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VERTICAL COORDINATION FROM THE ANGLE
OF FARMER LOYALTY AND ACCESS TO CAPITAL.
EVIDENCE FROM THE POLISH DAIRY SECTOR.

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Vertical coordination from the angle of farmer loyalty and access to credit.

Evidence from the Polish dairy sector.

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Abstract

Numerous studies have shown that processing and retail industries have actively engaged in assisting farmers to join the modern food marketing systems. Data from the Polish dairy sector shows that assistance is provided not only for the traditional-channel farmers wishing to modernise, but also for farmers already included in the modern marketing channel. Drawing on the literature two explanations could be provided to account for this phenomenon: 1) even the modern-channel farmers lack sufficient funds to maintain required quality/quantity on their own; 2) after undertaking the necessary adjustments the modern-channel farmers are more likely to quit their relationship with current processor and turn elsewhere so the assistance is needed to prevent them from doing that. Basing on the household data, it is robustly found that these hypotheses could provide at most partial explanation for vertical linkages observed between modern-channel processors and farms. The present paper takes advantage of logit models, instrumental variables' approach, panel data estimations as well as propensity score matching methods.

Keywords:

vertical coordination, access to credit, farmer loyalty, dairy sector, Poland

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1. INTRODUCTION

During the last two decades the process of ongoing globalisation has been profoundly reshaping the food marketing system. For that reason the issue of food supply chain restructuring has recently become a subject of great interest in the agricultural economics literature. Several important features of this phenomenon have been distinguished. Numerous contributions have stressed the need to recognise the vertically-linked nature of the food marketing system (see, for instance, Sexton and Lavoie, 2001; Hobbs and Young, 2001; or McCorrison, 2002, among others). Other authors have noted increasing consolidation of food processing and retailing sectors (Cotterill, 1999; Sheldon and Sperling, 2003). Moreover, a lot of attention has been devoted to the issue of strict food safety and quality standards recently being introduced by private sectors downstream from agriculture.

The above strand of the literature has mainly concentrated on the impact that supply chain transformation may have on small farmers' market participation. In summary, the investigated relationship adds to places where researchers have not reached a general consensus. What seems to be beyond dispute, though, is that, overall, inclusion in the modern marketing channel, i.e. the one governed by private quality standards, has been beneficial to farmers, regardless of their size. The present paper is an attempt to investigate this issue into more detail. More specifically, it takes closer look at the nature of vertical coordination occurring in dairy sector in Poland. During the past decade dairy industry has undertaken wide range of activities to encourage farmers to modernise. Recent survey showed that processors' assistance is provided not only to farmers wishing to adjust to new market conditions, but also to farmers already included in the modern marketing channel. Using quantitative data, the present paper attempts to contrast this finding with theoretical predictions provided in the current literature. In particular, two hypotheses for the emergence of vertical coordination are tested empirically. One of them assumes that vertical linkages stem from farmers' insufficient access to financial capital. The other perceives the issue of vertical relationships from the angle of farmer loyalty towards purchasers. Conducted regressions robustly indicate that neither of the two hypotheses may solely account for the support given to the modern-channel suppliers.

The paper is organised into five parts. Section 2 provides a brief overview of recent contributions to the literature dealing with the issue of vertical coordination in the

context of food supply chain modernisation. Basing on the presented theory, it generates testable hypotheses. Section 3 presents the data and gives some background information on the Polish dairy sector's restructuring. Section 4 collates the theoretical predictions with the data using econometric tests. The final part draws out the main conclusions.

2. VERTICAL COORDINATION – THEORY AND LITERATURE REVIEW

As mentioned earlier, there is a general consensus among researchers that inclusion in the modern marketing channel is beneficial to farmers irrespective of their size. Vast majority of contributions to the theoretical and empirical literature have attributed this outcome to the presence of vertical coordination in the food sector. Even from a cursory glance at the data it becomes clear that as modernisation of the food marketing system proceeds, transactions are less and less often made as spot market exchanges (Frank and Henderson, 1994; Hennessy, 1996). Instead they take a form of more or less sophisticated linkages between transacting parties (Henderson, 1994). Numerous studies have shown that farmers, faced with the necessity to comply with public and private food safety and quality standards, have been often provided by downstream food firms with various support measures (see Swinnen, 2006, for an overview of recent findings). In this regard, vertical contractual relationships between downstream and upstream sectors have become the key to farmers' participation in the evolving food supply chain.

Two main reasons have been provided in the agricultural economics literature for the emergence of vertical coordination in the food supply chain. On the one hand, it has been argued that after the implementation of quality standards downstream food companies lack sufficient supplies of high quality raw agricultural commodities (see e.g. Swinnen, 2007). As a result of that, their processing capacity cannot be fully utilised. In response to this, downstream enterprises undertake various activities to encourage farmers to upgrade and increase their production. Scope and intensity of processors' assistance depends on the extent of rural markets underdevelopment which impedes farmers' access to production inputs and to external funding in particular. In the remainder of the paper this approach to the emergence of vertical coordination will be referred to as the *insufficient capital hypothesis* reflecting that

vertical linkages arise predominantly as a response to farmers' insufficient financial capital endowments.

An alternative approach to the existence of vertical coordination places the analysis in the framework of transaction costs theory (Hobbs, 1996). In this context, the nature and intensity of vertical relationships are determined by the level and relative importance of costs arising prior, during, and after the transaction is made. From this point of view then, vertical coordination is perceived as a tool for establishing long-term and stable relationships with suppliers so as to minimise transaction costs associated with sourcing raw agricultural products (Hobbs, 1996). In this manner, one may see it as a tool to generate mutual loyalty between transacting parties.

In the context of vertical coordination, the issue of farmer (dis)loyalty towards downstream companies acquires special significance also when one approaches the analysis from the angle of agency theory (Hennessy, 1996; Chalfant *et al.*, 1999) and/or contract theory (Salanié, 1997; Bolton and Dewatripont, 2005). As noted earlier, adjustment processes at the farm level are often financially supported by downstream food enterprises. It is important to notice that, once engaged in assisting farmers to adjust, downstream companies may have incentives to continue to offer similar services also in the future. First, by doing so they reduce the risk of facing the moral hazard problem manifesting itself in farmers misusing the funds intended for given investments. Second, while engaging in closer co-operation with farmers, downstream food firms reduce the risk of losing their already modernised suppliers to competitors who either have larger financial resources or are less engaged in supporting changes at the farm level. In this regard, vertical coordination counterbalances potential advantage of competitors being able to offer farmers higher monetary bonuses. Therefore, close vertical linkages between downstream and upstream sectors may be seen as a tool to create new (dis)incentives to both transacting parties so as to generate mutual loyalty. Strengthening contract enforcement with the use of so-called private enforcement capital can be quoted here as an example (Gow and Swinnen, 2001). In the rest of the paper this approach to emergence of vertical coordination will be referred to as the *loyalty hypothesis* stating that vertical linkages are predominantly meant to prevent farmers from shifting to other purchasers.

The above discussion presented motivations for vertical coordination to arise. Section below tries to confront these considerations with empirical evidences from dairy sector in Poland. Focus is placed predominantly on testing whether the ‘loyalty’ and ‘insufficient capital’ hypotheses defined above could account for the support offered by the dairy companies to the modern-channel farmers, that is those already included in the restructured marketing system.

3. DATA & BACKGROUND INFORMATION

The picture presented below draws on qualitative data from 13 dairies as well as information collected from 185 dairy family farms from two regions located in north-eastern part of Poland, namely Podlaskie and Warmińsko-Mazurskie.¹ The survey was conducted in 2007 and covered, among others, information on households’ characteristics and farm linkages with dairy processors. In order to gain better insights into the nature and evolution of vertical coordination the questionnaire included number of retrospective questions referring to the year 2001.

One of the most profound features of the dairy supply chain restructuring has been the evolution of the modern marketing channel through which milk goes from farm to dairy. Traditionally milk sales have been organised with the intermediary of collection points. Milk has been delivered there by farmers and later on collected by the dairy. In the modern marketing channel, on the other hand, milk is directly purchased at the farm by a dairy truck.

Accordingly, it is useful to distinguish between two types of processing enterprises and farmers. On the one hand, there are dairy companies that source milk only through the modern marketing channel, hereafter referred to as the *modern-channel processors*. On the other hand, there are companies which combine milk supplies from both the modern and the traditional marketing channels, hereafter referred to as the *mixed-channel processors*. Analogically, farmers supplying the modern marketing

¹ The data was gathered as a part of the research conducted within the Regoverning Markets project investigating the impact of agro-food chain restructuring on farmers’ behaviour and practices. More about the project can be found at <http://www.regoverningmarkets.org/en>. For its application to the Polish dairy sector and detailed description of the data, see Wilkin *et al.* (2007) or Milczarek *et al.* (2007).

channel will be referred to as the *modern-channel farmers* and those supplying the traditional channel will be referred to as the *traditional-channel farmers*.

The collected data suggests that vertical coordination has become an inherent part of the dairy supply chain landscape. Assistance programmes and/or various incentive bonuses were provided by all surveyed processors.² What needs to be stressed here therefore, is the fact that vertical linkages between downstream enterprises and farmers could be observed in case of both the modern- and mixed-channel processors. In other words, relying solely on supplies coming from farmers meeting the modern channel requirements does not lead to quitting vertical linkages within the food marketing system.

Below an econometric analysis is employed to test whether the two above-mentioned hypotheses could account for the assistance provided to the modern-channel farmers. As mentioned earlier, the 'loyalty hypothesis' states that this assistance helps dairies to prevent already modernised farmers from switching to competitors. Therefore, if this hypothesis were to hold, one should observe the modern channel farmers being more eager to shift to other purchasers than their traditional counterparts. The 'insufficient capital hypothesis', on the other hand, states that assistance is needed to maintain the quality/increase the quantity of output. Hence, if this hypothesis were to hold joining the modern marketing channel should not lengthen farmers' odds on being granted a bank loan. Following strategy for econometric testing is adopted. First, a logit model is employed. Second, instrumental variables models are used. Finally, robustness check is done by taking advantage of the 'panel nature' of the data and using propensity score matching methods.

4. ECONOMETRIC ANALYSIS

LOGIT MODEL

Sample used here comprises 105 households that have always remained in the traditional marketing channel and 80 households that have joined the modern

² Three out of the 13 surveyed processors were relying only on the modern channel supplies whereas 10 of them could be described as the mixed-channel enterprises. In the latter share of the modern-channel supplies ranged from 57% to 94%.

marketing channel at some point after 2001. Logit model which serves as a baseline is specified as follows:

$$(1) \quad y_{it} = \beta_0 + \beta_1 MC_{it} + \beta_2 F_{it-n} + \beta_3 I_{it-n} + \beta_4 R_t + \varepsilon$$

where i and t index household and year respectively. y , depending on the model, is a measure of households access to bank loan or a measure of households willingness to shift to other purchaser (see further). MC is the main variable of interest and it aims to capture the effect of making the switch from the traditional to the modern marketing channel. It is defined as a dummy variable equal to one if a household joined the modern channel after 2001 and zero otherwise. F includes a set of variables representing three attributes of the farm manager (age, experience and education); farm size (in terms of both land and cow herd) and the level of assets. I aims to capture the effect of (dis)incentives that are likely to affect farmers' marketing channel choice. It includes variables measuring household access to off-farm job opportunities and unearned income sources. In addition, it includes a dummy indicating households that experienced problems with processors failing to pay on time. Finally, R represents a regional dummy to control for local specificities. In order to minimise the potential problem of reverse causality, except for the market channel choice variable, education and regional dummy all the control variables refer to 2001. Detailed definition of the variables is listed in an Annex. β 's are parameters to be estimated and ε is the residual.

In the equation (1) the dependent variable is defined in one of three ways. First, in order to test the 'insufficient capital hypothesis', it is specified as a dummy variable equal to one if a household was granted a bank loan after 2001 and equal to zero otherwise. Second, to test the 'loyalty' hypothesis two models are estimated. In one regression the dependent variable is specified as a dummy variable equal to one if a farmer would not be willing to shift to other purchaser and equal to zero otherwise. In the second regression the dependent variable is a dummy equal to one if a farmer would be willing to switch to other purchaser and equal to zero otherwise. Variables capturing farmer's propensity to switch between processors base on a following question: "Provided no additional costs, would you shift to other purchaser facing the opportunity of getting 20% higher price but having no guarantee that this price would hold in the future?".

All regressions were estimated using appropriate weights to account for the sampling design. The logit estimates are reported in Table 1. Given that the R^2 statistics range between 0.19 and 0.47, the F-statistics are significant at least at the 5% level and a number of the control variables behave as expected, the estimated model performed fairly well. Worth noting might be the coefficient on variable representing land endowments (columns 1 and 2). The obtained results indicate that, when controlling for the market channel choice, farms' access to bank loans is no longer dependent so much on the provision of collateral. As such this result is in line with findings coming from Petrick (2004) who analysed the problem of credit rationing in rural Poland and concluded that this was the reputation of the borrower, and not the availability of collateral, which has had the strongest effect on access to credit.

As far as the models investigating the issue of farms loyalty are concerned (columns 3, 4, 5 and 6), they provide evidence that farms are less willing to switch between processors when managed by older farmers or having weaker bargaining position (in terms of assets). On the other hand, experiencing problems with payment delays increases farms' propensity to look for better offer somewhere else.

Most importantly, however, the baseline specifications provide a tool to directly verify the hypotheses of interest. First, the reported findings do not support the 'insufficient capital hypothesis'. The signs on the coefficients of the market channel variable in the relevant models (columns 1 and 2) are positive and highly significant. This observation inclines towards the statement that, holding other things constant, the modern channel farmers have better access to bank credit than their traditional counterparts. This, in turn, implies that dairy companies may offload at least part of the burden of supporting the modern channel farmers onto banks. In a sense then, their role in assisting the modern farmers should either totally finish or substantially decrease. In this context, joining the modern marketing channel seems to be a clear sign for a bank that a given farmer is dedicated to his business. As a result, the odds on him misusing funds are reduced and farms' creditworthiness is increased. Second, the obtained results tend to show that there is no clear difference between the modern

Table 1. Logit estimates measuring the impact of market channel choice on farm's access to credit and farmers' propensity to shift to other purchaser

	(1)	(2)	(3)	(4)	(5)	(6)
	LOGIT/credit	LOGIT/credit	LOGIT/no switch	LOGIT/no switch	LOGIT/switch	LOGIT/switch
Marketing channel	1.315*** [0.0047]	1.452*** [0.0078]	-0.652 [0.43]	-0.805 [0.31]	-0.07 [0.94]	0.141 [0.85]
Age	-0.026 [0.35]	-0.031 [0.32]	0.071* [0.065]	0.073* [0.066]	-0.249 [0.11]	-0.260* [0.075]
Experience	0.106 [0.12]	0.103 [0.10]	-0.012 [0.72]	-0.011 [0.76]	0.22 [0.28]	0.224 [0.25]
Education	0.521 [0.23]	0.434 [0.23]	0.371 [0.21]	0.406 [0.17]	-0.335 [0.69]	-0.346 [0.69]
Assets typical	-0.294 [0.27]	-0.311 [0.26]	-0.258 [0.12]	-0.246 [0.11]	1.134 [0.16]	1.139 [0.15]
Machinery 2001	-0.162* [0.058]	-0.137** [0.033]	-0.151* [0.071]	-0.163* [0.053]	-0.058 [0.57]	0.011 [0.93]
Bank Credit before 2001	1.096 [0.32]		-0.677 [0.34]		0.509 [0.71]	
Dairy credit before 2001	-1.121 [0.39]					
Land owned 2001	-0.034 [0.34]	-0.026 [0.39]	-0.007 [0.70]	-0.011 [0.56]	0.026 [0.59]	0.029 [0.57]
Land leased 2001	0.053 [0.12]	0.052* [0.099]	0.054 [0.23]	0.054 [0.20]	-0.247*** [0.0027]	-0.236*** [0.0074]
Herd size 2001	0.086 [0.40]	0.104 [0.41]	0.155 [0.13]	0.141 [0.16]	-0.223*** [0.0088]	-0.226*** [0.0092]
Milk yields 2001	0 [0.18]	0 [0.98]	0 [0.53]	0 [0.37]	-0.001 [0.25]	-0.001 [0.12]
Labour endowments 2001	0.384* [0.053]	0.294 [0.17]	0.184 [0.38]	0.233 [0.22]	0.005 [0.99]	-0.05 [0.82]
Off-farm job 2001	0.812 [0.39]	0.856 [0.38]	0.955 [0.17]	0.871 [0.19]	-1.193 [0.19]	-1.168 [0.21]
Unearned income 2001	-0.884** [0.025]	-0.996** [0.039]	-0.351 [0.41]	-0.299 [0.43]	-0.105 [0.81]	-0.094 [0.75]
Delays in payments 2001	-0.299 [0.61]	-0.261 [0.64]	-1.650** [0.037]	-1.600** [0.044]	4.467** [0.011]	4.311** [0.013]
Podlaskie	0.499 [0.41]	0.481 [0.38]	-0.443 [0.67]	-0.433 [0.67]	1.836 [0.25]	1.857 [0.22]
Constant	-3.224*** [0.0087]	-2.177 [0.16]	-3.017** [0.038]	-3.500** [0.025]	3.088 [0.26]	3.495 [0.14]
Observations	185	185	182	185	182	185
Pseudo R-squared	0.263	0.246	0.196	0.19	0.477	0.472

p-values in brackets, *** p<0.01, ** p<0.05, * p<0.1

and traditional channel farmers in terms of their propensity to switch between processors. Therefore, no support for the ‘loyalty hypothesis’ is found either. The coefficients on variable representing market channel choice are not significant in none of the models 3, 4, 5 and 6. As a consequence, the baseline analysis provides no evidence that the modern-channel farmers may be more eager to quit the relationship with their current processors than the traditional channel farmers.

INSTRUMENTAL VARIABLES

The baseline model, although giving a direct insight into relationship between market channel choice and farmers’ access to bank credit/propensity to switch processors, is likely to suffer from the problems of reverse causality and unobserved heterogeneity (Angrist and Krueger, 2001). For instance, though it could be hypothesised that belonging to the modern marketing channel should facilitate access to bank loans (through the positive impact on farm’s creditworthiness) it would be difficult to refute the view that access to external funding stimulates farmers to modernise, and consequently to leave the traditional channel. Further, it could be argued that farmers’ decision to join the modern marketing channel is determined by some unobserved factors which are also likely to affect the odds on them getting the bank loan (their attitude to risk may be quoted here as an example). Similar concerns could be expressed with respect to the relationship between market channel choice and farmer loyalty. In order to account for these problems and to get more consistent insights on the ‘insufficient capital’ and ‘loyalty’ hypotheses, two-stage least squares instrumental variables estimator (2SLS) is applied.³ The model to be estimated is specified as follows:

$$(2) MC_{it} = \beta_0 + \beta_1 F_{it-n} + \beta_2 I_{it-n} + \beta_3 R_t + \beta_4 IV_t + \varepsilon$$

$$(3) y_{it} = \gamma_0 + \gamma_1 MC'_{it} + \gamma_2 F_{it-n} + \gamma_3 I_{it-n} + \gamma_4 R_t + \mu$$

where all the variables are defined as before and *IV* stands for instruments used to cope with the potential endogeneity problem. *MC'* denotes fitted values obtained from estimating equation (2).

³ When deciding for the 2SLS method, instead of using probit or logit to generate first-stage predicted values, an approach of Angrist and Krueger (2001) was followed. As argued by the authors, 2SLS produces consistent second-stage estimates even with a dummy endogenous variable. Moreover, 2SLS yields robust estimates even if the underlying second-stage relationship is non-linear. The same cannot be said about non-linear estimates unless non-linear model happens to be exactly right.

Two instruments included in the 2SLS model to control for the unobserved factors are distance from the farm to the closest dairy company and distance from the farm to the closest collection point. Both of them are believed to affect farmer's market channel choice but have no direct effect on dependent variables in the estimated models, i.e. access to credit and willingness to switch between processors. The logic to use 'distance variables' is as follows: the closer the farm to the dairy company (collection point) the lower are the transport costs which need to be incurred when supplying the modern (traditional) channel. Therefore, the more eager the farmer should be to join (remain in) the modern (traditional) channel.⁴

To test for the validity of instruments two methods were applied. First, both of the instrumental variables in the first stage regression have statistically significant effects on the endogenous variable. Second, they pass the Wooldridge's score test of overidentifying restrictions (Wooldridge, 1995).⁵

The obtained results are reported in Table 2. The findings of the instrumental variables models are fully consistent with the results coming from the baseline analysis. The estimated coefficients have the same sign and level of significance. Overall then, the conducted analysis provides strong evidence that changing from the traditional marketing channel to the modern one facilitates access to bank credit. On the other hand, no evidence was found that the modern channel farmers are more eager to switch between processors than their traditional channel counterparts.

Two additional approaches were used in order to check the robustness of the abovementioned analyses. The first took advantage of the 'panel' nature of the data and fit the fixed- and random-effect (FE/RE) models whereas the second based on propensity score matching methods. Since there is no retrospective data on farmers' propensity to switch the former model applies only to testing the 'insufficient capital' hypothesis.

⁴ It should be noted that both instruments measure the distance between the farm and the closest dairy/collection point and not the dairy/collection point farmer is delivering milk to. An alternative specification with instrument represented by the share of surveyed farmers from the same district having cooling tank in 2001 (being indispensable for modern marketing channel) was also estimated (not shown). Using this instrument instead of 'distance' variables did not affect the main results.

⁵ Where the dependent variable was a dummy representing willingness to switch, limited information maximum likelihood and generalised method of moments estimators performed better than two-stage least square estimator (Angrist and Krueger, 2001). Using different estimator, though, had no significant impact on the obtained results and for the reasons of brevity only 2SLS estimates are reported. Moreover, for the robustness check, all specifications were re-estimated using only one instrument (either distance to dairy or distance to collection point) leaving, however, the main results unchanged.

Table 2. Instrumental variables model measuring the impact of market channel choice on farm's access to credit and propensity to shift to other purchaser

	(1)	(2)	(3)	(4)	(5)	(6)
	2sls/credit	2sls/credit	2sls/no switch	2sls/no switch	2sls/switch	2sls/switch
Marketing channel	0.576*** [0.0074]	0.555** [0.011]	-0.221 [0.52]	-0.184 [0.63]	-0.222 [0.23]	-0.275 [0.17]
Age	-0.002 [0.61]	-0.003 [0.51]	0.013** [0.037]	0.013** [0.046]	-0.008** [0.013]	-0.009** [0.016]
Experience	0.015* [0.073]	0.015* [0.065]	-0.002 [0.66]	-0.002 [0.73]	0.005 [0.37]	0.004 [0.34]
Education	0.115* [0.087]	0.104 [0.10]	0.058 [0.45]	0.072 [0.40]	-0.028 [0.68]	-0.046 [0.49]
Assets typical to dairy 2001	-0.048 [0.19]	-0.05 [0.20]	-0.047** [0.035]	-0.045** [0.039]	0.054 [0.26]	0.051 [0.27]
Machinery 2001	-0.017 [0.10]	-0.017* [0.087]	-0.031* [0.061]	-0.031** [0.050]	0.002 [0.89]	0.002 [0.86]
Bank credit before 2001	0.097 [0.67]		-0.104 [0.48]		0.131** [0.047]	
Dairy credit before 2001	-0.143 [0.35]		0.325* [0.078]		-0.157 [0.24]	
Land owned 2001	-0.006 [0.35]	-0.005 [0.41]	-0.001 [0.71]	-0.002 [0.61]	0.002 [0.19]	0.003* [0.093]
Land leased 2001	0.007 [0.20]	0.007 [0.13]	0.009* [0.078]	0.009* [0.054]	-0.005 [0.19]	-0.005 [0.23]
Herd size 2001	-0.003 [0.82]	0.001 [0.96]	0.033 [0.13]	0.027 [0.24]	-0.001 [0.93]	0.006 [0.47]
Milk yields 2001	0 [0.38]	0 [0.39]	0 [0.53]	0 [0.48]	0 [0.72]	0 [0.51]
Labour endowments 2001	0.043 [0.18]	0.037 [0.33]	0.043 [0.29]	0.05 [0.19]	-0.006 [0.84]	-0.014 [0.68]
Off-farm job 2001	0.087 [0.41]	0.096 [0.41]	0.158 [0.14]	0.144 [0.16]	0.017 [0.65]	0.03 [0.49]
Unearned income 2001	-0.075 [0.24]	-0.096 [0.17]	-0.092 [0.43]	-0.066 [0.60]	-0.053 [0.44]	-0.087 [0.26]
Delays in payments 2001	-0.079 [0.46]	-0.071 [0.47]	-0.302* [0.057]	-0.310* [0.069]	0.332*** [0.0086]	0.346*** [0.0073]
Podlaskie	0.019 [0.89]	0.026 [0.85]	-0.063 [0.75]	-0.075 [0.72]	0.141 [0.22]	0.156 [0.23]
Constant	0.149 [0.46]	0.213 [0.29]	-0.098 [0.74]	-0.158 [0.55]	0.239 [0.27]	0.313 [0.20]
Observations	185	185	185	185	185	185
R-squared	0.22	0.224	0.232	0.227	0.237	0.19

p-values in brackets, *** p<0.01, ** p<0.05, * p<0.1

PANEL DATA ESTIMATIONS

As regards the panel analysis, two remarks should be made. First, it uses information for only two years (2001 and 2006). Second, it bases on the sample containing 185 observations. Overall then, it uses relatively limited information. Therefore, the results obtained with this method should be treated with some caution. Nevertheless, it is assumed that, if not strikingly different from the previous findings, the panel specifications could serve as a valuable tool to prove the robustness of the methods used earlier. Similar remarks concern also propensity score matching analysis that follows afterwards.

The main advantage of the FE specification is that it allows one to control for all unobservable factors which differ across households but are constant over time (Wooldridge, 2002). Employing RE model on the other hand, offers the possibility to additionally account for omitted variables that are constant between households but do vary over time. As a result, FE/RE models help to substantially reduce potential endogeneity-induced bias which is likely to affect logit results and, in the presence of weak instruments, IV results as well. Given the dichotomous nature of the dependent variable a logit model for panel data is considered. Following Hausman test, a logit random-effects model was found to be more efficient than a logit fixed-effects model. In case of the Polish dairy sector using RE specification instead of FE model is highly justifiable for at least three reasons. First, it allows one to control for changes in the regional development. Second, it allows one to account for changes in policies implemented both at national and regional level. Last but not least, it allows one to control for the effect of Poland's accession to the EU and thorough reorganisation of the local dairy sector following introduction of the milk quota system. Since there is no software available that would allow to run logit with weights, in addition to logit RE model, weighted linear fixed-effects model is employed.

The dependent variable in the FE/RE models measures households' access to bank loans in 2001 and 2006. As regards the independent variables, the main variable of interest (representing market channel choice) is a dummy distinguishing households supplying the modern channel (i.e. equalling zero for all observations in 2001 and equalling one in 2006 for those who changed the channel). The rest of the explanatory variables are defined as earlier and refer to 2001 and 2006. Compared to the baseline and IV analyses, some of them had to be removed due to lack of relevant information for both years or because they were constant over time.

The FE/RE results are reported in Table 3. When comparing them with the baseline and IV results, in most instances the estimated coefficients have the same sign and similar magnitude. The coefficient on the main variable of interest, i.e. the one representing market channel choice, in all three specifications is positive, thus being fully in line with the previous findings. In the former two models (columns 1 and 2) it is close to being statistically significant, whereas in the latter model (column 3) passes

Table 3. Random and fixed-effects models measuring the impact of market channel choice on farms' access to credit

Dependent variable: Access to credit	(1) RE logit/ without weights	(2) RE logit/ without weights	(3) FE/with weights
Marketing Channel	0.993 [0.12]	0.999 [0.13]	0.091* [0.097]
Age	0.02 [0.49]	0.023 [0.44]	0.016 [0.35]
Assets typical to dairy	0.134 [0.52]	0.196 [0.37]	0.034** [0.026]
Machinery	0.072 [0.53]	-0.052 [0.68]	-0.003 [0.93]
Herd size	0.101* [0.055]	0.087 [0.010]	0.009 [0.37]
Milk yields	-0.001** [0.021]	-0.001** [0.022]	-0.000* [0.088]
Land owned	-0.01 [0.67]	0.001 [0.96]	-0.001 [0.57]
Land leased		0.072* [0.054]	0.018 [0.20]
Labour endowments	0.031 [0.89]	0.08 [0.73]	0.009 [0.80]
Off-farm job	0.744 [0.19]	0.738 [0.21]	-0.027 [0.63]
Unearned income	-0.455 [0.39]	-0.667 [0.24]	0.024 [0.79]
Delays in payments		0.722 [0.38]	0.270** [0.025]
Constant	-3.521* [0.063]	-3.640* [0.066]	-0.269 [0.48]
Observations	370	370	370
Number of id	185	185	185
R-squared			0.258

p-values in brackets; *** p<0.01, ** p<0.05, * p<0.1

the relevant test at the 10% significance level. Although one cannot exclude that these results show that actual relationship between access to bank credit and farmers' market channel choice is somewhat weaker than that indicated by the previous analyses, higher standard errors may be due to relatively scanty information used for the analysis. Leaving this issue aside, it seems that the obtained results are fairly robust irrespective of whether one uses logit, IV or panel data models.

PROPENSITY SCORE MATCHING METHODS

As by the panel data techniques, the focus by the propensity score matching methods (PSM) is to employ methods that would allow to rule out the impact of unobservable

factors (Rosenbaum and Rubin, 1983). Otherwise the effect of belonging to the modern marketing channel may be easily confounded with that of the factors determining the decision to enter this channel. The main characteristics of PSM approach are outlined below.

Since one does not observe what would have happened if the modern-channel farmer had remained in the traditional channel (or the converse), an estimate of the counterfactual is constructed. Basing on number of observable characteristics the probability of supplying the modern marketing channel is calculated for each surveyed farmer. After that an index – the propensity score – for each individual is created. The next step involves matching between the modern- and traditional-channel farmers which have the same, or very close, propensity score. Thanks to that comparisons are made between farmers who, although belonging to two different groups, are as similar as possible.

As mentioned earlier, the propensity score matching methods are based on observable characteristics. Therefore, the result of matching is highly dependent on the quality of the latter (Becker and Ichino, 2002). For the purposes of the present analysis a wide range of variables is used to estimate propensity scores. These include variables representing farm's human, social and physical capital; features characterising dairy production (both quality and quantity); characteristics of dairy processors as well as regional specificities. Full list of variables used to estimate propensity score and their definitions are presented in Annex. Important to note is the fact that all matching covariates, except for variables measuring education and regional characteristics, refer to the year 2001. This was done in order to avoid the problem of endogeneity when estimating the propensity score.

Several matching methods are used in the analysis. First, 'the nearest neighbour with replacement' estimator is employed. In this setting, farmers from the two compared groups with closest propensity scores are matched. Since ideal matching might be impossible and the sample is relatively small it is allowed that farm from one group can be a best match for more than one farm from the other group. In addition, calliper equal to 0.01 is employed. The rationale for using calliper is to decrease the likelihood of obtaining inexact matching (Cochran and Rubin, 1973). Because the nearest neighbour match is exposed to the problem of existence of outliers in the dataset the analysis uses also more robust Epanechnikov kernel estimator. Finally, as a robustness check, Gaussian kernel and local linear regression estimators are employed

(Fan, 1992; Heckman et al., 1997; 1998). All matching methods did fairly well in terms of removing significant differences between the two groups of farmers being compared (see Table 4).

Table 4. Goodness of matching

	Covariates distribution did not overlap sufficiently: covariate significant after matching, p<0.05
Nearest neighbour – calliper 0.01	None
Kernel Epanechnikov	None
Kernel Gaussian	Labour endowments
Local linear regression	Labour endowments

The results indicating the differences between the matched households in terms of their access to credit and propensity to switch are reported in Table 5. As previously, no significant difference between the modern- and traditional-channel farmers was found in terms of their willingness to switch between processors. Overall then, these findings do not provide support for the 'loyalty' hypothesis. In addition, PSM methods generally are not in opposition with results from earlier methods as regards the impact of market channel choice on farm's access to credit.

Table 5. Differences between the modern- and the traditional-channel farmers – propensity score matching analysis

	Nearest neighbour call. 0.01	Local linear regression	Kernel Epanechnikov	Kernel Gaussian
WILLING TO SWITCH	+/-	+/-	+/-	+/-
NOT WILLING TO SWITCH	+/-	-*	+/-	+/-
ACCESS TO CREDIT	+/-	+/-	+/-	+**

“+” describes phenomenon more common among the modern channel farmers, whereas “-” describes phenomenon more common among the traditional channel farmers; “+/-” means that there is no significant difference between the two groups; ** and * denote the difference between the two groups of farmers being significant at the 5% and 10% significance level respectively

To summarise, the econometric analysis provided robust evidence that the modern-channel farmers are not more willing to shift to other purchasers than the traditional-channel farmers. Moreover, it has been shown that entering the modern-channel positively affects farmers' odds on getting the bank loan. These findings are not consistent with the 'loyalty' and the 'insufficient capital hypotheses' that predicted vertical coordination between processing industry and the modern-channel farmers to be caused by disloyalty or insufficient access to capital of the latter.

5. CONCLUSIONS

This paper aimed to analyse the vertically-linked nature of the dairy food chain in Poland. It has been observed, that dairy companies undertake various activities to assist farmers in adjusting to requirements of the restructured food marketing system. Interestingly, support is provided not only by processors sourcing from the traditional marketing channel, but also by dairies relying solely on the modern-channel suppliers. Basing on the current literature, two hypotheses are formulated that could potentially account for this phenomenon. The 'loyalty hypothesis' assumes that vertical coordination is used by processors to prevent their already modernised suppliers from shifting to other purchasers. The 'insufficient capital hypothesis' on the other hand, states that vertical linkages are mainly due to farmers' insufficient access to financial capital. From this perspective then, processing industry uses various assistance programmes to assure the optimal level and high quality of supplies. To test these hypotheses logit model, instrumental variables, panel data techniques and propensity score matching methods are employed. All of them produced consistent results, which indicate that the modern-channel farmers do not differ from their traditional-channel counterparts in terms of willingness to shift to other purchasers. Therefore, providing them with assistance cannot be explained on the grounds of the 'loyalty hypothesis'. Moreover, joining the modern channel improves farmers' access to bank loan. This suggests that the modern-channel farmers are not left to processors' resources, but have other opportunities to raise the necessary funds. This finding is not consistent with the 'insufficient capital' hypothesis. Overall then, explanations provided in the current literature are at most partial with regard to the situation considered here.

The obtained results suggest, therefore, that there must be some other factors determining assistance provided by the modern-channel processors and that should become of interest for future research. Exploring the issue of bargaining power of the downstream and upstream sectors in the context of the supply chain reorganisation could be one of the potential departure points. Further understanding of the investigated phenomenon could be gained if analyses were made for other countries.

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Annex: Observable characteristics used in the empirical analysis (all referring to 2001 except variables measuring education and regional characteristics)

Personal characteristics

Age of head of the household
Gender of head of the household
Experience in managing farm (years)
Level of education of head of the household
Is it agricultural education
Maximum education reached by the rest of the family

Household characteristics

Index of assets typical to dairy production (yes/no)
Index of machinery having general application (no. of items)
Land owned (ha)
Land leased (ha)
Labour endowments (weighted sum of people over 15 years old)
Access to off-farm job (yes=1, no=0)
Access to unearned income (yes=1, no=0)
Access to credit (yes=1, no=0)

Dairy production

Herd size (no. of cows)
Milk yields per cow (litres/year)
Had milk refused due to poor quality (yes=1, no=0)
Experienced problems with timely payments (yes=1, no=0)
Distance to the closest processor (km)
Distance to the closest collection point (km)

Regional characteristics

Majority of neighbouring households quitted milk production in 2001-2006 (yes=1, no=0)
Few of neighbouring households quitted milk production in 2001-2006 (yes=1, no=0)
Podlaskie – household located in Podlaskie region (yes=1, no=0)



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