory framework, they respond with different strategies when faced with these
470 changes to the basic conditions.

471 Dairy farming systems are also slow to adjust, therefore stable market conditions are needed, or
472 alternatively a strategy to manage price volatility is needed (EC, 2014, 2016; Jongeneel et al., 2010). As
473 shown in this article, effective institutional arrangements to safeguard individual farming systems were not
474 in place or not sufficiently effective prior to quota abolition and the market disturbance that followed in
475 2015, which may be an important factor in understanding the current crisis (EC, 2016).

476 Market liberalization has implied that the European dairy sector is increasingly competing with those in
477 countries outside the EU, thus, changes in these other sectors will inadvertently influence market
478 conditions in Europe and vice versa (Young et al., 2006). The European dairy market liberalization makes it
479 difficult to transfer increasing costs of production to the market in situations of extreme local events, like a
480 drought, as these are decoupled from global market dynamics (Biggs et al., 2011). Positive local
481 externalities such as landscape preservation or employment are potentially difficult to transfer at a global
482 level, as consumers have a higher preference for effects in the local area (Feldmann and Hamm, 2015).

483 Although produce is sold locally commodity prices are not determined by local dynamics and according to
484 Veerman et al. (2016) this implies that a need to emphasize risk management. Thus, strategies to manage
485 volatility are critical for the resilience of farming systems. However, as shown in this article, dairy farming
486 systems have very few strategic opportunities to cope with this volatility and they for instance cannot easily
487 convert to other commodities like arable farmers. Therefore, the opportunities for risk management are
488 few as the competitive space is restricted because milk is a highly standardized product and the strategic
489 choice primarily relates to how input factors are converted into milk. Milk is also perishable which calls for
490 fast and continuous processing.

491 A resilient farming system needs to be able to buffer shocks, adapt, or transform, while still maintaining its
492 identity (Darnhofer, 2014). In this article, we show that it is difficult for farming systems to address the
493 challenges they face in the context of liberalization and price volatility; in fact, the cases reported here
494 illustrate different strategies that are not very resilient because they have changed the nature and identity
495 of the systems. For instance, we observe structural development and restricted investments and
496 abandonment that prevents succession on dairy farms. Apparently, dairy farming systems are unable to
497 adopt resilient strategies, as these do not sustain the family-based farming that are typical to European
498 dairy production. Although these problems are not exclusively caused by market liberalization and
499 increasing price volatility these disturbances certainly aggravated them.

500 **5.3 Implications for policymaking**

501 The analysis of the five case studies provides an important comparative perspective on the ongoing
502 changes in the European dairy sector following liberalization and increasing price volatility. The core idea
503 behind the EU policies have been to liberalize market conditions and mitigate the negative effects by
504 income support, rural development initiatives, and by improving collective organization of producers, to
505 promote individual insurance, and to combat unfair trading practices (EC, 2013). This article illustrates the
506 importance of a more holistic focus on the challenges of dairy farming systems in order to sustain resilience
507 by developing sectoral strategies to address systemic issues that these systems face. Farming systems are
508 part of a complex value chain, and resilience cannot be advanced at farm level alone, but should be
509 sustained across the entire value chain.

510 As also documented in this article, there are considerable differences in the contractual arrangements of
511 different European dairy farming systems, however, the “Milk Package” provisions are insufficient to
512 ensure resilience in the dairy sector. Development of producer organizations does provide dairy farming
513 systems with more bargaining power, particularly in regions with few cooperatives (EC, 2014). However,
514 the volatile market conditions (of milk and input factors) are largely unaffected by the provisions in the
515 “Milk Package”. Strengthening producer organizations to improve producers’ bargaining power has been
516 successful, but many downstream players are large-scale multinational corporations that are powerful and

517 difficult to challenge. Furthermore, as we have shown in this article, farming systems in countries with a
518 high share of cooperatives do not experience significantly better conditions. An explanation may be that
519 improving the bargaining power of farming systems in relation to processors is ineffective if the latter are
520 also in a disadvantaged position in relation to downstream actors (Clapp, 2014). Moreover, the
521 internationalization of the processors has changed their internal power dynamics reducing the influence of
522 individual farmers and has accentuated their need for a global market orientation (Madelrieux et al., 2018).

523 **6. Conclusion**

524 The aim of this article was to explore how different European farming systems have responded to
525 liberalization of milk markets and resulting price volatility based on a comparative case study of dairy
526 farming systems in five European countries. The article shows that dairy farming systems in all five
527 countries have been challenged by these disturbances, but have adopted different strategic responses.
528 These differences across countries can be explained by diverse strategic options for the farmers due to
529 differences in the strategies of the dairies, production factors (production facilities and biophysical
530 conditions), and market orientation. Nevertheless, no country has successfully formulated strategies
531 sustaining resilience of their farming systems. Hence, the structural changes we have seen so far may
532 continue and imply a longer readjustment of the European dairy sector with an impact on land use when
533 grazing dairy cows disappear or grasslands are converted to other land use, unless new policies mitigating
534 these changes are developed.

535 We contend that the crisis European dairy farming systems have experienced since the abolition of the milk
536 quota is not the result of unfair trading practices, but rather the effect of a successful European integration
537 in the world market. This is a predicament for policymakers, as it is difficult to effectively address the
538 challenges of this market integration without compromising the underlying idea of liberalization and the
539 resulting price volatility.

540

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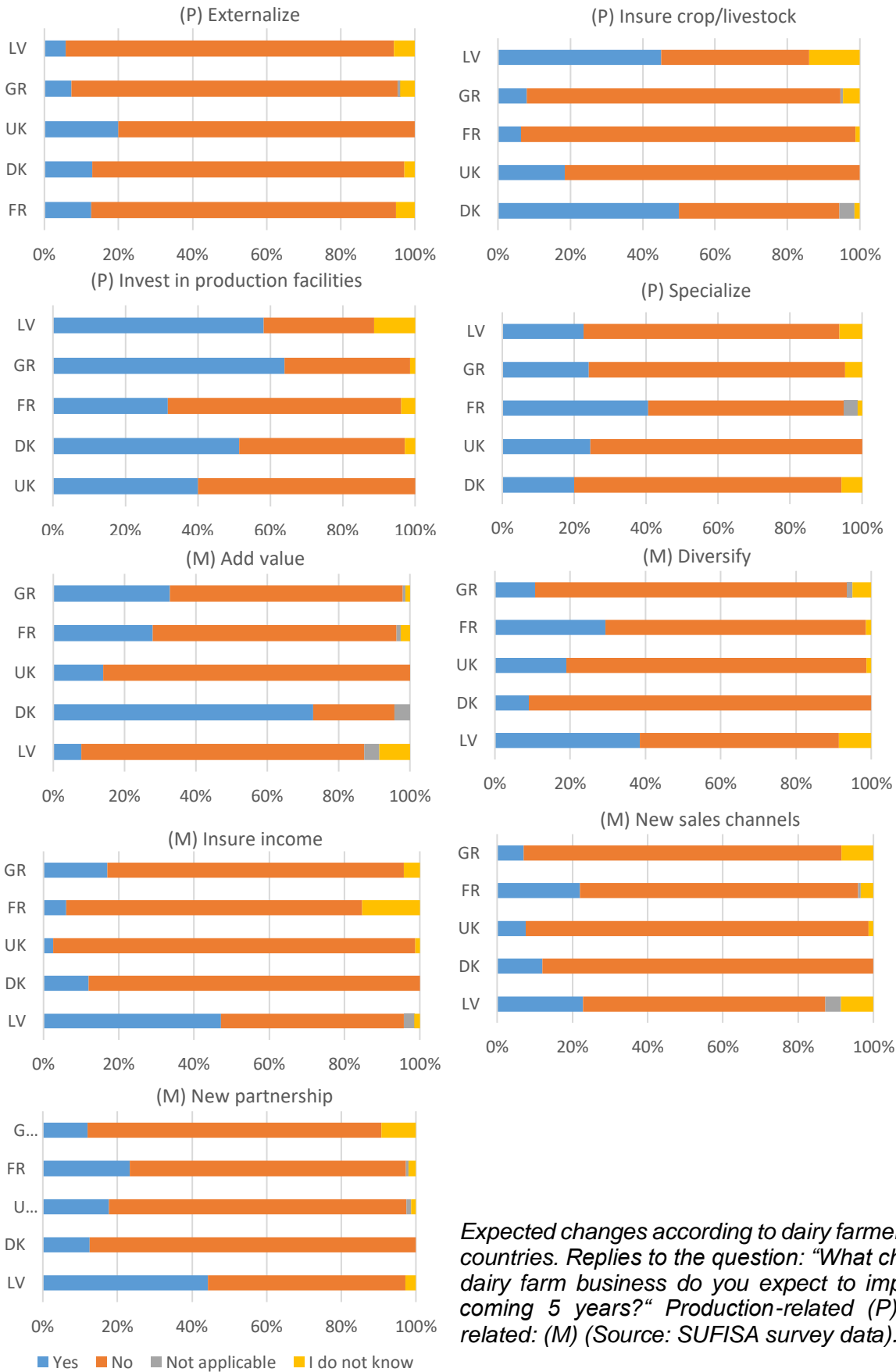
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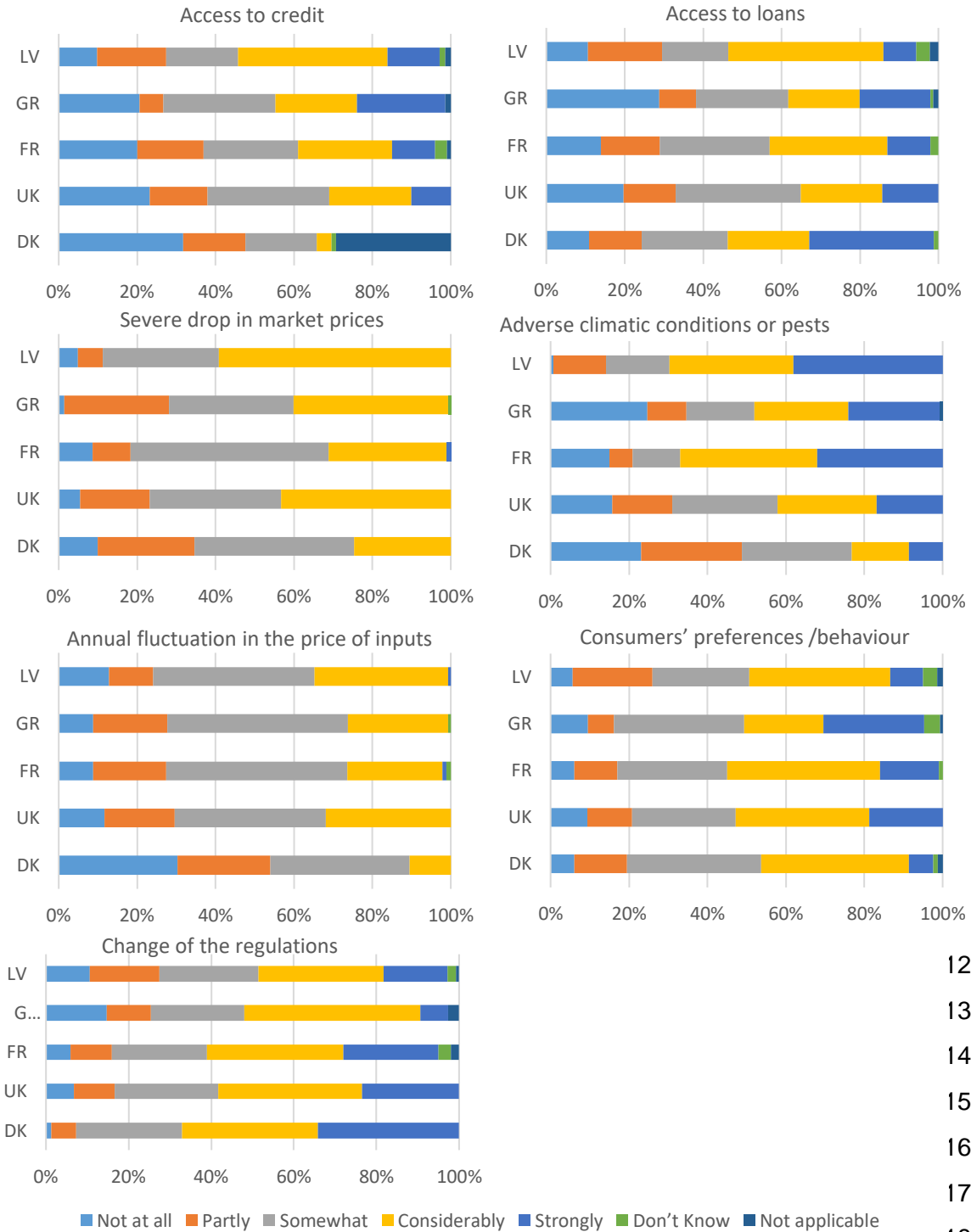
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Expected changes according to dairy farmers from the five countries. Replies to the question: "What changes to your dairy farm business do you expect to implement in the coming 5 years?" Production-related (P) and market-related: (M) (Source: SUFISA survey data).

690 **Appendix 2**



Drivers of farmers' strategies according to dairy farmers from the five countries. Replies to the question: „To what extent might the following factors influence your decisions regarding your production and farming strategies for milk?“ (Source: SUFISA survey data).