

Determinants and Consequences of Participating in a Restructured Supply Chain: the Experience of the Dairy Sector in Poland

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Abstract

Supply chain restructuring and its impact on farmers has become the subject of interest among agricultural economists. However, there have been relatively few studies trying to quantitatively assess this issue. With data from the dairy sector in Poland, we investigate factors determining farmers' participation in the modern market channel and the impact of supply-chain modernization on farm revenues. We find that joining the modern market channel is crucially dependent on access to funds and facilitated by having larger cow herds. Further, with the help of instrumental variables, it is shown that joining the modern market channel positively affects farmers' revenues.

Keywords: supply chain restructuring, dairy sector, farm revenues, Poland.

JEL Code: D22, Q12, Q13.

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Introduction

Supply chain restructuring has been one of the most striking phenomena observed in recent years in the agro-food sector worldwide. Due to some specific features (changes in political and economic regimes, market development, rise of food quality and safety standards) this process has been particularly profound in transition countries. The changes concerned both the market structure, and the relations within the supply chain (Dries et al., 2011). Substantial restructuring in retail and processing (including FDI inflow, the so-called “supermarket revolution” and processing consolidation) has been accompanied with dynamic changes at the farm level (see Gow and Swinnen, 2001; Reardon and Timmer, 2007; and Swinnen, 2007 for an overview).

In the dairy sector in Poland these processes have been extremely visible. Several things are particularly noteworthy. First, dairy processing has experienced a dynamic consolidation. While large dairy companies were responsible for the consolidation, contrary to the trend elsewhere, these were large domestic companies as opposed to foreign-based firms (Wilkin et al., 2007; Dries et al., 2011).¹ Trends in the processing sector closely tracked developments in the retail sector. The expansion, consolidation, and internationalization of the retail sector created new outlets for dairy processors but at the same time imposed new requirements related to quality, assortment of products, volume, and consistency of deliveries. This resulted in the improvement in the quality and assortment of final processed dairy products as well as in the improvement in the quality of milk. The latter in turn required considerable adjustments at the farm level. One of the most profound changes has been a thorough reorganisation of the way that milk is delivered to processors. A modern market channel (MMC) has emerged, where milk is directly collected from cooling tanks at farms by dairy trucks. On the other hand, the role of a traditional market channel (TMC), based on farmers’ deliveries to collection stations, has decreased.² This has resulted in heterogeneous modes of market participation among dairy farmers with some of them belonging to the TMC, and some of them belonging to the MMC (see Wilkin et al., 2007 for an overview).³

¹ It has to be acknowledged though, that foreign companies have indirectly contributed to the consolidation process by posing a threat to domestic companies (Dries and Swinnen, 2004).

² According to estimates, the share of milk collected from the farm increased from 5% in 1993 to 20% in 2001 (Nowakowski, 2002). However, this trend has significantly sped up in recent years and now milk collected directly from the farm ranges from 75% to 100% of the dairies’ supplies (Seremak-Bulge, 2005; Wilkin et al., 2007).

³ This, obviously, does not exhaust the list of changes and adjustments that have taken place at the farm level. Meeting sanitary and veterinary requirements or complying with regulations concerning manure storage and animal welfare may serve here as examples. For a comprehensive description of these phenomena see Seremak-Bulge (2005) or

It is therefore interesting to see what factors have been conducive to farmers' participation in the restructured supply-chain. Answering this question gains particular importance in the light of the ongoing debate over the impact of supply-chain restructuring and specifically whether it tends to exclude or include small farms. In Poland this is especially significant given the phenomenon of (dairy) farm fragmentation; over half (58%) of farms having dairy cows have less than 10 ha (based on EUROSTAT 2010). What is also telling, while in 2010 the average statistical cow herd in Poland consisted of 6 cows, the average for Germany was 46, for France 45 and for Netherlands 74 cows.⁴

Further, simultaneous to the changes in the supply-chain, Polish dairy farmers experienced a noticeable increase in their incomes.⁵ There is thus a need to investigate whether these two phenomena are related and what is the impact of supply-chain restructuring on farms' financial situation. While there are a number of theoretical benefits that farmers may enjoy after entering the modern supply chain, there is scant empirical evidence of a direct link between joining the modern supply chain and farm revenues, and it is based predominantly on case studies and anecdotal accounts (for an overview see World Bank, 2005; Swinnen, 2007; notable exceptions include Falkowski, 2012a and Van Herck, 2012). Several recent studies from transition countries suggested the positive impact of supply chain restructuring on output, productivity and output quality (see e.g. Noev et al., 2009; Dries et al., 2009; Van Herck et al., 2012).

The present study differs from others on the agro-food supply chain transformation in a transitional context. Most of the existing empirical literature concentrates on vertical integration and assistance programmes offered to farmers by the processing industry (Dries and Swinnen, 2004; Gorton et al., 2006; Noev et al., 2009; Falkowski, 2012b; Dries et al., 2012). While all these studies point to the potential role of supply chain restructuring in facilitating farmers access to funds and/or assistance, there is a lack of systematic evidence on what determines whether farmers can participate in these developments. Our paper explores these determinants. Further, studies that try to quantitatively assess the impact of supply-chain modernisation on farms' financial situation provide mixed evidence. Moreover, to the best of our knowledge, they are still very limited and concentrate predominantly on developing countries in Africa (e.g. McMillan et al., 2002; Wilcox and Abbott, 2004; Maertens and Swinnen, 2009) or India (Kumar, 2010 and Kumar et al., 2011). While these studies could be of general relevance, our dataset is unique

Wilkin et al. (2007).

⁴ Authors' estimations based on EUROSTAT data from 2010.

⁵ According to Farm Accountancy Data Network (FADN) data, depending on the farm-type and region, in the period 2004-2007 the average increase in income ranged from 36% to 244%. FADN data for Poland start only since 2004, therefore coherent data for earlier period is not available.

in allowing us to look at the abovementioned issues from a transition country's perspective, which may provide additional insights. From this perspective, our paper aims to contribute to the existing transition-country studies documenting the impact of supply chain restructuring on farm behaviour (see e.g. Dries and Swinnen, 2004, 2010; Falkowski, 2012a; Van Herck et al., 2012). In contrast to most existing studies we focus on the relationship between market channel choice and farm revenues which, up to now, has hardly been investigated.

The paper is organised into six parts. The second section presents theoretical considerations highlighting key issues that are likely to determine farmers' capabilities of keeping pace with supply chain restructuring and the impact that the latter may have on a farm's financial situation. The following sections describe the data and present our econometric strategy. The last two sections present the results of the econometric analysis and conclusions.

Determinants and impact of dairy supply chain restructuring on farmers' revenues

Below we briefly review some recent contributions to two strands of the literature that has relevance to our research. First, we look at the literature highlighting the main factors that could have determined farmers' choice of the market channel (traditional or modern). Second, we review some arguments regarding the relationship between market channel choice and farms' revenues.

To start with, there are two well-established approaches that offer predictions of factors that should affect the farm relationship with the market. The first approach emphasizes the role of input and output markets (Heidhues and Brüntrup, 2003). According to this approach, farms' market participation decisions are driven by the extent of various market imperfections. The latter constrain farms' activities and thus importantly limit their opportunities to choose or change their modes of participating in market transactions. Another approach to understanding the relationship of farms to the market is based on transaction costs theory. According to this theory, existing market channels are designed to limit transaction costs associated with the farmer-processor relationship.⁶ Consequently, factors affecting these costs may also exert a strong impact on farm orientation and the mode of participation in transactions (see e.g. Key et al., 2000).

Drawing on the abovementioned theories and taking into account specificities of dairy production, below we try to list the most important factors that could be responsible for market participation decisions of dairy farmers in Poland. First, we look at factors that could be related to the *market imperfections approach*.

⁶ These costs include costs of accessing the market, transportation, bargaining process as well as monitoring and enforcing the contract.

To start with, a decision to enter the modern market channel (MMC) involves large investments at the farm level. These include, for instance, buying a cooling tank, increasing herd size, renovation of milking rooms or upgrading of milking systems. Therefore, joining the MMC would be expected to depend on a farm's access to physical and financial capital. The former would determine the scale of necessary adjustments whereas the latter would set the level of investments being within farm's capabilities. Taking into account that farm households in Poland earn less than the national average (GUS, 2007)⁷, a farm's own resources are likely to be insufficient and access to external funding might be of special importance. In this respect, the functioning of the credit market is crucial. Further, since farmers' market channel choice could be seen as crucially dependent on available income strategies, one may assume that it would depend also on a farm's access to unearned income and off-farm job opportunities. This in turn allows for the possibility that the mode of participation in market transactions should be related to labour market imperfections.

As far as factors drawing on a *transaction costs approach* are concerned, they include the level of production as well as distances to dairy and collection point. This is because they all determine the level of transaction costs involved in delivering milk to market. Taking into account that costs of transport are incurred by dairy companies in the MMC and by farmers in the TMC, it seems reasonable to assume that having larger cow herds or higher milk yields per cow should facilitate entering the MMC. Proximity to a dairy plant (collection point) should have the similar (opposite) effect. Furthermore, assuming that processing companies would look for opportunities to optimise their system of suppliers, the number and development of other farms in the neighbourhood may also affect the probability that a farmer enters the MMC.

Moving to the second research question, i.e. what is the impact of farm orientation on farm performance, the following literature is relevant.⁸ One of the main concerns of previous scholarship is that changes taking place at the downstream stages of the chain, such as consolidation (Sexton and Lavoie, 2001; Sexton et al., 2007) and implementation of food quality standards (Jaffee and Henson, 2004; Henson and Reardon, 2005), are likely to adversely affect farmers' bargaining power and, as a consequence, their performance as well (see e.g. Delgado, 1999; Reardon and Barrett, 2000; Weatherspoon et al., 2001; Humphrey et al., 2004).

⁷ According to estimates of the Polish Central Statistical Office (GUS), monthly income per capita in households of farmers accounted in 2006 for roughly 82% of the national average (GUS, 2007). For the evolution of returns to various income strategies in rural Poland during transition see Fałkowski et al. (2014).

⁸ For a broad literature review see e.g. Swinnen (2007) or Reardon and Timmer (2007) and citations therein.

This detrimental effect might be especially strong for small farms leading to their exclusion from the market.⁹

While the abovementioned arguments for the potential exclusion of small farms are difficult to refute, one should note that the evidence from transition countries does not necessarily support them. In fact, several studies found the opposite (see Swinnen, 2007 for an overview). The positive relationship between supply chain restructuring and farms' revenues could be expected on several counts. First, considerable investments on farms should result in quality improvement and thus in higher prices (OECD, 2006). Second, it is reasonable to suspect that to make these investments profitable, joining the MMC would require increasing the scale of production which should also affect the level of income. Further, due to improvements in farming practices and investments in new technologies, farmers' productivity is expected to increase (Swinnen, 2007). Finally, assistance programmes directed to farmers (Gow et al., 2000; Gow and Swinnen, 2001; Dries and Swinnen, 2004; Saenger et al., 2012) allow them to overcome credit and/or input market imperfections (Berdegue et al., 2005; White and Gorton, 2006). Thanks to this they may also use more efficiently other resources, which are not necessarily involved in producing contracted output (Minten et al., 2007). Consequently, the hypothesis about a positive relationship between joining the MMC and a farm's financial situation gains further support.

This discussion seems to be particularly salient to the Polish dairy sector. The question of the impact of a supply chain's reorganization on farmers acquires special importance if one takes into account the remarkable extent and speed of the restructuring taking place in the Polish dairy sector as well as the fact that local milk production remains highly fragmented (Dries et al., 2011; Wilkin et al., 2007). It is therefore vital to improve our understanding of the actual impact of the dairy supply chain's modernisation on farm performance. The existing evidence, although not dispositive, seems to be in line with the *positive impact hypothesis*. As indicated by Dries and Swinnen (2004) and Swinnen et al. (2006), no systematic evidence for small farmers' marginalisation in Poland was found. Interestingly, similar conclusions were drawn with regard to other post-communist countries (Swinnen et al., 2006; White and Gorton, 2006; Dries et al., 2012). This would suggest that in contrast to evidence from Latin American and African countries, supply chain restructuring in post-communist countries may give rise to positive outcomes.

We further investigate this issue. The abovementioned theoretical considerations are verified with the help of econometric analysis that is presented in sections to follow after a review of the data.

⁹ It should be noted that exclusionary effects might not be limited only to small farmers, but may also concern small processors as well as small independent retailers (Haggblade et al., 2002). Examples from the dairy sector have been provided by Dirven (1999) for Chile, Gutman (2002) for Argentina, Saenger (2012) for Vietnam or Wilkin et al. (2007) for Poland.

Data

Empirical analysis is based on survey data gathered in two regions located in the north-eastern part of Poland, namely Podlaskie and Warmińsko-Mazurskie. These two regions are leaders in terms of dairy production in Poland. Thanks to weighting techniques, the obtained results can be regarded as representative for the selected regions.

The paper uses information from 323 individual dairy farms surveyed in accordance with a stratified random sampling methodology in January and February 2007. In addition to collecting information from 2006, the survey contained a number of retrospective questions concerning events dating as far back as 2001. This was done in order to avoid potential problems with determining the direction of causality between variables of interest. Although the sector restructuring started already at the beginning of 1990s, the year 2001 was chosen as a reference point for two main reasons. First, in June 2000 EU accession negotiations related to agriculture began. Second, in September 2001 the regulation specifying 2002/2003 as a reference year for the milk quota system was introduced. Accordingly, in this year, strong signals of imminent and dynamic changes at the farm level were created.

The data we use include detailed information about farm management and ownership. Most importantly, they show sufficient variation in use of market channels to investigate factors relevant to integration with the modern market channel and to test whether participation in the modern channel is related to farm revenues. The sample that we use in the analysis contains 218 farms that delivered milk to the MMC and 105 households that delivered milk to the TMC.¹⁰

Note also that the period under investigation is the period during which important changes in the dairy supply chain have taken place. The MMC has become a dominant mode of delivering milk to the market while the TMC has started to play a diminishing role. It is believed, therefore, that our sample shows sufficient variation among market channels to investigate the impact of supply chain modernisation.

Econometric models

The two relationships which are of interest to us could be represented as follows. The model explaining the determinants of market channel choice could be written as:

$$M_i = \alpha + \beta X_i + \varepsilon_i \quad (1)$$

where i denotes household, M is a dummy variable equal to one for farms belonging to the MMC and equal to zero for households supplying the TMC. X_i is a vector of covariates, β is a vector of parameters to be estimated and ε_i is the error term.

¹⁰ These data refer to 2006.

As far as the second model is concerned, i.e. the impact model of supply chain modernisation, it could be written as

$$Y_i = \gamma + \omega M_i + \mu Z_i + \lambda_i \quad (2)$$

where Y_i stands for an outcome variable defined as a natural logarithm of total household revenues (in PLN)¹¹, M_i is defined as above and Z_i is a vector of other controls. The main variable of interest is M_i and it aims at directly capturing the impact of inclusion into the MMC on farms' financial situation. γ , ω , μ are (vectors of) coefficients to be estimated and λ_i is the error term.

As noted in the literature, choice or impact evaluation models give rise to difficulties stemming from the interdependence of dependent and explanatory variables (e.g. Angrist and Krueger, 2001; Murray, 2006). Therefore, in order to avoid the potential problem of reverse causality and to minimize the problem of unobserved heterogeneity, both models take into account retrospective data referring to 2001. It follows that our dependent variable (market channel choice in the first model and farm revenues in the second model) refer to 2006 whereas all the covariates that vary over time refer to 2001.¹² Obviously this is done at a cost of not using the most recent information. In other words we are trading off unbiasedness against precision of estimates.

While the approach outlined above addresses the main issues related to equation (1), it does not fully resolve all issues related to the impact model in equation (2). This is because in equation (2) the dependent variable (farm revenues) and the main explanatory variable (market channel choice) both refer to 2006. Moreover, it could be argued that there exist some unobserved factors that are likely to affect both farm revenues and choice of market channel. Examples include farmers' attitudes toward risk or availability of dairy processor's assistance. Therefore, to address this problem, we adopt the instrumental variables strategy. In this case, the instruments must have an effect on the choice of market channel and have no direct effect on the outcome variable, i.e. farm revenues. As noted earlier, transaction costs could play a role in affecting the choice of market channel. Thus, one possible set of instruments for choosing market channels are differences in these costs due to distances of farms from collection points and dairy factories, and this should be independent of earnings potential. Another possible factor relevant to

¹¹ What could be noted is that our measure accounts also for direct payments that farmers have started to receive after Poland's accession to the EU in May 2004. That said, obviously, a preferred measure would be a farm income. Unfortunately, we are not able to calculate farm incomes due to lack of sufficient data on production costs and thus we rely on farm revenues. This shortcoming should be kept in mind while interpreting the results.

¹² Variables that are invariant over time include education and all the covariates referring to farm localisation.

choosing a market channel could be the state of development and number of other farms in a region.

Our instrumental variables therefore include: (a) the distance to the closest dairy factory (in kilometres), (b) the distance to the closest collection point (in kilometres), and (c) the share of surveyed farms from the same district having a cooling tank. It is believed that all of these variables affect a farmer's choice of market channel without directly having a decisive impact on farm revenues.¹³ Below two out of three instruments we use are shown to have statistically significant effects on market channel choice of farmers.

The first stage regression in our instrumental variables strategy is identical to the model in equation (1). The covariates that we use at this stage, except for the instruments, were chosen based on the theoretical considerations outlined above. In addition, suggestions from other studies dealing with similar topics were taken into account (Huang et al., 2007; Neven et al., 2006; Gorton and White, 2007). More specifically, our covariates include characteristics of household head (age and education), proxies for household assets (herd size, annual milk yields and land endowments), information on labour endowments, sources of income (access to unearned income, access to off-farm job) as well as information on access to credit and one's own financial resources (farm revenues in 2001). The latter variables could serve as proxies for potential labour and credit market imperfections respectively. The detailed definitions of all these variables are given in the Appendix.

Throughout the text, we report the results from models that try to account for the survey settings. Our findings remain qualitatively the same when we do not adjust for the survey weights but allow for robust standard errors to account for potential heteroscedasticity. Using OLS we also checked for potential multicollinearity and we found no evidence for that (the variance inflation factors well below 10).¹⁴

Results

Determinants of market channel choice

Table 1 shows the descriptive statistics of the main variables we use. Table 2 presents the results of our econometric analysis. Column 1 reports the estimates of the model in equation (1) which investigates the main determinants of farmers' market channel choice. This is at the same time the first stage regression of our 2SLS instrumental variables strategy. Several points could be noted. First, access to unearned income negatively affects the propensity to join the MMC (see the negative

¹³ All of those variables are believed to affect farmers' choice through their impact on transport/transaction costs that need to be incurred when arranging the deal.

¹⁴ We thank an anonymous referee for suggesting this to us.

and statistically significant coefficient labelled as variable *UNEARNED*). This in turn seems to suggest that unearned income discourages farmers from undergoing necessary modernisation. Second, the positive and highly significant effect of variable *CREDIT* clearly shows that access to external funds appears to be indispensable to keep up with modernization pressures. This assertion is further strengthened by the fact that variables measuring access to off-farm employment (*OFF-FARM JOB*) and farm revenue (*FARM REVENUE*) have no impact. These results suggest that neither off-farm employment nor farm revenue provide sufficient resources to finance investments that allow a shift to the MMC. The lack of significant impact – either positive or negative – of having additional employment (*OFF-FARM JOB*) seems to indicate that rural labour market fails to attract farm workers, marginalising at the same time potential benefits that households could derive from having abundant labour endowments. This hypothesis is indirectly confirmed by the insignificant impact of the variable capturing farm labour endowments (*LABOUR*) which may be indicative of inefficient usage of production factors employed in agriculture. Last but not least, it should be emphasised that household's decision to join the MMC was crucially dependent on the size of a herd (*HERD*) and its quality (*YIELDS*). Farms larger in terms of herd size were more successful in adjusting to new conditions than smallholders. However, this observation does not conclusively prove the hypothesis that small farms were marginalised. We return to this issue further.

The significant impacts of herd size (*HERD*) and quality (*YIELDS*) may also help to explain the lack of statistically significant relationship between joining the MMC and the distance between the farm and the dairy company (*DISTANCE DAIRY*).¹⁵ The obtained results indicate that higher transport costs, although having the potential to discourage a dairy company from coming to collect milk at a farm, seem to be less important for a dairy company than enlisting large and high quality suppliers.

There is also no evidence that the shift to the MMC is conditioned on early investments in cooling tanks. This is shown by no effect of the variable *COOLING TANK*. In other words, being relatively backward in terms of equipment was not necessarily a major obstacle to join the MMC.

Interesting insights are also provided from the analysis of the 'neighbourhood effect'. The variable *SHARE TANK*, which captures the share of farms in the same district with cooling tanks, has a positive and statistically significant effect on be-

¹⁵ Since this result may point to the weakness of the chosen instrument the Wooldridge's score test of overidentifying restrictions was conducted (Wooldridge, 1995) and passed. Further, in order to check the robustness of the analysis, models were re-estimated using only two instruments (distance to collection point and share of farms having cooling tank both being statistically significant). The main results remained however the same.

ing in the MMC. This provides some evidence that modernisation processes at the farm level could have taken place in clusters. Whether this was inspired by dairy processors or farmers themselves remains open and could be an interesting area for future research.

Finally, and to some extent unexpectedly, variables measuring household human capital are not found to have a significant effect. One could interpret this to mean that practical rather than theoretical knowledge related to school education matters more.¹⁶ Worth noting is also the negative and statistically significant impact of variable *COOPERATION*, which captures whether a farmer cooperates with other farmers or not. This observation shows that the potential costs of remaining in the TMC (e.g. lower price, higher risk of milk refusals, lower quality premiums etc.) may be outweighed by benefits created by cooperation (lower costs of transport etc.). This result suggests that farmers' collaboration, often commonly advised as having great potential for stimulating further restructuring, does not necessarily have the desired effects.¹⁷

¹⁶ Obviously this interpretation is correct provided that our proxy for human capital (measured from one to four where one refers to elementary education, four refers to higher education and two and three refer to vocational and secondary education respectively) is appropriate. We have also tried to proxy human capital with years of experience in managing the farm. The results however were qualitatively the same. We thank an anonymous referee for pointing this to us.

¹⁷ In some specifications, our set of covariates included also a dummy variable capturing farms that were delivering milk to dairy cooperatives as well as a dummy variable capturing farms that experienced their milk being refused by the dairy due to poor quality. The former variables aimed at capturing the fact that the Polish dairy industry is dominated by (domestic) cooperatives. The latter variable on the other hand aimed at capturing potential correlation between market channel choice and potential problems with upgrading milk quality. Neither of these variables however appeared to be statistically significant. These results are not shown for brevity reasons but may be obtained from authors upon request.

Table 1. Descriptive statistics of the main variables – means and standard deviations

| Variable | Mean | Standard Deviation |
|-------------------------|-------------|---------------------------|
| Age 2006 | 42.32 | 9.49 |
| Education | 2.01 | 0.77 |
| Herd size 2001 | 13.04 | 8.16 |
| Yields 2001 | 4317.23 | 1192.11 |
| Cooling tank 2001 | 0.58 | 0.49 |
| Land 2001 | 25.68 | 13.87 |
| Labour 2001 | 2.77 | 1.02 |
| Credit 2001 | 0.09 | 0.28 |
| Unearned 2001 | 0.42 | 0.49 |
| Off farm job 2001 | 0.21 | 0.41 |
| Revenues 2001 | 74875.88 | 57641.45 |
| Cooperation 2001 | 0.19 | 0.40 |
| Podlaskie | 0.50 | 0.50 |
| Distance dairy 2006 | 28.15 | 19.48 |
| Distance point 2006 | 3.28 | 3.07 |
| Share cooling tank 2006 | 0.82 | 0.17 |
| Number of observations | 323 | |

Source: Authors' calculations based on the survey sample. For detailed definitions see Appendix (Table A1).

Table 2. Factors increasing probability of belonging to MMC and affecting farm revenues

| Dependent variable: (1) Market channel choice in 2006 (1 = MMC, 0 = TMC) (2) (3) (4) Natural logarithm of farm revenues in 2006 | (1) Probit | (2) 2SLS | (3) OLS Channel choice estimated from model (1) | (4) OLS Actual channel choice (one stage regression) |
|--|-----------------------|---------------------|--|---|
| Modern market channel | | 0.166* | 0.231** | 0.248* |
| | | [0.071] | [0.027] | [0.050] |
| Age | -0.00618 | -0.003 | -0.003 | -0.003 |
| | [0.73] | [0.36] | [0.44] | [0.36] |
| Education | -0.328 | 0.011 | 0.017 | 0.018 |
| | [0.23] | [0.82] | [0.75] | [0.67] |
| Herd size 2001 | 0.286*** | 0.018*** | 0.017*** | 0.016*** |
| | [0.0066] | [0.0022] | [0.0025] | [0.0043] |
| Yields 2001 | 0.000554*** | 0.000* | 0.000* | 0.000* |
| | [0.0083] | [0.058] | [0.058] | [0.089] |
| Cooling tank 2001 | 0.0703 | | | |
| | [0.76] | | | |
| Land 2001 | -0.00776 | 0.003 | 0.003 | 0.003 |
| | [0.35] | [0.47] | [0.49] | [0.54] |
| Labour 2001 | 0.0105 | 0.048* | 0.047* | 0.046* |
| | [0.95] | [0.063] | [0.064] | [0.082] |
| Credit 2001 | 1.600** | | | |
| | [0.013] | | | |
| Unearned 2001 | -0.262* | -0.087 | -0.076 | -0.074 |
| | [0.076] | [0.23] | [0.27] | [0.37] |
| Off farm job 2001 | -0.0338 | -0.109 | -0.111 | -0.110 |
| | [0.94] | [0.18] | [0.18] | [0.16] |
| Farm revenues 2001 | -0.146 | 0.503*** | 0.500*** | 0.500*** |
| | [0.71] | [0.0027] | [0.0025] | [0.0031] |
| Cooperation 2001 | -1.006*** | | | |
| | [0.0038] | | | |
| Podlaskie | 0.233 | 0.086 | 0.084 | 0.085 |
| | [0.64] | [0.46] | [0.45] | [0.50] |
| Distance dairy 2006 | -0.00852 | | | |
| | [0.37] | | | |
| Distance point 2006 | 0.305* | | | |
| | [0.060] | | | |
| Share tank 2006 | 3.733** | | | |
| | [0.024] | | | |
| Constant | -5.883 | 4.980*** | 5.011*** | 5.012*** |
| | [0.18] | [0.0023] | [0.0021] | [0.0024] |
| Number of observations | 322 | 322 | 322 | 322 |
| R-squared | 0.537 | 0.787 | 0.787 | 0.786 |

p values in brackets *** p<0.01, ** p<0.05, * p<0.1, All models use appropriate weights to account for the survey settings. In column (1) McFadden R² reported for a model not accounting for the survey settings; *Source:* Authors' calculations based on the survey sample. For detailed definitions see Appendix (Table A1).

Determinants of farm revenues and impact of market channel choice

As far as the second type of the estimated models is concerned, i.e. the impact model, the results are reported in column (2). The two stage least squares (2SLS) method was used to obtain these results. As noted by Angrist and Krueger (2001), using a linear regression for the first-stage estimates generates consistent second-stage estimates even with a dummy endogenous variable, whereas “*using a non-linear first stage (...) does not generate consistent [second-stage] estimates unless the nonlinear model happens to be exactly right (...) which makes the dangers of misspecification high* (p.80).” Furthermore, as noted by the authors, 2SLS is a robust estimation method even if the underlying second-stage relationship is non-linear. Nevertheless, we also show the model which used probit regression in the first stage (see further).

The presented figures provide strong evidence that inclusion into the MMC contributes to considerable improvements in farms’ financial situation. This is clearly indicated by the positive and statistically significant coefficient of the variable MODERN. This result is fully in line with theoretical predictions as well as other studies examining agro-food supply chain restructuring in transition countries (e.g. Swinnen et al., 2006; White and Gorton, 2006). It might be worth noting here that the effect of belonging to the MMC holds regardless of farm herd size, though benefits for smallest farms were of a lesser magnitude. We investigated this issue by estimating additional specifications (not reported) which included interaction terms between the dummy variable for the MMC and various farm size categories. While the coefficient for the interaction between the MMC and farms with less than 5 cows was negative, it was on the edge of being statistically significant at the 10% level.¹⁸ This means that inclusion into the MMC appeared to be beneficial not only for the largest farms, as suggested by the positive and statistically significant impact of herd size (HERD), but also for farms of medium and smaller size. Further, quality (YIELDS) has a positive and statistically significant impact, though it is of much smaller magnitude than that of herd size (HERD). This result can be seen as capturing rents from applying more sophisticated production techniques and having cows of higher quality. In accordance with expectations, farm revenues were found to be positively correlated with households’ physical endowments and financial assets. Further, interesting insights are provided from the analysis of variable OFF-FARM JOB, which entered the estimated equation with negative sign. This finding deserves more attention since it might appear counter-intuitive. Usually, access to off-farm job opportunities is expected to positively affect farms revenues. However, as discussed earlier, it is reasonable to assume that

¹⁸ Specifications including these variables are not reported here but could be obtained from the authors upon request.

the rural labour market in Poland is heavily biased towards agricultural employment. Under these circumstances undertaking an off-farm occupation might be an expression of seeking any extra employment to help cover basic needs rather than a form of having a stable and decent occupation. This hypothesis finds support in the negative and statistically significant correlation between the level of 2001 farm revenues and access to off-farm activities.

With regard to human capital endowments, interestingly, none of the variables aimed at capturing this effect were statistically significant. This result might give rise to concerns about farmers' returns from education. Although this finding needs further confirmation, it may reflect that farmers lack incentives to educate and train. This obviously is of interest for policy designers aiming at facilitating rural development.

Finally, some interpretation is needed to understand the negative impact of variable *COOPERATION*. This result, at the first glance, looks surprising. That is because cooperation is generally recognised as allowing farmers to benefit from pooled resources and higher bargaining power. Accordingly, it is generally advised that cooperation can help farmers increase their revenues. However, as noted earlier, cooperation may also contribute to preservation of traditional production and market channel practices. In this regard, it may slow down the modernisation process which is reflected by the negative sign associated with that variable.

In order to check the robustness of the 'impact analysis', two additional methods were applied. First, in column (3) we show the model which used probit regression in the first stage. In other words, we show here the second stage model in which the main variable of interest is based on the estimates presented in column (1). The second method used simple (one-stage) OLS regression (column (4)). This choice was dictated by the fact that tests conducted in order to assess the problem of endogeneity found explanatory variables to be exogenous. What needs to be stressed here is the fact that both these additional methods (columns (3) and (4)) were fully consistent with previous specifications confirming that belonging to the MMC positively affects farmers' revenues.

Impact of supply-chain restructuring on small farms¹⁹

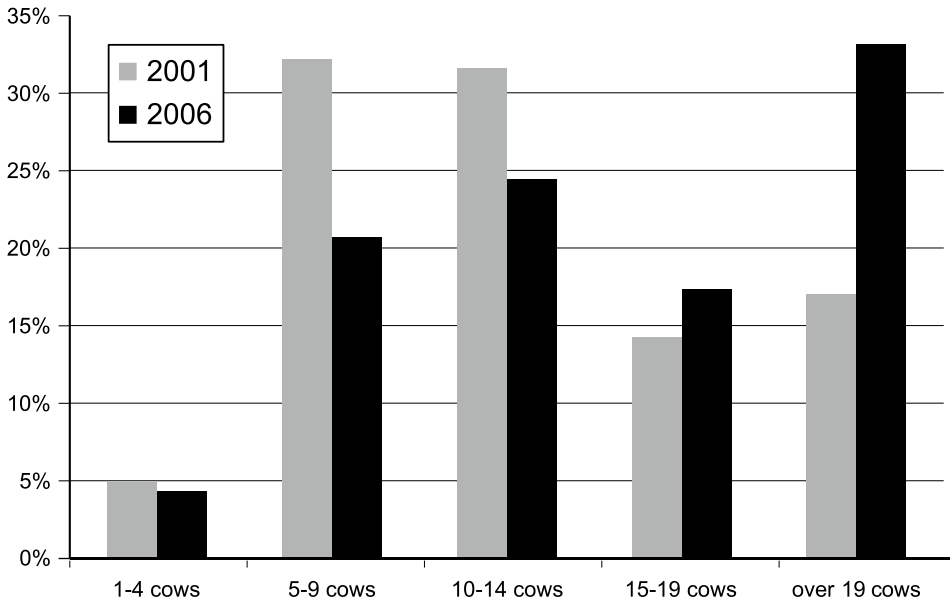
As presented above, the decision to supply the modern market channel is significantly dependent on herd size. Therefore, below we briefly discuss to what extent this result could be indicative of the exclusion of small farms. To do so, we explore the size distribution of our sample in both 2001 and 2006. Further, we provide some descriptive evidence on access to external funding in relation to various size

¹⁹ A comprehensive discussion about smallholders and the process of their restructuring in dairy sector in Poland could be found in Milczarek-Andrzejewska (2014).

classes. While these additional observations certainly cannot serve as definitive proof or evidence of the absence of exclusion of small farms from the market, we hope that they will complement, at least to some extent, the discussion presented above.

Figure 1 shows the distribution of farms according to their size in 2001 and 2006. What is evident is that the share of small farms (having less than 10 cows) decreased substantially in this period. At the same time, an increase in the share of larger farms, i.e. commercial farms with fifteen cows or more) is observed. This tendency was not limited to the regions under study but was also visible in the whole Poland (see e.g. Dries et al., 2011).

Figure 1. Farm size distribution according to size classes in 2001 and 2006



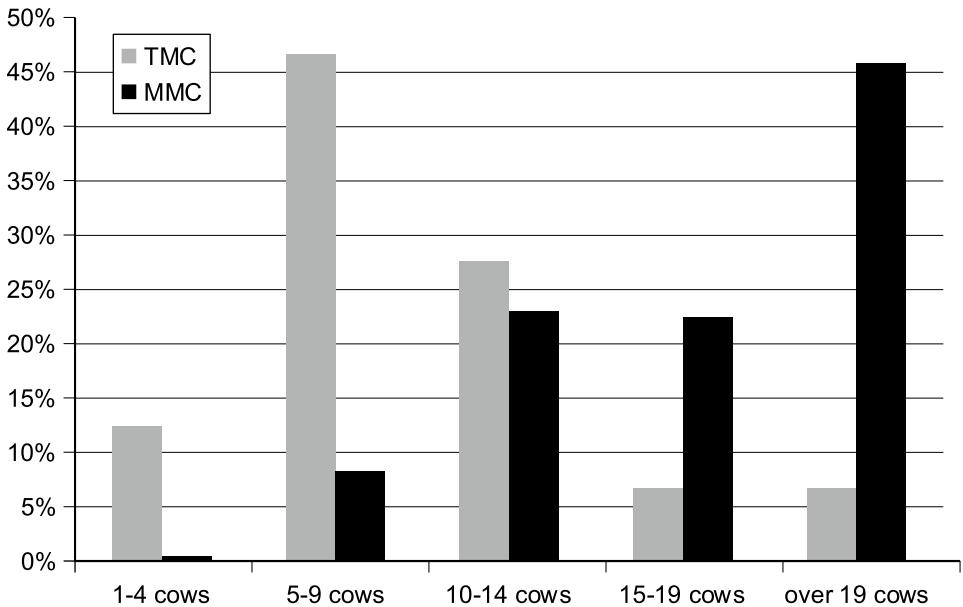
Source: Authors' calculations based on the survey sample.

In addition, in the period covered by this study, small farms were delivering milk mostly to the traditional market channel (TMC). In 2006 about 59% of farms belonging to the TMC were farms having less than 10 cows. What should be noted though is that these farms have also participated in the modern market channel (MMC) (about 9% of farms in MMC). The share of the smallest farms (with less than 5 cows) in the MMC however, reached only about 0.5%. Figure 2 presents the distribution of farms in the MMC and the TMC in 2006.

Based on the data, it could be argued that the smallest farms (with less than 5 cows) might have suffered from an unfavourable location with respect to a dairy plant, which could have been decisive for their decision not to modernize but to remain in the traditional market channel. This conjecture stems from the fact that,

on average, both in 2001 and 2006 distance between dairy processing facilities and farms from this group has been much larger than in the case of farms having larger herds. In 2001 the average distance between the dairy processing facility and the smallest farm amounted to approximately 34 km while it ranged from about 25 to 27 km for farms having 10 or more cows (in 2006 it was, respectively, roughly 40 km and from about 25 to 33 km).

Figure 2. Share of milk producers in traditional (TMC) and modern (MMC) market channels according to size classes in 2006



Source: Authors' calculations based on the survey sample.

The marginal share of small farms supplying the MMC could be interpreted as supporting the hypothesis that the dairy supply chain restructuring could have taken place at the expense of small farms. This picture, however, lacks a dynamic perspective that would include information on farms switching market channels and moving across size categories. This perspective is essential to consider when attempting to form a comprehensive understanding.

It should be noted therefore that our survey provides some evidence showing that very small and small farms were able to join the MMC between 2001 and 2006. About 3% of farmers who have changed their market channel and modernized had less than 5 cows and about 24% of them had between 5 to 9 cows. One might ask whether this process could not have been more open to smallholders, but the fact that 30% of those who switched to the MMC could be regarded as small cannot be neglected either.

Further, our data show that small farms (with less than 10 cows) were able to access external funds and, at least in their subjective view, were not necessarily marginalized on the credit market (see Table 3). This is important since, as it was shown above, access to external funds appears to be one of the key determinants of market channel choice. What should be noted, though, is that there seems to be a positive correlation between farm size and access to credit. Moreover, for the period after 2001, the reported figures for the smallest size class (with less than 5 cows) are of much lesser magnitude than for other categories. While for the majority of farmers the self-assessed probability of getting credit for milk production was high (approximately 90% of farmers within different size groups said that they could get credit from a bank and about 50% - from dairy product processors), farms having less than 5 cows estimated this likelihood as relatively low (respectively, 50% and 13%). Also, the share of very small farms with credit after 2001 was the lowest in comparison to other size classes. It is inconclusive, however, to what extent these statistics could be seen as standing in contrast with the findings of other studies dealing with the Polish dairy sector that have not evidenced the exclusion of small farms (Dries and Swinnen 2004; Swinnen et al. 2006). Unfortunately, our data set does not allow for exploring this issue in more detail. We have no data, for instance, on actual refusals of credit applications submitted by farmers, a data point which could add a lot to this discussion and could be worth investigating in future research.

Table 3. Credit availability and credit obtained according to size classes

| | Size class | | | | |
|---|------------|----------|------------|------------|--------------|
| | 1-4 cows | 5-9 cows | 10-14 cows | 15-19 cows | over 19 cows |
| Number of observations (total 323) | 16 | 104 | 102 | 46 | 55 |
| Share of famers who could receive credit for dairy production according to farmers' opinion | 50% | 89% | 92% | 89% | 93% |
| from bank | 50% | 83% | 92% | 83% | 91% |
| from dairy | 13% | 57% | 57% | 59% | 45% |
| Share of farmers with credit in 2001 or before | 25% | 13% | 17% | 26% | 27% |
| Share of farmers with credit after 2001 | 25% | 34% | 47% | 54% | 40% |

Source: Authors' calculations based on the survey sample.

Conclusions

This study analysed determinants of market channel choices of local dairy farmers in light of the dynamic and thorough transformation taking place in the Polish dairy sector. It also investigated what impact this choice may have on financial performance of farms and specifically on farm revenues which had not been investigated until now. In the detailed analysis of years 2001-2006 we find results relevant for current and future changes in the agro-food supply chain. The processes which started at the beginning of the transition period are still in force (including changes in the way milk is delivered and the process of dairy processing consolidation). Two key findings emerged from this study. First, and interestingly, neither human capital nor households' initial physical assets are the decisive factors for entering the modern market channel (MMC). It is rather access to funds that allow for undertaking necessary adjustments that seem to have an important impact. Given that farms' financial capital endowments are limited, the market channel choice is crucially dependent on having access to external funds. This may explain an important role of dairy processors in assisting farmers and stimulating the restructuring found in other studies (see Dries and Swinnen, 2004, 2010 or Wilkin et al., 2007). Further, joining the MMC is facilitated by possessing assets specific to dairy production and having herds of larger size and improved cow breeds.

The second important finding is that entering the MMC positively affects farms' financial situation. This effect has been found for all farms regardless of their size. For the smallest ones, however, the impact is of lesser magnitude. Although the situation of small producers was not the main topic of this study, several interesting conclusions about small farms may be drawn. No systematic evidence for small farmers being excluded from the MMC was found, though it seems that the smallest ones (with less than 5 cows) might have had difficulties in accessing external funds needed for modernization. In addition, transaction costs related to the transport of milk might have also contributed to the unfavourable situation of small farms. As most of this additional analysis was based only on descriptive statistics, a deeper investigation could be very interesting and seen as a potential topic for future research.

What should be noted is that, due to data availability, our analysis stops in 2006. In effect, we are not able to cover the changes that have been taking place in the dairy sector since then. Yet, it is important to notice that a large part of this recent restructuring is a continuation of the trends observed earlier which are captured by our analysis. Further, our analysis, although based on older data, is related to current debates on institutional change in agro-food supply chain. It may also deliver important conclusions about structural changes in a still fragmented industry and with a large number of small producers. Thus it could be relevant for other Central and Eastern European states as well as other countries or regions in

the world with analogous industry sectors. That said, we are fully aware that this analysis touches only a part of the complex picture of (dairy) supply chain restructuring and a number of interesting points still remain very poorly understood. As far as the dairy sector in Poland is concerned, for instance, one topic that seems to be very interesting concerns dairy cooperatives and their role in affecting the adjustment processes.²⁰ The other fruitful line of inquiry might be to look at changes in dairy supply chain governance and factors that affect bargaining power of various actors operating in the sector. We hope that this paper could be a useful building block for these analyses.

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²⁰ We thank an anonymous referee for making this point.

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APPENDIX

Table A1. Definition of explanatory variables used in the estimated models

| Variable | Definition |
|-------------------------|---|
| Age 2006 | Age of households' head in 2006 |
| Educationa | Level of education of household's head; 1=elementary, 2=vocational, 3=secondary, 4=university |
| Herd size 2001 | Number of cows in 2001 |
| Yields 2001 | Annual milk yields in 2001 in litres |
| Cooling tank 2001 | Dummy =1 for households having in 2001 cooling tank and =0 otherwise |
| Land 2001 | Total land endowments (owned and leased) in 2001 in hectares |
| Labour 2001 | Labour endowments in 2001; weighted sum of household members older than 15 years of age, with wage 0.5 for members 15-17 years of age, 1 for members older than 17 and younger than 65 years of age (61 for women), 0.4 for members older than 65 (61) years of age |
| Credit 2001 | Dummy =1 for households having in 2001 or earlier credit either from a dairy or a bank and =0 otherwise |
| Unearned 2001 | Dummy =1 for households having in 2001 unearned income and =0 otherwise |
| Off farm job 2001 | Dummy =1 for household's head having in 2001 off-farm income and =0 otherwise |
| Revenues 2001 | Natural logarithm of total household revenues in 2001 (in PLN) |
| Cooperation 2001 | Dummy =1 for households cooperating in 2001 or earlier with other households and =0 otherwise |
| Podlaskie | Dummy =1 for households located in Podlaskie region and =0 otherwise |
| Distance dairy 2006 | Distance to the closest dairy factory in 2006 in km |
| Distance point 2006 | Distance to the closest collection point in 2006 in km |
| Share cooling tank 2006 | Share of surveyed farmers in given gmina (smallest administrative unit) having cooling tank in 2006 |

^a Controlling for education of household head by using separate dummies reflecting subsequent education levels does not affect the results.