Dairy supply chain modernisation in Poland – what about those not keeping the pace?[*]

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Abstract of the paper

This paper studies the determinants and consequences of heterogeneous market participation among dairy farmers in Poland. It uses a unique data set on supply chain characteristics and individuals with different relationships to the market. First, the study estimates the factors that cause households to choose not to participate in the market. Then, based on semi-parametric methods, it analyses their current revenues and compare with that of similar households that remained in commercial milk production. The key finding is that farms that decided for quitting milk sales perform worse than those that maintained commercial dairy business. However, more detailed analysis shows that this difference could be attributed to supply chain modernisation and becomes insignificant once subsistence farmers are compared to commercial farms supplying traditional marketing channel. Our estimates suggest that severing relations with the market is mainly determined by worse endowment of farms with dairy specific assets, smaller cow herds and older age of the farm manager.

Keywords and JEL codes: milk production, dairy supply chain, subsistence farming, matching methods, Poland, Q12, Q13.

1 INTRODUCTION

Dairy supply chain in Poland has recently been a subject of several interesting studies. Seremak-Bulge (2005) and Wilkin *et al.* (2007) documented the main changes that could have been observed in the sector over the last decade, and tried to highlight their causes and consequences. Among others, considerable decrease in number of dairy farms, increase in milk yields, an outstanding improvement in milk quality or concentration of the processing industry were acknowledged as the most remarkable changes. The EU accession and integration process, on the other hand, were recognised as the main driving forces behind the sector's restructuring. Hockman and Pieniądz (2005) looked at the Polish dairy sector from the angle of EU quality and food safety standards that became binding upon both the milk production sector as well as processing industry. Dries and Swinnen (2004; 2005) explored the role of dairy processors in stimulating the necessary adjustment processes at the farm level. The obtained results indicate that, assistance programmes directed to farmers by dairy processors were of crucial importance as they enlarged farmers' capacities to access external funding, technology or information. Finally, Milczarek-Andrzejewska *et al.* (2007) attempted to investigate the impact of supply chain modernisation on dairy farmers' revenues finding positive relationship.

There are also two other key points that arose from these studies which should deserve special attention. First, a new marketing channel through which milk is delivered to the market has emerged. Traditionally milk was delivered by farmers to collection stations operated by dairy processors. Nowadays more and more often milk is collected directly at the farm by a dairy truck (Milczarek *et al.*, 2007). It is estimated that this latter channel, hereafter referred to as the modern one, accounts for 60-100% of milk supplies (depending on a dairy company) (Seremak-Bulge, 2005; Wilkin *et al.*, 2007). It is remarkable that growing dominance of the modern channel has taken place despite the fact that entering this channel required from farmers undertaking considerable investments at the farm (e.g. buying cooling tank, increasing herd size[1], etc.). Again the role of processing industry's assistance should be acknowledged. Second, no systematic evidence was found in favour of the hypothesis that small farmers were excluded from the assistance programmes. On the contrary, collected findings suggest that support was provided both to smallholders as well as to larger producers (Dries and Swinnen, 2004; 2005; Milczarek-Andrzejewska *et al.*, 2007).[2] Nevertheless, herd size and milk yields per cow had a positive and significant impact on farmers' propensity to join the modern marketing channel (Milczarek-Andrzejewska *et al.*, 2007). Overall then, based on the experiences of the Polish dairy sector, it is difficult to take a definite stand on the common belief that food supply chain modernisation, and introduction of private quality and food safety standards in particular, may lead to smallholders' marginalisation (see, for instance, Key and Runsten, 1999; Reardon and Barret, 2000; Weatherspoon and Reardon, 2003; Humphrey *et al.*, 2004; among others).

In this context, it seems particularly interesting to have a closer look at factors determining local dairy farms' survival and current situation of those that withdrew from (commercial)

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[1] One could argue that increasing a herd size *per se* was not a factor conditioning joining the modern marketing channel. However, investments in cooling tank or in quality improvements, if they were to be profitable, often required sufficient scale of production. To illustrate this, one may recall the study by Milczarek-Andrzejewska *et al.* (2007) reporting that almost 85% of the then surveyed farmers who switched from traditional to modern channel increased their herd size.

[2] Evidence from micro-study reported in Milczarek-Andrzejewska *et al.* (2007) suggests, however, that the smallest farms, i.e. those having less than 5 cows, could have been marginalised with respect to their access to bank/dairy loans.

milk production. This investigation is the more desirable as the Polish dairy sector experienced during transition a significant outflow of people. The number of dairy farms declined by more than 1 million, from 1.8 million in 1990 to roughly 0.7 in 2005 (GUS, var. vol.). Obviously significant part of these producers could be regarded as producing milk only for own consumption and therefore their withdrawal was a natural course of events. However, even if one would adjust these figures to reflect only producers delivering to dairy industry, decline in number of farms still amounts to 0.55 million.[3]

Interestingly, in spite of the scale of this process, the fate of those who decided to quit milk production is very poorly documented. Some insights could be gained from the study by Dries and Swinnen (2004) where main determinants of dairy farms survival were investigated. Taking into account however, that the focus of that study was on those who survived it certainly does not exhaust the topic. In response to this, this paper aims at having closer look at milk producers that fell outside the commercial dairy supply chain. More specifically, an attempt is made to determine the main factors responsible for decision to stop milk sales (but not necessarily to stop milk/agricultural production). The focus is on the importance of changes taking place in vertical linkages between farms and dairy processors. Further, a comparison between those who quitted and those who stayed in commercial dairy sector is made to see whether the decision to quit could be regarded as optimal. Once again the importance of different characteristics of dairy supply chain is investigated. To reach this goal the average effect of market participation decision on farm revenues is estimated by means of semi-parametric propensity score methods. The choice of this approach is of importance for at least two reasons. First, these techniques are robust in the situation where farms quitting milk sales may systematically differ from those that do not. Second, they do not impose any functional form assumption on how market participation decision affects revenues. Therefore, they can allow for any heterogeneity in the relationship between farm revenues and their observable characteristics. Taking into account the universality of self-selection problem as well as complexity of household decision making process, these two points cannot be overestimated.

By doing so, this paper aims at further reconsidering the link between subsistence farming/ farm exits and farm revenues by putting into perspective supply chain modernisation. The analysis is based on a unique survey data conducted in 2007 among 395 randomly sampled individuals with different relationships to the dairy market. Another advantage of this data set is that it collected information on 2001 and 2006. Thanks to this, dynamic aspects of farm decision making process could be elaborated. It is also important to note that the period covered in this study (i.e. 2001-2006) encompasses the time when important phenomena took place as a result of dairy supply chain modernisation and EU accession (Wilkin et al., 2007). Accordingly, our dataset should allow to capture these effects. Furthermore, contrary to many other studies dealing with the issues of farm orientation/exits, this paper adopts a sector-focus rather than a general agricultural perspective.[4] This difference may be of importance since the latter approach could veil several sector-specific factors determining farm relationship to the market and its consequences. Last but not least, it should be noted that determinants of farm

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[3] Number of producers delivering milk to dairy industry in 1990 amounted to 850 thousands. In 2005 this number amounted to 294 thousands (GUS var. vol.).

[4] Although there exist studies dealing with farm development in/exits from dairy sector (Foltz, 2004; Hansson *et al*., 2008; Peerlings and Ooms, 2008), the majority of the literature looks at this problem from more general perspective and investigates changes in number of farms in agricultural sector as a whole (see, for instance, Weiss, 1999; Gale, 2003; Key and Roberts, 2006; Breustedt and Glauben, 2007, among others). Similarly, the literature on subsistence farming is dominated by studies adopting a more general perspective (see, for instance, Balint and Wobst, 2006; Bezemer and Lerman, 2004; Kostov and Lingard, 2002; Sarris et al., 1999).

exits were studied mostly in developed countries (see, for instance, Weiss, 1999; Kimhi, 2000; Goetz and Debertin, 2001; Breustedt and Glauben, 2004, among others); whereas not in transition context. Notable exceptions include Rizov and Mathijs (2001), Dries and Swinnen (2004) and Juvancic (2006) that studied survival and growth of farms in Hungary, Poland and Slovenia respectively. Further, the focus was on determinants of that decision rather than on consequences it may bring.

The paper is organised as follows. Section 2 draws on the theoretical discussion on some of the most important factors that motivate farms to remain in/stop (commercial) production. It also reviews findings in the recent studies examining the relationship between marketing choices of farmers and farm performance. Section 3 presents the data and an econometric approach. Section 4 reports descriptive statistics. Section 5 presents results of econometric analysis, while Section 6 summarises and concludes.

2 LITERATURE REVIEW

Given the purpose of the paper, the focus in this section is on two strands of the literature, namely the literature on subsistence farming and the literature on farm exits. In addition, a brief overview of the literature linking supply chain modernisation and farm revenues is also provided.

2.1 Subsistence farming

In recent literature on subsistence farming two key approaches could be distinguished (Kostov and Lingard, 2004). On the one hand, subsistence farming can be associated with the existence of transaction costs (de Janvry and Sadoulet, 1994). Transaction costs *rise the price effectively paid by the buyer and lower the price effectively received by sellers of a good, creating a "price band" within which some households find it unprofitable to either sell or buy* (Key *et al.*, 2000, p. 245). They include both proportional as well as fixed costs. The former include per-unit costs of accessing markets associated with transportation and imperfect information, whereas the latter include costs of searching the trading partner, of bargaining process, and of monitoring and enforcing the contract. Number of empirical studies found that these costs are likely to affect agents' market participation decisions (e.g. Goetz, 1992; Sadoulet *et al.*, 1998; Key *et al.*, 2000).

On the other hand, farmers' risk aversion is put into perspective. Within this framework farmer's decision on his relationship to market takes into account wider range of risks than price risks alone (Kostov and Lingard, 2003). Obviously, of key importance here is whether farmers' motivation to produce is to secure consumption or to sell (Ozanne, 1999). This is of relevance since it might determine farmer's perception of risks involved and strategies employed to avoid unwanted events.

Having this in mind, from our perspective of importance is the relationship between supply chain restructuring and the level of transaction costs/risk aversion. As noted by many authors (e.g. Key and Runsten, 2001; White and Gorton, 2006) supply chain modernisation has been associated with institutional innovation that took the form of contracts. Further, emergence of private capital enforcement mechanisms in vertical relations between farms and downstream companies should also be recognised (Gow and Swinnen, 2001). In this context, one may assume that supply chain modernisation should act in favour of reduction of transaction costs and price risks. Moreover, provided that it is accompanied by assistance programmes to farmers (Dries and Swinnen, 2004; Wilkin *et al.*, 2007) it should also mitigate other risks

resulting from imperfect information or other markets' imperfections. These considerations find support in the study by Milczarek-Andrzejewska *et al.* (2007). The authors report that farmers rate the modern channel more highly than the traditional one in terms of, among others, level of price paid, security of milk collection, lower risk of delayed payments or technical and credit assistance. Overall then, belonging to the modern marketing channel should lower the odds of quitting milk sales through its impact on the level of transaction costs and risks faced by the farmer. Consequently, it should lower the odds of quitting milk sales. This is the more plausible since joining the modern marketing channel very often requires additional investments in the farm and thus its impact on farmer's decision may be perceived from the sunk costs perspective.

2.2 Farm exits

As mentioned above, supply chain modernisation has also entered the discussion on farm exits. More specifically, concerns have been expressed that it can lead to the exclusion of small farms from formal food supply chains. It is important to see though that overall empirical findings on this issue are mixed. Evidence from Eastern and Central Europe as well as from Commonwealth of Independent States tend to indicate that downstream market power, even if exists, does not need to lead to smallholders' marginalisation (Swinnen *et al.*, 2006; White and Gorton, 2006; Gorton and White, 2007; Swinnen, 2007). Different picture emerges from findings on African and Latin American countries (Delgado, 1999; Key and Runsten, 1999; Dolan and Humphrey, 2000; Weatherspoon *et al.*, 2001; Reardon and Berdegue, 2002; Reardon and Farina, 2002). However, examples of Morocco (Chemnitz, 2007) or Madagascar (Minten *et al.*, 2007) where no systematic evidence for small farms' marginalisation was found should be kept in mind. It is concluded therefore, that the impact of supply chain modernisation on farm exits is not certain.

In this context, it is worth considering other factors that could contribute to farmers' decision to exit from farming. To start with, it might be worth mentioning that, as noted by Breustedt and Glauben (2007), most exits from farming are voluntary. On the one hand, exit from farming might be a consequence of old age and/or poor health (Jovanovic, 1982; Bentley and Saupe, 1990; Gale, 2003).[5] On the other hand, exiting from (small-scale) agriculture might be sometimes accounted for by macroeconomic prospects recovery (White and Gorton, 2006).

Moving to empirical studies dealing with dairy sector, Dries and Swinnen (2004) show that farm survival is crucially dependent on herd size. Other factors of relevance include membership in cooperative as well as access to dairy assistance programmes. Off-farm employment opportunities, on the other hand, favour exiting from farming.[6] Similar findings are reported for dairy farms in the Netherlands by Peerlings and Ooms (2008). Finally, it is worth noting that using data for Swedish dairy farms, Hansson et al. (2008) find that farm

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[5] As noted in studies of non-farm business, the operator's age may be related to knowledge about firms' relative competitiveness with older owners being able to acquire more information (Jovanovic, 1982). Further, in the presence of financial constraints, the older the owner, the higher probability that he would finally accumulate enough funds to operate on sufficient scale (Evans and Jovanovic, 1989; Holtz-Eakin *et al.*, 1994). The fact of having or not the successor to take over the business might also be of great importance here.

[6] In this context, it is worth noting that the evidence on the association between off-farm employment and farm exits is not clear. To quote an example, Pfeffer (1989) and Weiss (1999) documented that part-time farming is a step in the way out of agriculture. On the contrary, more recent studies (see, for instance, Kimhi, 2000; Goetz and Debertin, 2001; Breustedt and Glauben, 2007, among others) concluded that off-farm opportunities tend to decrease the probability of farm exits.

growth is more likely on farms with larger dependence on milk production and previous investments made.[7]

2.3 Farm revenues

As mentioned above, we are interested not only in factors determining households decision to (not to) quit milk sales but also in comparing revenues of those who quitted with revenues of farms that maintained dairy business. Following discussion could help to build the context for our analysis. First, several recent studies attempted to investigate what are the impacts of farmers' market choices on their incomes (for an overview see Huang and Reardon, 2008). The case of dairy sector in Poland (Milczarek-Andrzejewska *et al.*, 2007) as well as strawberries growers in Mexico (Berdegue *et al.*, 2007) provide evidence that choosing the modern channel had a positive impact on farms' financial situation. Examples of tomato growers in Indonesia, China, Turkey and South Africa show no significant impact of choosing the modern channel, whereas example of dairy sector in India reveals negative relationship (Huang and Reardon, 2008). Second, the research conducted in Senegal shows that the supply chain restructuring may offer earning opportunities not only on the product market but also on the labour market (Maertens and Swinnen, 2006). In these circumstances, farmers not being able to meet new requirements may benefit from shifting away from contract farming and hiring themselves as workers on large-scale estates. It should be noted, though, that this scenario does not always hold. McMillan *et al.* (2002) report increase in unemployment in the case of cashew nut growers in Mozambique. Similar findings are provided by Wilcox and Abbott (2004) for cocoa beans sector in Ivory Coast. In this context it is worth recalling mixed evidence on the relationship between growing engagement in salaried off-farm positions and household's wealth level (see, for instance, Reardon, 1997; Lanjouw and Lanjouw, 2001; or Joshi *et al.*, 2003; and citations therein).[8]

3 DATA & ECONOMETRIC STRATEGY

3.1 Data

The analysis presented below uses primary survey data collected in 2007 in two regions located in north-east Poland, namely Warmińsko-Mazurskie and Podlaskie. Both of them, after experiencing considerable restructuring, rank among the best developed dairy regions. As such, they may serve as a textbook case of sector's transformation and provide valuable insights for other parts of the country that are behind in the adjustment process.

Altogether 395 dairy farm households were surveyed. The questionnaire gathered information on household, farm and neighbourhood characteristics. It aimed at capturing the main features of changes in dairy supply chain with the focus on adjustments taking place at the farm level.

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[7] It should be also noted that extensive literature exists on the relationship between farm exits and farm subsidisation programmes (see, for instance, Barkley, 1990; Tweeten, 1984; Key and Roberts, 2006, among others). Foltz (2004) and Peerlings and Ooms (2008) provide examples of studies examining this relationship in dairy sectors. However, due to our data limitations, unfortunately we are not able to investigate this issue and therefore, we do not review this literature here.

[8] A strong positive relationship was found for African countries as well as China (Reardon, 1997; Rozelle *et al.*, 1999). Latin American countries and India provide evidence for U-shaped relationship indicating that obtaining the highest share of non-agricultural employment is a common facet of both poorest and wealthiest households (Reardon, 2000; Hazell and Haggblade, 1990). Deininger and Olinto (2001), on the other hand, found that a strong positive association between total income and 'specialization', i.e. relying only on one main source, either on- or off-farm, held true in the case of households in Colombia.

In order to get better insights, information on two years, namely 2006 and 2001 were collected. This was done to capture the dynamics of the restructuring process.

The overall sample consisted of a sub-sample of 66 farms that quitted milk sales at some point after 2001. These farms answered additional questions relating to their reasons to withdraw from commercial milk production. This aimed at making it possible to investigate the fate of those farms that did not keep the pace with the dairy sector restructuring or simply did not want to do it.[9]

As regards farmers' market choices, in 2001 146 farms were in the modern marketing channel (milk collected at the farm) and 249 were in the traditional one (milk delivered to collection points). Taking into account 66 farms that quitted milk sales, in 2006 these numbers were 218 and 111 respectively. As such we classify farmers into two groups: the modern channel farmers and traditional channel ones. Within those two categories farmers that quitted milk production and farmers that switched between marketing channels could be distinguished.

3.2 Econometric strategy

The first research question, i.e. what factors determine decision to quit milk sales, is addressed by using logit maximum likelihood procedure. Therefore, we assume that our dummy dependent variable, equal to one for farms that stopped to sell milk and equal to zero for farms that maintained their dairy business, depends on an unobserved continuous propensity of a farmer not to participate in a dairy market. We specify this unobserved variable as a linear function of number of explanatory variables (see below).

In order to address the second research question, i.e. how do the farms that quitted their participation in dairy market perform compared to those that still sell their milk, we employ propensity score matching methods (see, for instance, Rosenbaum and Rubin, 1983; Heckman *et al.*, 1997; 1998; Smith and Todd, 2005, among others). Although these methods originate from other research fields, they are quickly making their way into agricultural economics (examples include: Dabalen et al. 2004; Bento et al., 2007; Mendola, 2007; Key and Roberts, 2008; Briggeman et al., 2008; Maertens and Swinnen, 2009; Pufahl and Weiss, 2009). We use two measures of performance here, namely agricultural and total revenues per capita. The focus by this method is to rule out the impact of unobservable factors that might affect the level of farm revenues and thus to overcome the potential selection bias problem. Moreover, it relaxes linearity assumption allowing for any heterogeneity in the effect of quitting milk sales, as long as it is related to the observable factors. Thanks to applying this method we reduce the risk that the effect of quitting milk sales is confounded with that of the factors determining this decision. Since one does not observe what would have happened if the farm that quitted had remained in commercial production (or the converse), an estimate of the counterfactual is constructed. Conditional on number of observable characteristics the probability of quitting milk sales is calculated for each farm, the propensity score. Based on this estimate, the next step involves evaluating the difference in farm revenues between the farms that decided to withdraw from dairy market (treated) and those that did not (control). Since matching relies on comparing farms with similar values of propensity score the inferences are not distorted by counterfactuals very different from the treated observations.

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[9] Taking into account that the rate of withdrawal from commercial milk production in the period 2002-2005 amounted to roughly 21%, slight under-representation of such farms in the sample should be kept in mind while interpreting the results. Nevertheless, it is believed that exploring information provided in this sample could provide valuable insights on those who stopped milk sales.

4 DESCRIPTIVE STATISTICS

We start addressing our research questions by referring to some descriptive statistics. The data show that 30% of farmers that decided to quit milk sales related this decision to low profitability of milk production. Another 21% saw the decisive factor in lack of necessary funds for investments. 13% mentioned old age and having no successors, whereas 12% referred to meeting with a refusal from a dairy due to low quality of milk. Great majority of surveyed farmers (95%) would not resume milk production if they could. In a sense, this may suggest that notwithstanding what lied at the heart of the decision to withdraw from milk sales farmers generally do not regret it. Interestingly though, when asked to compare their current financial situation with that from 2001 (i.e. when they sold milk), only 18% of respondents declared improvement, whereas 35% saw no change and 38% found their finances to be lower than previously. It might be worth noting that among farmers continuing milk sales these figures were 68%, 24% and 6% respectively. Moreover, it should be kept in mind that for almost 80% of those who fell outside the commercial dairy supply chain milk sales constituted either the most important or an important source of income. These observations, although being simple proportions, put the decision to quit milk sales in a bit different light suggesting that withdrawing from dairy sector might not have been the best strategy to optimise farm income. This, in turn, induces to pose some more detailed questions with respect to factors that inclined farmers to stop selling milk.

First insights on factors determining decision to quit milk production could be gained from looking at descriptive statistics reported in Table 1 where farmers that quitted milk production are compared to farmers that kept their relationships to dairy market. Several things seem to be worth noting. To start with, not surprisingly, farmers who decided to quit milk sales were worse endowed with dairy specific assets. This manifested itself, for instance, in smaller cow herds, having cows of poorer quality or lower incidence of having cooling tank, milking machine, manure storage place etc. Worth mentioning is also the fact that over the last decade only 30% of those who quitted undertook investments to satisfy requirements of dairy processors. For comparison, necessary adjustments were undertaken by roughly 80% of those who stayed in milk production. As a result of this relative underdevelopment, the former group of farmers could not benefit from premiums for high-quality milk or for delivering larger quantities. Consequently, they obtained lower milk prices.

Table 1. Farm characteristics in 2001 – descriptive statistics

		Quitted milk sales	Stayed in milk sales	t-stat[a]
Milk production	Herd size (cows)	7	12.8	9.25***
	Milk yields (litres/cow)	3926	4302	2.36**
	% of households having Holstein-Friesian or mixed cattle	27.3	46.5	2.90***
	% farms having cooling tank	30.3	57.4	4.10***
	Index of assets specific to milk production (max 7)	2.59	4.07	6.64***
	Milk production sold (%)	88	94.2	0.65
	Average milk price (PLN/hectolitre)	68.9	75.1	3.68***
	Membership in dairy cooperative (%)	65.1	72.9	1.28
	Distance to dairy (km)	23.7	26.4	1.24
	Distance to collection point (km)	2.1	2.92	2.69***
Human capital	Age	41.8	37.3	2.91***

	Education of head of a household (1=elementary, 2=vocational; 3=secondary; 4=university)	1.81	2.01	1.85*
Land & labour endowments	Labour endowments	2.46	2.77	2.29**
	Land owned (ha)	16.1	22.2	4.87***
	Land leased (ha)	0.27	3.37	7.88***
Financing investments in last 5 years	Investments financed with own savings (%)	65	84	3.04***
	Investments financed with a bank credit(%)	25.7	48.6	3.45***
	Investments financed with a dairy credit(%)	3	17	4.70***
	Investments financed with EU funds (%)	13.6	26.4	2.61**
Revenues & off-farm income	Agricultural revenue per capita (PLN)	13 121	16 708	2.31**
	Share of milk revenue in agricultural revenue (%)	52	66	3.43***
	Share of agricultural revenue in total revenue (%)	77	94	4.51***
	Off-farm employment of household's head (%)	9.1	7.3	0.50
	% of households with unearned income	44	46	0.29

Source: Authors' survey. [a]Hypothesis tested: $mean_{quit} = mean_{stay}$; ***, **, * denote 1%, 5% and 10% significance level respectively

Notwithstanding all these facts, reported statistics suggest that in case of both investigated groups of farmers great majority of milk produced was delivered to the market. This indicates that ascertaining that these were semi-subsistence farmers who quitted is not necessarily the case here. Further, the presented figures do not support the view that farmers who decided to quit were particularly unfavourably located with regard to dairy processor or dairy collection point.[10] Lack of significant difference between the two groups as regards ties with dairy cooperative should also be noticed. In order to check the so called 'neighbourhood effect', farmers were asked a question whether households in their neighbourhood also quitted milk production. Provided that number of positive and negative answers among the two groups of farmers was the same no clear relationship could be drawn with this respect.

The abovementioned observations, together with the fact that those who decided to quit earned in 2001 less than those who stayed, could indicate, that withdrawing from milk production was a conscious decision aimed at optimisation of resources' usage. This line of thinking is further supported by the fact that those who quitted were significantly older than those who stayed. There are, however, some points which rise doubts whether the choice made was indeed voluntary. First, it should be noted that those who quitted relatively rarely took advantage of external funding. This, obviously, may be simply a reflection of smaller activity with respect to undertaking investments but could also be indicative of their poorer access to bank/dairy loans.[11] Second, worth mentioning is the fact that households that decided to quit milk production had at their disposal smaller labour and land endowments, which surely adversely affected their alternative income opportunities. Moreover, also their human capital endowments tend to argue against them. In other words, it might have been the case that farmers who decided to quit milk production were forced to do so by either objective (e.g. age) or subjective (e.g. lack of access to credit) factors without being appropriately prepared to look for other income sources.

This hypothesis could be examined by looking at the consequences that this choice brought about. First of all, it is instructive to compare financial situation of farms that quitted and of

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[10] Actually, farms that quitted milk sales were closer to collection points than those who remained in commercial.

[11] The former hypothesis is supported by the fact that farmers who quitted less frequently financed their investments with own savings and EU funds.

those that stayed in milk production and delivered to the market through the traditional marketing channel (TMC). The choice of the latter group as a reference point is dictated by the fact that 90% of farms that decided to withdraw from milk production were in this channel prior to their exit from dairy sector. Accordingly, one might say that this is the best approximation of what one could get once decided to stay instead of quitting. Interestingly, while in 2001 those who quitted did not differ significantly from those who stayed in TMC (13 vs. 12 thousands PLN, t-stat = 0.69), the latter enjoyed higher revenues in 2006 (17 vs. 12 thousands PLN, t-stat = 1.76). Bearing in mind that these are only sample averages, this result again suggests that the choice to withdraw from milk production might not have been the best choice to maximise farms' profits.

Other remarkable insights could be obtained from investigating behaviour of those who quitted after their choice was made. First, roughly 18% of them quitted also farming. Taking into account that those who quitted agricultural production for good were definitely older than the rest, tends to indicate that the former group simply retired. This supposition is further confirmed by the fact that in this group pensions and allowances were indicated as main source of income. For this reason our comparisons include only farmers that remained in agricultural production (i.e. the sub-sample of 66 farms that quitted milk sales reduces to 54 observations). As far as their income sources are concerned, for majority of them agricultural production remained to be the main source of income (74%). 13% of them earn their leaving mainly outside agriculture (roughly 4% are self-employed) whereas another 13% draw pensions.

Interestingly, semi-subsistence farming predominates among those who quitted milk production but are still involved in agriculture. 34% of them produce either only for own consumption or sell only small surpluses on the market, 31% sell half of what they produce and only 35% sell all or majority of their production. Taking into account that during the times they produced milk majority of production was directed to the market, this observation suggests that those who quitted milk production but stayed in agricultural production moved towards semi-subsistence farming. In other words, shadow prices changed in such direction that producing for own consumption rather than for market became the optimal choice. This course of events could be, to some extent, explained by the fact that in 2006 farms that quitted milk sales took advantage of off-farm employment much more often than farms that stayed in commercial milk production. One may conclude therefore, that resigning from milk production required looking for off-farm employment. 38% of farms that quitted milk sales confirmed this supposition, whereas 62% reported that working on the farm was sufficient.

Taking into account that almost half of those who quitted (47%) decided to withdraw from dairy commercial production before 2004, it seems that this decision was not necessarily a response to changes in the economic environment related to Poland's EU accession (May 2004).

Section below tries to further examine these issues by using econometric analysis.

5 ECONOMETRIC ANALYSIS

5.1 Variables definition

Based on the discussion presented above as well as theoretical considerations outlined in Section 2, following variables were chosen for the purpose of econometric modelling. The key variable of interest is a dummy variable *channel*. It distinguishes farms belonging to modern marketing channel and thus aims at capturing potential impact of supply chain

modernisation on farm orientation. The variables *age*, *education* and *agric. education* refer to farm operator and represent age in years, dummy for operators with only elementary education and dummy for operators with agricultural education respectively. The variables *herd-size*, *yields*, *dairy-assets* and two dummies *milking parlour* and *manure storage* describe farm's capacity to produce milk. The two former variables represent number of cows and log of annual milk yields per cow respectively. The third one on the other hand, is an index of equipment used specifically for milk production. The scale for this index was constructed based on Mokken scale procedure (Sijtsma and Molenar, 2002) and factor analysis (Bartholomew and Knott, 1998).[12] These two methods suggested that for having a milking parlour and manure storage place separate scales are needed and therefore these two are not included in the general index but represented with appropriate dummies. Finally, the variables *coop-member*, *share-milk*, *labour-endowments*, *revenues* and *off-farm* refer to household characteristics. The former informs whether a farmer belonged to dairy cooperative. *Share-milk* represents a share of milk sales in total agricultural sales. *Labour-endowments* is defined as a weighted sum of household members over 15 years old.[13] *Revenues* represent the log of farm revenues and *off-farm* is a dummy variable distinguishing households having access to off-farm wages and both of them aim at capturing potential effect of overall economic prosperity. All explanatory variables refer to 2001. Provided that decision to quit was made at some point after 2001, this strategy was adopted in order to mitigate potential endogeneity and reverse causation problems.

These variables are used for both logit model as well as first stage matching method.[14] As regards the first stage of matching methods, explanatory variables are chosen to reduce the bias attributable to unobserved factors and thus are crucial for the quality of matching (Becker and Ichino, 2002). Basically, reducing the bias should be accomplished by using diversity of the conditioning variables. However, provided our relatively small sample it was decided to use a limited number of covariates that are likely to influence both the decision to quit/maintain dairy business and agricultural revenues. Accordingly, we decided to base our estimation of propensity score on covariates used in the logit model.[15]

5.2 Logit model

The results of estimation analysing the binary decision to quit milk sales/maintain commercial production based on the full sample are presented in Table 2. Five key points should be noted. Most importantly, we find no significant effect of market choice variable, although its coefficient has an expected sign. This in turn indicates that development opportunities in dairy sector were not restricted to farmers already included in the modern marketing channel. Second, however, we find that larger producers, in terms of herd size, were less likely to stop

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[12] This index captures the incidence of having a particular piece of equipment from the following list: separate barn for cows, milking machine, cement-floor stand for cows, cooling tank, and separate room for cooling tank.

[13] Weights used for this calculation were: 1.0 for men aged 18–65 years and women aged 18–60 years; 0.5 for all household members aged 15 to 17; and 0.4 for men over 65 and women over 60 (Grontkowska and Klepacki, 2006).

[14] Other specifications with additional covariates (e.g. access to credit before 2001, access to unearned income in 2001) were also tried. However, explanatory power of these covariates was very small. Therefore, for brevity reasons, the results of these additional specifications are not shown but may be obtained upon the request.

[15] While using matching, in addition to working with full sample, we also work with sub-samples (see further). In these latter cases variable *channel* predicts success in logit model perfectly. Therefore, it is not included when calculating propensity score in these two samples and thus it is not reported in Table 3.

milk sales. It should be noted that this result, although of importance for the discussion on smallholders' exclusion, may simply reflect the fact that larger farms are simply more profitable.

Table 2. Logit results for quitting milk sales

Independent Variables	Dependent variable: =1 for those who quitted milk sales =0 for those who maintained milk sales
Supply chain characteristic	
Modern channel	-0.757
	[0.19]
Farm operator characteristics	
Age	0.0633***
	[0.0013]
Level of education	-0.139
	[0.75]
Agric. education	-0.215
	[0.64]
Farm characteristics	
Herd size	-0.177**
	[0.020]
Yields	-0.707
	[0.47]
Labour endowments	-0.439**
	[0.028]
Off-farm	0.736
	[0.14]
Revenues	0.196
	[0.64]
Share milk	-0.323
	[0.80]
Dairy specific assets	
Dairy assets	-0.900*
	[0.090]
Manure storage	-0.604
	[0.24]
Milking parlour	-1.149**
	[0.028]
Coop-member	-0.460
	[0.43]
Constant	3.721
	[0.56]
Observations	374
Pseudo R-squared	0.329

Source: Own calculations. p values in brackets; *** p<0.01, ** p<0.05, * p<0.1

Third, the variables describing farm productivity provide evidence of an important dichotomy. While higher milk yields per cow appeared to be insignificant, *dairy-assets* is negatively associated with quitting milk sales. The latter observation could be a reflection of sunk investments that are likely to bind dairy producers' relationship to market. The same can be said about the negative impact of *milking parlour*. Fourth, we find that decision to quit milk sales is positively affected by farmer's age. Provided that older age is closely related to retirement considerations and poor health (Gale, 2003), this result is in accordance with expectations. It is also corroborated by findings coming from the literature investigating the problem of dairy farm development/exit (Khimi and Rubin, 2007; Peerlings and Ooms, 2008).

Fifth, we also find that farms with higher labour endowments are more likely to maintain milk sales. This could be due to two reasons. On the one hand, larger family workforce means higher chances for having a successor which is of great importance for decision making in farm households (Pfeffer, 1989; Glauben *et al.*, 2004). On the other hand, quitting milk sales while having larger labour endowments would result in facing the necessity of finding alternative income sources for larger number of people.[16] Further, it might be worth noting that other variables, although being statistically insignificant, have the expected sign.

Finally, it might be interesting to collate these results with those obtained by Dries and Swinnen (2004) who analysed Polish dairy farms' survival based on data from 1995-2000, i.e. a five years period preceding our study. Number of similarities could be observed. To start with, in both cases farm survival was dependent on herd size. Moreover, Dries and Swinnen (2004) found positive and significant impact of assistance programmes offered by a dairy company. Taking into account that these programmes, by and large, facilitated farms' access to production assets (e.g. cooling tank, milking machine etc.) we believe that in our case this result is captured by the variable *dairy-assets*. Finally, it seems that belonging to cooperative and access to off-farm employment are no longer crucial for maintaining a dairy business and nowadays age as well as labour endowments play more important role.

5.3 Propensity score matching

Having established the main determinants of farm decision to quit milk sales, we move to address the second research question, namely: was that decision optimal when looking from farm revenues perspective.[17] In order to do so, we compare revenues generated by farms that quitted milk sales (but remained in agricultural production) with revenues of farms that decided to maintain commercial milk production. The reference point for farm revenues is 2006.

Table 3 provides information on how well does the matching procedure perform in our case. We consider here three cases. *Full sample* specification compares farms that quitted milk sales with all farms that kept dairy business. *Limited sample A* specification on the other hand, compares farms that quitted milk sales with farms that maintained commercial production but remained in the traditional marketing channel. Finally *Limited sample B* specification compares farms that quitted milk sales with farms that remained in dairy market and made a shift from traditional marketing channel to the modern marketing channel. The latter two specifications were also chosen in order to have more insights on heterogeneity within farms that remained in commercial milk production. They may be also treated as a robustness check for the full sample analysis.

As shown in Table 3, farms that quitted milk sales and farms that maintained their dairy business differ systematically in terms of number of characteristics. This is illustrated by the fact that the null of equal means of unmatched treated and control is rejected for almost all variables in case of the *full sample* and *limited sample B* specifications. As regards *limited sample A*, in accordance with expectations, farms do not display such differences but nevertheless some notable exceptions remain, namely *dairy-assets*, *labour-endowments* and, to a lesser extent, *age* and *herd-size*. What is evident though, is that matching performs well

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[16] This statement obviously bases on the assumption that household's labour endowments are positively correlated with number of household members working on the farm.

[17] Important to note is the fact that our data limitations do not allow to work with profits. Therefore, we base on farm revenues and assume that they may serve as a reasonable proxy for farm profits.

and removes all these differences, and equalises the means of all covariates across all specifications. The only exception is *labour endowments* in specification *B* which retains very different distribution in the treated and control groups. This suggests the need for conditioning also on this variable in this specification. Overall then, we conclude that matching is needed to have reliable comparisons between the groups of farms of our interest.

Table 3. Balancing properties of propensity score matching

Variable	Sample	Full sample Mean		t-test	Limited sample A Mean		t-test	Limited sample B Mean		t-test
		Treat	Control	p>|t|	Treat	Control	p>|t|	Treat	Control	p>|t|
Age	Unmatched	39.43	37.27	0.143	39.8	37.2	0.15	39.74	37.63	0.266
	Matched	38.54	38.86	0.882	39.0	38.3	0.705	38.38	36.94	0.534
Level of education	Unmatched	0.37	0.26	0.114	0.37	0.35	0.774	0.36	0.30	0.506
	Matched	0.34	0.37	0.774	0.40	0.31	0.365	0.33	0.20	0.239
Agric. education	Unmatched	0.31	0.47	0.028	0.31	0.32	0.835	0.29	0.46	0.060
	Matched	0.32	0.29	0.754	0.27	0.30	0.728	0.36	0.36	0.999
Herd size	Unmatched	7,00	13.14	0.000	7.10	7.69	0.326	6.95	11.91	0.000
	Matched	7.30	7.84	0.502	7.15	7.10	0.944	7.52	8.23	0.398
Yields	Unmatched	8.19	8.33	0.001	8.19	8.17	0.809	8.20	8.39	0.000
	Matched	8.21	8.18	0.649	8.18	8.19	0.801	8.25	8.28	0.673
Dairy assets	Unmatched	0.48	0.78	0.000	0.47	0.61	0.032	0.48	0.67	0.006
	Matched	0.51	0.53	0.790	0.50	0.52	0.814	0.58	0.60	0.851
Share-milk	Unmatched	0.13	0.25	0.073	0.48	0.50	0.667	0.12	0.25	0.094
	Matched	0.13	0.20	0.337	0.50	0.47	0.682	0.13	0.04	0.181
Off-farm	Unmatched	0.07	0.26	0.003	0.20	0.20	0.976	0.08	0.34	0.001
	Matched	0.08	0.18	0.160	0.20	0.22	0.791	0.11	0.40	0.005
Labour endowments	Unmatched	0.46	0.66	0.000	2.39	2.69	0.069	0.46	0.66	0.000
	Matched	0.48	0.47	0.934	2.4	2.42	0.863	0.49	0.38	0.116
Coop-member	Unmatched	0.23	0.16	0.230	0.62	0.69	0.432	0.25	0.10	0.022
	Matched	0.26	0.21	0.612	0.61	0.64	0.768	0.22	0.11	0.247

Source: Own calculations. T-test: H_0: Mean(treated)=Mean(control).

Matching estimates are presented in Table 4. Given that analytically computed standard errors for matching estimators can be at best good approximations of the real ones, they were obtained using bootstrap. Again, the results are presented for both full and limited samples. In case of full sample specification we find that farms that quitted milk sales generated lower agricultural revenues per capita than farms that maintained commercial milk production. This result is also found for *limited sample B* specification where farms shifting from traditional to modern marketing channel serve as a reference point. On the other hand no systematic difference could have been observed between agricultural revenues per capita between farms that decided to quit and those supplying traditional marketing channel a result consistent with earlier observations from Section 4. It suggests, that farms no longer participating in dairy

markets managed to substitute potential milk revenues from traditional channel with other agricultural enterprises.

Table 4. Matching estimates of the differences in revenues between farms that quitted milk sales and farms that maintained commercial milk production (all estimates concerning the year 2006).

Variable	Sample	Treated	Controls	Difference	S.E.[a]	T-stat
Average treatment on treated						
Full sample, no. of obs. = 364						
Annual agricultural revenue per capita	ATT	13027.2	23260.8	-10233.6	4548.8	-2.25**
Total annual farm revenues	ATT	15954.7	24716.8	-8762	4851.7	-1.81*
Limited sample A, no. of obs. = 145						
Annual agricultural revenue per capita	ATT	12976.4	18354.5	-5378.1	5012.2	-1.07
Total annual farm revenues	ATT	16532.8	19848.2	-3315.3	5508.5	-0.60
Limited sample B, no. of obs. = 126						
Annual agricultural revenue per capita	ATT	11611.1	32958.6	-21347.5	8489.4	-2.51**
Total annual farm revenues	ATT	14448.4	35817.2	-21368.8	9393.9	-2.27**

Source: Own calculations. *** p<0.01, ** p<0.05, * p<0.1; [a]Standard errors were computed by bootstraping with 500 replications.

The same picture comes out from comparisons based on total farm revenues per capita. When comparing farms that quitted milk sales with all farms that remained in dairy business (*full sample*) the former group comes out poorly. However, when compared only to group of farms supplying traditional marketing channel, total revenues of farms that quitted milk sales do not lag behind (*limited sample A*). This tends to point that farms that quitted milk sales succeeded in finding non-agricultural income sources so that their total revenues per capita are comparable with farms delivering milk to collection points.

Further, total revenues of farms that quitted milk sales do systematically differ from total revenues of farms that joined the modern channel at some point after 2001 (*limited sample B*). This shows that maintaining the dairy business could be profitable provided a shift is made to the direct milk collection from the farm. As such, the obtained results are consistent with an earlier evidence on the Polish dairy market pointing to positive influence of supply chain modernisation on farm revenues (Milczarek-Andrzejewska *et al*., 2007).

Overall then, based on figures presented in Table 4, we conclude that decision to quit milk sales could be regarded as optimal for farms not willing to modernise in the future. Whether this decision was a voluntary one remains an open question.

Finally, it is also important to note that comparison of estimates for matched and unmatched samples indicate that standard parametric methods might overestimate the difference in revenues between the two groups when heterogenous farms are considered (full sample, limited sample B) and slightly underestimate it when more homogenous farms are considered

(limited sample A).[18] Furthermore, the obtained results also indicate that focusing on group of farms that maintained dairy business as a whole masks important sources of variation that could be attributable to supply chain modernisation.

6 CONCLUSIONS

In response to rapid and profound changes taking place in the Polish dairy sector manifesting themselves in a significant outflow of people and supply chain modernisation, this paper aimed at having a closer look at factors determining farmer's decision to quit milk sales. Moreover, taking into account supply chain characteristics, it attempted to check whether this decision could be regarded as an optimal one. In order to do so, semi-parametric methods were employed to compare revenues of farms that quitted milk sales with revenues of farms that maintained commercial milk production. The analysis was based on a unique data set on individuals with different relationships to the market and belonging to different dairy supply chains.

The key finding is that farms that quitted milk sales compare unfavourably with farms that participate in dairy market in terms of total (agricultural) revenue per capita. However, the obtained results revealed important heterogeneities among farms that maintained dairy businesses depending on dairy supply chain characteristics. Compared to farms that quitted milk sales, farms from the modern marketing channel have significantly higher revenues, whereas farms from the traditional marketing channel have similar revenues. These results show that quitting milk sales could be regarded as optimal for farms not willing to modernise. For those who wanted to do so but failed (irrespective of true reasons for that) this decision resulted in worse financial situation. The obtained results showed that decision to quit milk sales is predominantly dependent on herd size, access to production-specific assets, age and labour endowments. The former two results could be indicative of small-farms' marginalisation, however further research is needed to better understand this phenomenon. This is especially so as no significant impact of farmers' market choice on farm orientation has been found.

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[18] Estimates of differences in total revenues for unmatched samples were higher than that for matched samples by 62%, 19% and 10% for full and limited A and B samples respectively. For agricultural revenues these differences were 61%, 12% and 1% respectively.

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