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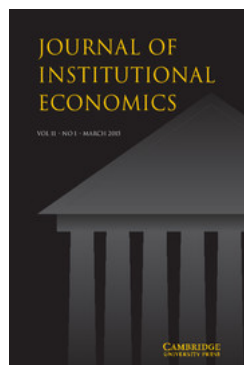
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The evolution of the Dutch dairy industry and the rise of cooperatives: a research note

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Abstract: Economic historians tend to explain the rise of the cooperative form in agriculture from the advantage of cooperative over private factories in reducing transaction costs with suppliers. This study provides a first test of this thesis using data on 1,130 dairy factories in The Netherlands. Indeed, we find that cooperative factories performed significantly better than private factories. The persistence of private factories in certain regions can be explained by first-mover advantages.

1. Introduction

In several European countries (e.g. Denmark, Ireland and The Netherlands), the industrialisation of the dairy sector at the end of the 19th century involved the emergence of cooperative factories, which came to dominate in the 20th century. Economic historians have extensively studied the dairy sector, because few other sectors have shown such a rapid and wide diffusion of cooperatives (Henriksen, 1999; O’Grada, 1977; O’Rourke, 2006; Van Zanden, 1994). Among historians, consensus has grown that the success of cooperatives can be attributed mainly to their capability to solve the ‘transactional’ problem between farmers and factory owners. The high transaction costs between private factory owners and milk-supplying farmers stemmed from the difficulty of factory owners to monitor the quality of the milk supplied, while farmers who join a cooperative were less incentivised to supply low-quality milk. Furthermore, joining a cooperative provided a way for farmers to break the spatial monopsony position of private factories and, by doing so, to realise a higher return on their milk. Hence, the success of cooperatives can be understood from the superior alignment of farmers’ incentives and interests in cooperatives compared with a vertically disaggregated market.

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The evidence for the success of cooperative over private dairy factories has been circumstantial: after an initial period during which private enterprise dominated, cooperatives quickly became the dominant organisational form in the dairy industry, be it in Ireland (O'Grada, 1977; O'Rourke, 2006), Denmark (Henriksen, 1999; O'Rourke, 2006) or The Netherlands (Van Zanden, 1994). Though this pattern of diffusion is certainly remarkable and suggestive, one cannot deduce from the diffusion of the cooperative form that cooperative factories outcompeted private factories. Instead, one is in need of a statistical test controlling for other possible performance determinants. Furthermore, the continuing presence of private dairy factories in selected regions calls for a more detailed analysis.

We analyse the survival determinants of dairy factories including, among other variables, a factory's organisational form (private vs. cooperative). In doing so, we follow the spirit of transaction cost reasoning. In the words of Williamson (1981: 574): 'the transaction cost approach relies – in a somewhat informal, background, and long-run way – on the operation of natural selection forces'. That is, predictions stemming from transaction cost economics rely on the idea that market competition will, ultimately, favour those organisational forms that best align incentives and interests will survive (Hodgson, 1996). As cooperative factories provide a better return on the milk supply of farmers compared with private factories, cooperative factories are expected to survive at the expense of private factories.

Our main result holds that, indeed, cooperative factories display superior performance to private factories. Cooperative factories have significantly higher chances of survival than private factories. A second result holds that the persistence of some private factories in certain regions can be explained by first-mover advantages (Lieberman, 2013). Since factories in the first cohort were all privately owned, the private form remained present in these regions in contrast to other regions. Importantly, the results on the superior performance of cooperative form and the existence of first-mover advantage are shown to be robust for the inclusion of geographical determinants of survival, including land fertility (which proxies factory size) as well as provincial dummies.

This note is structured as follows. In Section 2 we present a short history of the Dutch dairy industry discussing the rise of the cooperative form and the regional differentiation herein. Section 3 discusses the research design, which is based on survival analysis. In Section 4 we present the empirical results and in Section 5 we conclude the paper.

2. The evolution of the Dutch dairy industry

Dairy factories emerged when farmers recognised that they could realise scale economies when merging their supplies of milk to be processed centrally. In particular, the advent of centrifugal separation machines in the 1880s increased

the level of scale economies substantially. This technology made it possible to produce butter on a continuous basis and with a much higher return for each litre of milk supplied compared with butter production at the farm. The scale advantages were further reinforced with the widespread adoption of steam-powered separator technologies around the turn of the century (Van Zanden, 1994).

Before the introduction of centrifugal separation technology, dairy products were made at the farm. In The Netherlands, the production of dairy products at farms concerned mainly butter and cheese. Geographically, dairy production concentrated in the west (Holland) and the north (Friesland) of the country, both areas with fertile grasslands. Part of the dairy production was exported to England (mainly butter from larger factories in Friesland) and to Germany, Belgium and France (mainly cheese from smaller factories in Holland) (Geluk, 1925; Van Bers, 1994; Van Zanden, 1994).

In the sandy soils in the eastern and southern parts of The Netherlands, dairy products were produced at lower qualities by small factories for local markets. Cows were held mainly to fertilise the land. However, with the rapid fall of grain prices from 1870s onwards¹ and the advent of artificial fertiliser, farmers in the eastern and southern parts became more prone to engage in dairy production as a core activity. This explains why the spread of dairy factories from 1871 onwards did not only concern the traditional grassland area in the west and the north, but also involved the eastern and southern provinces (Van Zanden, 1994).

Although the advent of the dairy industry is made possible primarily by the invention of centrifugal separation technologies in the early 1870s, its rapid development should also be understood from a market perspective (Van Bers, 1994; Van Zanden, 1994). Dutch butter exports to England dropped rapidly due to the competition of high-quality butter from Denmark and Normandy produced with the new separator technology. By contrast, the average quality of Dutch butter deteriorated due to fraud with 'illegal' addition of substances by both farmers and merchants. Hence, the key problem for private dairy factories was to effectively monitor the quality of the milk supplied by farmers.

The national government realised that in a vertically disintegrated dairy industry, the quality of Dutch dairy products would remain low. The advent of margarine butter by Dutch companies further reinforced the need for regulated quality to distinguish 'real' butter from margarine and to avoid that margarine was mixed with butter to reduce costs. A market-pull factor concerned increased inland consumption of dairy products due to rising income and changing consumption patterns. During the 1860s and 1870s, the percentage of household budgets spent on dairy products almost doubled (Van Zanden and Van Riel, 2004).

1 Prices dropped 40 per cent between 1877 and 1897 (Van Zanden and Van Riel, 2004).

Lacking governmental institutions to regulate quality, farmers were advised to set up their own cooperatives in a report issued by a government committee for agriculture² in 1886 (Roosen, 1993). In the Dutch context, the diffusion of cooperatives was further accelerated through learning from earlier successful practices in Denmark. Not much later, the cooperative form became dominant. As economic historians claim (Bijman, 2000; Henriksen 1999; O'Grada, 1977; Van Zanden 1994), farmers preferred to deliver their milk to cooperative factories to solve transactional problems. As in many other industries, the ambiguity regarding the quality of supply led to excessive monitoring costs (Ouchi, 1979). Indeed, as mentioned before, illegal practices involving the addition of substances were a real concern. A second reason for farmers to join a cooperative has been to break the power of private factories, which enjoyed a spatial monopsony position (Van Zanden, 1994). The dependence of farmers on a local private factory followed from the high transportation costs, which severely limited the possibility to switch between factories. As a result, private factories were able to appropriate most of the returns of dairy products. The founding of a cooperative factory allowed farmers to make a better return on their milk supply, given the increased product quality and higher profit margins. As factory owners, farmers were able to reap the full benefits of milk processing, while, at the same token, production benefitted from more certainty regarding milk supply and its quality. As farmers' incentives are better aligned in cooperative factories than in private factories, cooperatives are expected to survive longer than private factories. Our first hypothesis holds:

Hypothesis 1. Cooperative dairy factories survive longer than private dairy factories.

Though the advantages of cooperative milk processing became apparent to farmers throughout the 1880s and 1890s, private factories did not disappear and even continued to increase in absolute numbers. Some of these factories remained in business for many years. This suggests that private factories found ways to face the competition of cooperative factories. One common way has probably been to adjust prices for milk supplies upwards to levels paid by cooperatives. Thus, as suggested by O'Grada (1977, p. 295) in his study on Ireland, even though private factories had a *de facto* monopsony position, they can be expected to have paid acceptable prices under the threat of farmers setting up their own cooperatives or supplying their milk to nearby cooperatives. Put differently, the market was more or less 'contestable'.

In this context, the co-existence of private and cooperative factories in the northern regions is worth discussing (Van Zanden, 1994). This phenomenon has also been noted in studies on Ireland (O'Grada, 1977) and Denmark (Henriksen, 1999). In the Dutch case, the co-existence of private and cooperative factories, however, has not been universal but restricted to the provinces north

2 This committee was called *Staatscommissie voor de Landbouw* in Dutch.

of the Rhine, where almost 30 per cent of all factories that ever existed were private (Willemsens and de Wit, 1995). In this grassland area with a tradition in dairy export, many merchants with experience in dairy trade started private factories in the early stage of the industry (Van Zanden, 1994). By contrast, in the sandy soils area of the southern provinces of Limburg and Northern Brabant, dairy production had always been for local consumption only. Here, private enterprise was reluctant to start commercial factories, leading to the relative dominance of the cooperative form. This tendency was further reinforced by the Catholic Church that played an important role in southern provinces in supporting farmers financially and administratively in setting up their cooperatives (Willemsens and de Wit, 1995). Indeed, out of all factories that ever started in Limburg and Northern Brabant, less than 10 per cent have been privately owned (Willemsens and de Wit, 1995).

One can expect that the continuing presence of private factories in the upper Rhine area is due to first-mover advantages of early entrants (O'Grada, 1977). There are several reasons to expect that early entrants perform better than later entrants. First, following O'Grada (1977), having the first pick, early entrants were strategically well located in villages and towns with a tradition in milk and butter. Second, early entrants gained experience before local competition between factories took off. The continuing presence of private factories in grassland areas may thus be understandable from the fact that many early entrants were private factories combined with higher survival rates for any early entrant. Our second hypothesis holds:

Hypothesis 2. The earlier a dairy factory started, the longer it will survive.

3. Research design

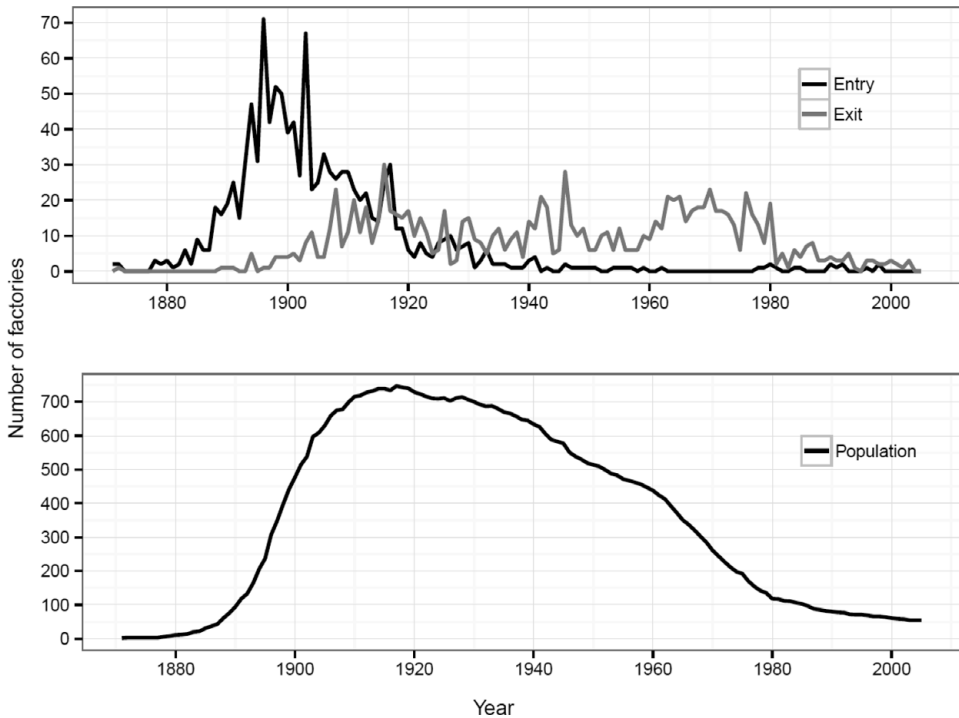
To test the determinants of the survival of dairy factories, we will apply the Cox regression method (Audretsch and Mahmood, 1994). We use Cox regressions because this method makes use of the contribution of censored cases. This is necessary because some factories still existed in 2005.

The data are taken from an encyclopaedia by Willemsens and de Wit (1995) on 1,475 dairy factories in The Netherlands starting from the first dairy factories starting in 1871 until 1994.³ We have updated the data to 2005 using the information of the Productschap Zuivel, which is the national association of dairy factories.⁴ This leads to a total of 1,477 factories.

³ According to Willemsens and de Wit (1995), their data are not fully complete. They estimate that their data contain at least 95 per cent of the total Dutch dairy companies ever established.

⁴ Data for 2006 and later could not be found, as these are not reported on the website of the national dairy product association (<http://www.prodzuivel.nl/>). Yet one can expect that – as for the period 1980–2005 (see Figure 1) – the number of entries that exist have also been low in the period after 2005. Hence, it is unlikely that the results of our statistical analysis are affected by the omission of data for the period after 2006.

Figure 1. Number of dairy factories and annual number of entries and exits, 1871–2005. (Source: Willemsens and de Wit, 1995)



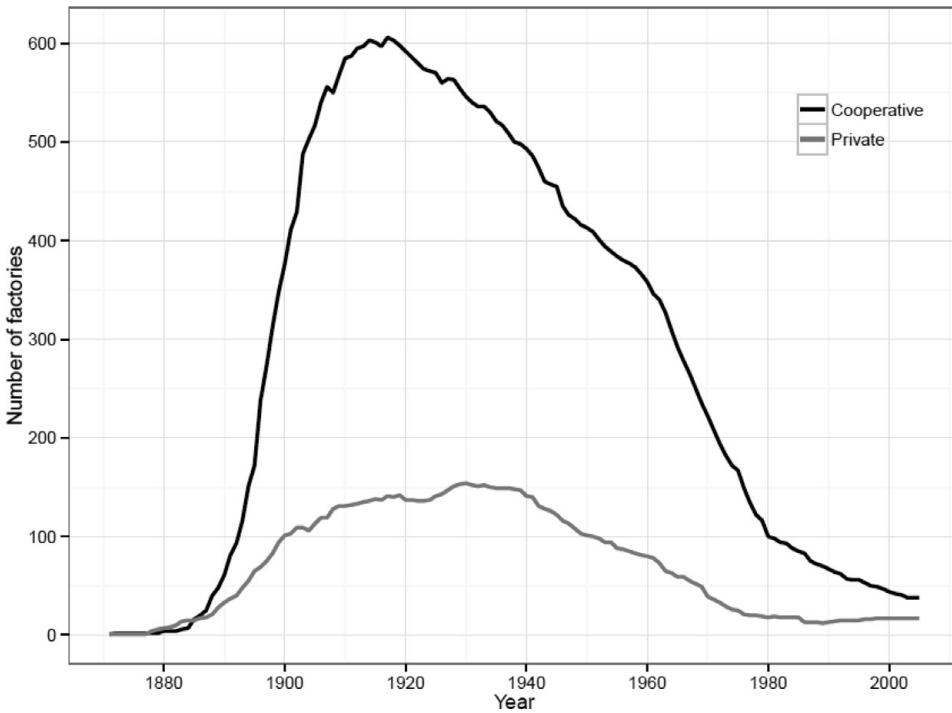
The data contain the entry and exit years for most factories. The entry year is the first year, in which a factory started producing dairy products commercially. The exit year is the last year of commercial production. For some factories, the entry year and/or exit year were unknown. In these cases, the factories were left out of the analysis. These missing data reduced the dataset from 1,477 companies to 1,141 companies. Most entry or exit data that are lacking concern data on private companies. This is probably caused by the fact that private companies were not members of regional associations, the records of which are well kept.

The data also contain information on the organisational structure of each factory, that is, whether it concerns a private or cooperative factory, or a factory that changed organisational form from private to cooperative or *vice versa*. Finally, the data contain the name of the province where the factory has been located, as a regional variable.

4. Results

The rapid proliferation of dairy factories in The Netherlands is clear from Figure 1, in which the total number of factories is plotted for the period 1871–2005 as well as the annual number of entries and exits. The evolution of the

Figure 2. Number of private and cooperative dairy factories, 1871–2005. (Source: Willemsens and de Wit, 1995)

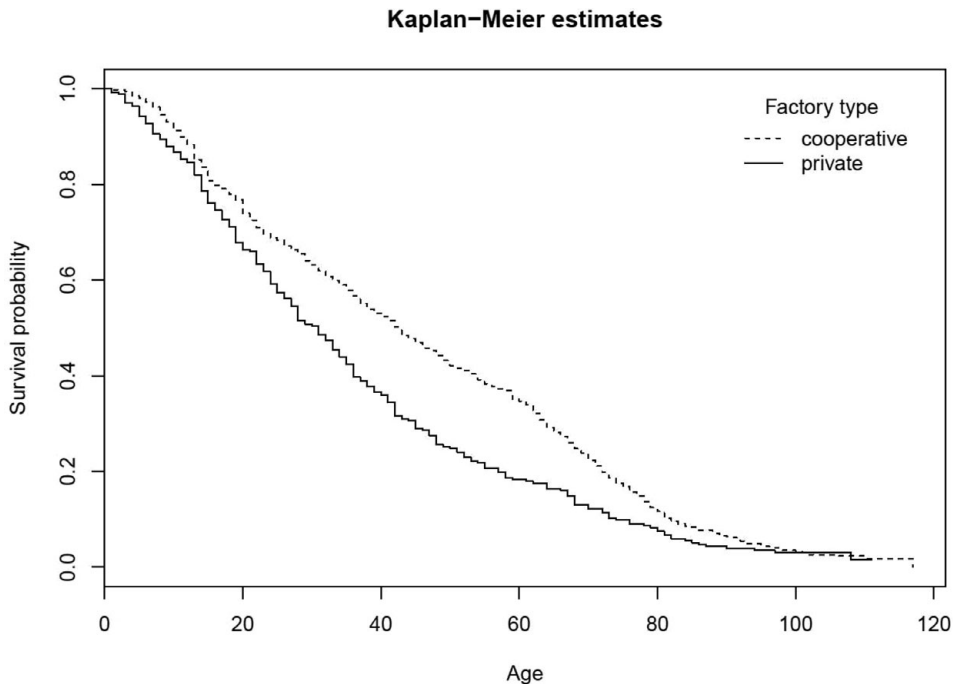


number of factories shows a clear industry lifecycle pattern with rapid entry in the early period of the industry and subsequent concentration of the industry (Klepper, 2002; Klepper and Simons, 1997). The process of concentration reflects a continuous rise in the minimum efficient scale of operation resulting from a series of process innovations in milk processing as well as in transport and conservation technology.⁵

Figure 2 shows the total number of cooperative or private factories present in The Netherlands per year following the classification by Willemsens and de Wit (1995). This figure is based on 1,130 factories instead of 1,141, as 11 out of the 1,141 factories changed organisational form in an unknown year (eight factories changed from private to cooperative form and three factories changed from cooperative to private form). This figure shows that the cooperative form became rapidly dominant in the Dutch dairy industry. However, given that the

⁵ Interestingly, the ‘shake out’ took much longer than observed in manufacturing industries (Klepper and Simons, 1997). This can be understood from the fact that dairy factories have always been dependent on regional suppliers of fresh milk. This dependence implies that increases in the scale of production have been more constrained by transport costs than its manufacturing counterparts, resulting in a more gradual process of concentration of the industry.

Figure 3. Kaplan–Meier plot of cooperative dairy factories and private dairy factories.



majority of the 334 missing data concern private factories, it should be noted that the dominance of the cooperative form has been less than suggested by Figure 2.⁶

We start the survival analysis by testing the first hypothesis by plotting the survival curves using a Kaplan–Meier plot (Figure 3).⁷ This plot shows the proportion of private and cooperative factories surviving at a certain age. Clearly, the cooperative factories outperform the private factories. The difference is most pronounced at the age of 60: less than 20 per cent of private factories succeed in reaching this age, while for cooperative factories this percentage is close to 40 per cent. For long-lived factories of 100 years and older (which are, of course, only few), the difference in the survival rate vanishes between cooperative and private factories.

⁶ Nevertheless, the dominance of the cooperative firm remains evident. Figure 2 shows that for the larger part of the dairy history, there exist at least 250 more cooperative factories than private factories. Even if all 334 missing data would have concerned private factories, cooperatives would still outnumber private factories, because these 334 factories would not exist throughout the whole history. From the Kaplan–Meier plot (Figure 3), one can observe that half of the private factories do not reach the age of 30, while more than 80 per cent never reaches the age of 60.

⁷ The χ^2 for the log-rank test equals 19.1 ($p = 0.0000123$).

Table 1. Regression results (Cox)

Variables	Model 1	Model 2	Model 3	Model 4
Cooperative	-0.311*** (0.073)	-0.302*** (0.072)	-0.309*** (0.072)	-0.438*** (0.083)
Entry year		+0.008*** (0.002)	+0.008*** (0.002)	+0.006* (0.002)
Pasture			-0.134* (0.068)	+0.023 (0.136)
Provincial dummies	No	No	No	Yes
Log-likelihood	17.68	30.68	34.69	150.70
R ²	0.016	0.027	0.030	0.125
N	1130	1130	1130	1130

*** = Significant <0.01; * = significant <0.10.

The results of the Cox regression are presented in Table 1. Model 1 shows that cooperatives indeed perform better than private factories, supporting hypothesis 1. This result confirms the descriptive analysis shown before based on the Kaplan–Meier plot in Figure 3. The negative sign indicates that the probability of exit is smaller for cooperative than for private factories. Also note that the coefficient is highly significant.⁸

Early entry also increases life expectancy (hypothesis 2), measured as entry year in model 2. The positive and significant sign of the entry year variable means that factories entering later in time have a higher probability to exit. Note that the inclusion of the entry year variable hardly affects the coefficient of the cooperative variable. Hence, both hypotheses 1 and 2 hold.

Given the fact that most entries in the first decade were private factories, this finding explains why many private factories continued to co-exist with cooperative factories. Even if the cooperative form can be assumed to have been more successful, the first-mover advantages of early private firms allowed them to survive for a reasonable amount of time. The persistence of private factories in the fertile western and northern regions in The Netherlands can thus be explained by the advantage enjoyed by the early factories that were erected mainly in these regions.

To analyse the robustness of the results for the inclusion of other variables that may affect the survival of factories, we include a variable called pasture to

⁸ Recall that we lack the entry and exit data for 334 factories. The large majority of the missing data concern private factories. As one can expect that the reason the entry and exit data could not be collected is due, at least partly, to their short existence, the mean lifetime of a private factory omitted is probably significantly shorter than the mean lifetime of those in the dataset. This would suggest that the true difference in hazard between private and cooperative factories is probably even greater than our result indicates.

indicate whether the factory was located in the most fertile grasslands (mainly in the north and west). This information is available from Van Bers (1994) and Willemsens and de Wit (1995). The average size of factories in these pasture areas is known to have been much larger than the size of factories in other areas (Van Zanden, 1994). Hence, the pasture variable can also be considered as a proxy of size, distinguishing between small and large factories. As larger factories can better cope with adverse events than smaller factories, one can expect that larger factories have a lower hazard to exit than smaller factories (Caves, 1998). After including the pasture variable in model 3, the cooperative and entry year variables remain significant and the size of their coefficients is hardly affected. Hence, the hypotheses regarding the superior performance of the cooperative form (hypothesis 1) and the first-mover advantage (hypothesis 2) still hold. The sign and significance of the coefficient of pasture indicates that, as expected, factories located in fertile areas have lower chances to exit, though this effect is only significant at the 10 per cent level.

Finally, we include dummies for the 12 provinces in The Netherlands to capture unknown region-specific effects (e.g. land use, urbanisation and infrastructure). After including the provincial dummies in model 4, the effect of the cooperative variable remains highly significant, and becomes even stronger in size. The effect of entry year, however, becomes less significant and its effect becomes less strong. The pasture variable is no longer significant, as this effect is most probably picked up by the dummy values of the provinces that have ample fertile grassland.

5. Conclusion

In this note, we have analysed the relative performance of cooperative factories compared with privately owned factories in the Dutch dairy industry. Our survival analysis clearly indicated the superior performance of cooperative over private dairy factories. The continuing existence of private factories in selected regions can be explained by the first-mover advantages that early private factories enjoyed over cooperatives, which were founded only at a later stage. The results on the superior performance of cooperatives and the existence of first-mover advantages have been shown to be robust for the inclusion of geographical variables, including pasture and provincial dummies.

The study has shown the value added of survival analysis in testing commonly received explanations by historians regarding the success of cooperatives in the dairy industry. Though the history of the dairy industry has been rather specific, the main argument and methodology are general enough to be applied to different industries as well as to other hybrid organisational forms (Hendrikse and Feng, 2013; Ménard, 2004). In particular, the analysis of the rise of cooperatives in the renewable energy sector can be of specific interest in the light of sustainable

development (Van der Vleuten and Raven, 2006; Walker and Devine-Wright, 2008).

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