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The economic effects of radical reorganisation of the agro-food supply chain: some evidence from Poland

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Abstract

While transacting parties may find ways to avoid adverse effects of weak contracting institutions, radical reform reorganising the system of exchange can be very costly. We illustrate this by studying the economic consequences of the dislocation of the Polish dairy supply chain during transition. Examining a natural experiment between two different modes of governance (bureaucratic and market-based), we provide evidence that the disorganisation of vertical linkages between upstream and downstream producers negatively affected output. Our most conservative estimates suggests that the dislocation to inter-firm relationships accounted for approximately 20% of the fall in milk output observed in the early-transition phase.

JEL codes: P30, O13, Q10

Keywords: supply chain reorganisation, disorganisation effects, transition, Poland, agriculture, milk

1. Introduction

There is now a growing consensus among economists that the way in which transactions are organised has important implications for economic outcomes and the efficiency of resource allocation. This seems to matter particularly for those production processes that are sequential in nature and involve at least two production stages. A reflection of this belief can be found in an exciting literature that has emerged in recent years investigating various aspects of vertical relationships between upstream and downstream firms.¹

The topic that has received special attention is institutions governing supply chains. Overall, the literature provides convincing evidence that the organisation of a supply chain is an important determinant of economic performance. Nevertheless, we are still far from having a clear understanding of the channels through which supply chain institutions affect economic outcomes. Further, especially at the macro level, there are many blind spots in our understanding of the relative role of different institutional arrangements that determine inter-firm relationships and thus the aggregate workings of the economy. Finally, there is a question about the economic consequences of changing the rules that govern supply chains. In the multiple equilibria scenario one could ask whether changing the organisation of supply chains may cause a movement from one equilibrium to another. In the scenario with a unique stable equilibrium instead, one could ask about the temporary impact. The latter issue seems to be particularly important the more important since institutions affecting vertical linkages between upstream and downstream producers are shaped not only by evolutionary processes, but often are subject to revolutionary changes. These radical reorganisations could be driven by a number of reasons including natural disasters, social conflicts, financial crises or political reforms, all of which may disturb the institutional underpinnings of the organisational aspects of production and exchange. To the extent that this leads to a serious dislocation to inter-firm relationships, it can be very costly, especially in the short run.

This paper is an attempt to shed some more light on these issues and tries to empirically investigate the economic effects of a radical reorganisation of the supply chain. It also aims at identifying a particular channel through which these effects may take place. To do so, we examine the reform in institutions governing dairy supply chain in Poland after the collapse of the communist system in 1989. The different coordination mechanism of the supply chain that has emerged following the transition from plan to market offers a natural experiment to

¹ Obviously, these studies importantly borrow from earlier seminal contributions such as Coase (1937); Williamson (1975); or Grossman and Hart (1986). For a comprehensive survey of this literature see e.g. Joskow (2005). In addition, Helpman (2006) or Antras and Rossi-Hansberg (2009) discuss a growing body of research related to vertical integration in the context of global value chains and international trade.

evaluate its impact.² Under communism the agroindustry was highly concentrated with food processing, distribution, and input supplies being monopolised by the state (Brooks et al., 1991). This also included procurement of raw agricultural products which was organised via state-owned rural collection points. With the departure from central planning this system of exchange collapsed. Food processors lost guaranteed supplies and farmers had to find ways to market their products without the intermediary in the form of the state. As a result, new commercial relations between upstream and downstream producers had to be established based on market institutions. In effect, the agro-food supply chain has been utterly reorganised with bureaucratic coordination mechanisms being substituted by market coordination mechanisms (Kornai, 1994).

Below we investigate the consequences that this change might have had for milk output which experienced a dramatic decline in the early phase of transition.³ Although the effect of disturbances in supply chain coordination mechanisms may occur through a number of different channels, we focus on one that the literature highlights as very important, namely on dislocation to inter-firm relationships (Kornai, 1994; Blanchard and Kremer, 1997; Roland and Verdier, 1999; Swinnen and Rozelle, 2006).

The rationale to investigate this particular channel arises from the fact that the elimination of bureaucratic coordination was not gradual but proceeded very quickly. As a result, while the old institutions ceased to exist, the new ones came into being only after some time. In effect, at least in the early transition, institutions responsible for governing specific economic relations, disseminating information or supporting the functioning of input and output markets were either absent or worked inefficiently. In such an environment, decentralised bargaining system and searching for new trading partners involved considerable transaction costs, often so high that the gains from exchange were more than offset by the expense of the needed bargaining (Blanchard and Kremer, 1997; Roland and Verdier, 1999). This led to serious disorganisation in procurement and sales channels, which in turn made it difficult for farmers to purchase required inputs and sell their output (see e.g. Swinnen and Rozelle, 2006; Liefert and Liefert, 2012).

This argument has strong theoretical foundations drawing on agency theory, transaction costs theory or property rights theory (Blanchard and Kremer, 1997; Roland and Verdier, 1999). It also seems to have obvious appeal. However, quite surprisingly, in the empirical work to date, the effect that these disruptions may have had on economic performance in agricultural sector has hardly been documented.⁴ What follows, the empirical validity of this idea in relation to

² The choice to focus on dairy sector in Poland can be motivated as follows. First, dairy sector has traditionally had the largest value share in the total procurement of agricultural products (in 1988 it was roughly 22%). Second, the procurement system has played a much more important role in animal than in crop production. In 1989, the share of milk purchased by dairy industry in total milk production accounted for roughly 71%. In crop sector instead this share was much smaller. For potatoes it accounted for around 11%, whereas for cereals it was roughly 20%. An additional argument is that animal production is much less dependent on weather and climatic conditions than crop production. This is important as one can assume that potential bias from omitting these weather/climatic conditions for the analysis of dairy sector is much smaller than for the analysis of crop production. Finally, compared to other sectors of the Polish agriculture, the data coverage for dairy sector is relatively broad.

³ See e.g. Csaki (2000); Lerman (2001); or Swinnen et al. (2012) for a general description of the situation in agricultural sectors in Central and Eastern European countries during transition.

⁴ The evidence for other sectors is more easily available although still quite limited. Examples include Blanchard and Kremer (1997); Konings and Walsh (1999); Bevan et al. (2001); or Marin and Schnitzer (2005).

agro-food chain under transition remains largely untested. This paper is an attempt to provide such a test.

Several literatures are relevant to this paper. First, our work is related to a large literature on agro-food supply chain restructuring. Numerous contributions have stressed the need to recognize the vertically linked nature of the food marketing system (for a literature review see e.g. Sexton and Lavoie, 2001). There is also a considerable research on the main driving forces behind changes taking place within the agro-food chain (for an excellent collection of recent studies in this field see e.g. Swinnen, 2007). None of these papers however, provides a systematic evidence on the relationship between the reorganisation of supply chains, the dislocation to inter-firm relationships and economic output. There is also a large literature investigating the effects of specific innovations introduced to agro-food chains (examples of studies on dairy sector in transition countries include: Dries and Swinnen, 2004; Gorton and White, 2007; Dries et al., 2009; Falkowski, 2012). These papers certainly improve our understanding of the role of particular institutional solutions to agency problems and/or high transaction costs. They also help to explain many organisational decisions undertaken by either downstream or upstream producers. However, focusing often on a single aspect of governance, they have only limited application to study more complex and radical reforms of the coordination mechanisms governing supply chains and potential channels through which they may affect economic outcomes.

The second strand of literature which is relevant to us investigates the patterns of agricultural output during transition. A number of papers try to provide explanations for the falls in quantity and quality of output witnessed shortly after the collapse of communism (for an overview of this research see Rozelle and Swinnen, 2004). The existing analyses however, although mentioning supply chain reorganisation as an important casual factor, rarely attempt to verify this claim empirically. If they do, they either are case studies in nature or fail to establish causality and only highlight essential correlations in the data (see the discussion in Swinnen and Rozelle, 2006). The notable exceptions are two studies by Macours and Swinnen (2000a, 2000b). These papers, though, use very rough measures to control for organisational changes in vertical linkages between upstream and downstream producers. As a result, they seem to underline the importance of a broad cluster of institutions without allowing to determine the relative role of particular channels in transmitting the effect they document. In fact, when justifying the usage of their measure Macours and Swinnen (2000a) link it to both *"the break-up of contracting relationships and suboptimal factor allocations because of land and capital market imperfections (p.183)."*

In this paper we aim at expanding the existing evidence. Two key features distinguish our paper from the previous studies. First, through the use of more direct measure of problems affecting vertical relationships between farmers and processors we have access to higher quality proxies for the supply chain disruptions. Second, in contrast to the existing studies which exploit variation between transition countries, we focus on within country evidence. Focusing on one specific country assures that we do not confuse or misinterpret the effects of changes in the whole set of complex institutions that are all different, which is likely to be the case in multi-country analyses and transition context. The typical concern with cross-country studies is that the issue in question is correlated with some other unobservable country level variable. We address this concern by operating at a lower level of aggregation. Thanks to this we should be able to avoid the problem of measuring various economic and political reforms as these were common for the whole country. Further, working with regional data allows to overrule a strong assumption that is implicitly made in cross-country studies namely, that institutions and policies have uniform effects over the whole country. We are not aware of

any other contribution investigating agricultural output during transition using within-country variation.

Finally, arguments presented in this paper have also some relevance to the literature on institutional change and the role of historic events in shaping economic outcomes (for an overview of recent research along this line see e.g. Nunn, 2009). Using historical example, in this paper we aim at documenting the economic consequences of a radical change in the rules governing supply chains. By examining contracting frictions between downstream and upstream producers, we also attempt to identify a particular channel through which the effects of this change may occur.

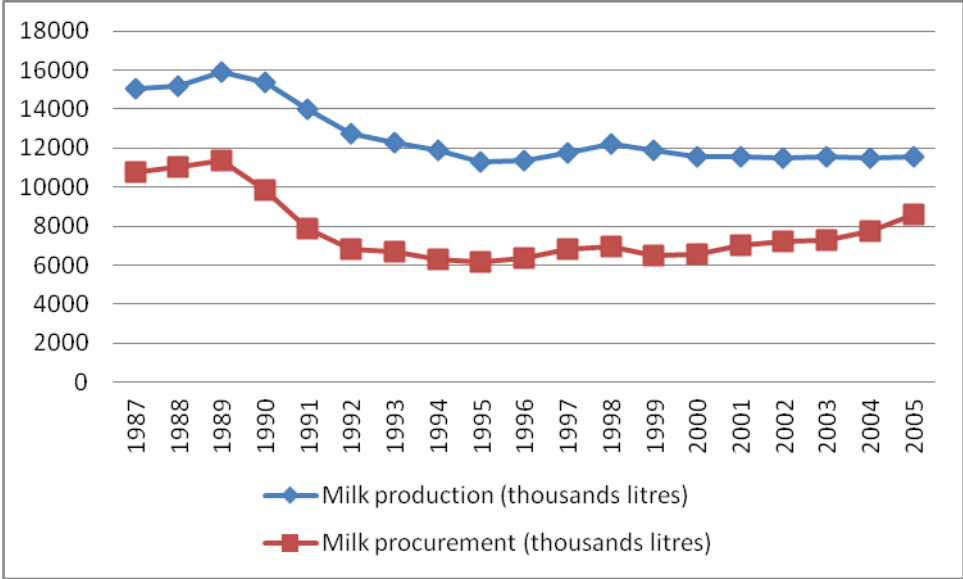
That said, it has to be emphasised that our approach has also a shortcoming. More specifically, it might be the case that our findings may reflect regularities that are specific only to the Polish context and thus may not be easily generalised. Another caveat is that our evidence is based on historical correlations. Therefore we cannot rule out that the statistical association between disruptions in the milk procurement system and milk production that we document is driven by some omitted variable. What should be stressed though is that our results seem to be robust across different specifications. Moreover, we also present some other evidence that is reassuring and gives some credence that what we uncover is not simply a coincidental relationship.

The reminding of the paper is organised as follows. Section 2 provides background information and an overview of changes in the Polish dairy sector during the period under study. Section 3 presents our empirical strategy and data whereas in Section 4 we show and discuss our results. Finally, Section 5 concludes.

2. Background information

Main changes in total milk production and milk purchases by dairy industry over transition period at the country level are illustrated with Figure 1.

Figure 1. Milk production and milk purchases by a dairy industry in Poland (1987-2005)



Source: GUS var. vol.

Our focus is especially on the period 1989-1997, which we symbolically refer to as the early phase of transition. Two observations are particularly noteworthy. First, a sharp decline in both total milk production and milk procurement could be noted. Prior to the reform, milk procurement accounted for 70% of the total milk production, which in 1989 amounted to 15.9 billion litres (GUS, var. vol.).⁵ During the first 7 years of the post-reform period milk production dropped by almost 29% or roughly 4.6 billion litres (Figure 1). The decline in milk purchases by dairy companies was even larger and amounted to almost 5 billion litres. In relative terms this meant a 44% reduction. Interestingly, the decrease in milk procurement was mainly visible in the first three years following the reforms, i.e. in 1989-1992. Instead, the reduction in milk production was more equally spread over the period 1989-1996. This fact is important for our identification strategy, and we return to it later. These downward trends were reversed only in 1996. From this year onwards milk production has stabilised at the level of 11.5 billion litres, whereas milk purchases by dairy industry started to slowly increase.

These developments led to a dramatic decline in the share of total milk production being purchased by dairy industry, which is the second key point to be observed. While as mentioned before in 1989 this share was equal to roughly 70%, in 1992 it amounted to only 54% and this level remained more or less stable until 1999. The pre-reform level was restored only in 2005 and has been relatively stable until now.

Practically speaking, the tendencies described above were noticeable all over the country. At regional level though, important variation could be observed. Table 1 provides some descriptive statistics to illustrate this point. For example, depending on the region, the share of milk purchased in 1989 (1992) in total production ranged from 37% (15%) to 87% (91%). Further, while the relative decrease in milk procurement in the period 1989-1992 in an average region was 43%, in some regions it well exceeded 50%. An exception to this rule was *łomżyńskie voivodship* where we actually observed milk procurement to increase by roughly 2%. Similar variation was observed for the relative change in milk production. During the first 7 years after overthrowing the communist system, in an average region it decreased by 30%. At the maximum however, this decline equalled to almost 63%. An exception again was noted for the *łomżyńskie voivodship*, which was the only region to experience growth in milk production (by 6%).

Table 1. Milk production and milk purchases by the dairy industry in Polish regions - descriptive statistics

	No. of obs.	Mean	Min	Max	Std. Dev.
Share of milk procured in total milk production 1989	49	71.02	37.18	87.72	13.53
Share of milk procured in total milk production 1992	49	52.35	15.52	91.32	18.42
Change in milk procurement (%) 1989-1992 ^a	49	43.60	-1.89	69.58	15.32
Change in milk production (%) 1989-1996 ^b	49	30.74	-6.07	62.76	15.17

Source: Own calculations based on GUS var. vol. Note: ^aChange in milk procured was calculated as: $change_{89-92} = 100 * (proc_{89} - proc_{92}) / proc_{89}$ where $proc_i$ is the total milk procurement in year i . Therefore, positive number refers to a decrease, and negative number refers to an increase, in milk procurement over the period 1989-1992.

^bChange in milk production was calculated as: $change_{89-96} = 100 * (prod_{89} - prod_{96}) / prod_{89}$ where $prod_i$ is the total milk production in year i . Consequently, positive number refers to a decrease, and negative number refers to an increase, in milk production over the period 1989-1996.

⁵ The remaining 30% was used for self-consumption (around 20%), feeding (around 7%) and export (around 3%).

Given our focus, two things emerge from the above statistics that seem to be of particular importance. First, in the period under discussion we observe a considerable collapse in milk procurement, which we treat as a direct evidence for serious disruptions in vertical relationships between farmers and milk processors. Second, it is clear that changes in milk procurement and changes in milk production coincided with each other and moved in one direction. Below, we present some more systematic analysis investigating the relationship between dislocation of the dairy supply chain and milk output. We first present our empirical strategy and data. The results follow shortly afterwards.

3. Empirical strategy and data

Empirical strategy

The empirical approach we adopt is similar in spirit to a standard difference-in-differences method. To study the outcomes of the disruptions in supply chain we adopt an event-study approach. Thus, we compare the relative changes in milk production in the post-treatment period relative to pre-treatment period between regions more or less exposed to disruptions to supply chain. Motivated by the discussion presented above, to proxy for these disruptions we use the reduction in milk procurement in the early years of transition which directly measures the extent to which vertical relationships between farmers and milk processors broke-up. As shown in Figure 1, the disruptions in dairy supply chain occurred almost entirely during the first three years of the transition period, i.e. between 1989 and 1992. We exploit this fact in our empirical strategy and define our treatment as the relative change in milk procured over this three-year period. Thus, in contrast to a standard difference-in-differences strategy our treatment is a continuous measure and not a zero-one dummy variable.

Two key empirical challenges that we have to overcome are the following. The first is an issue of reverse causality. Disruptions in dairy supply chain might have contributed to changes in milk production, but at the same time changes in milk production might have contributed to changes in milk procurement. The second concern is joint determination. During the period under analysis milk production may have changed for many reasons and these may well have been co-determined with the forces that affected changes in the supply chain. In other words, development in both milk procurement and milk production may have been driven by some unobserved factors. We take number of measures to address these concerns. First, all our models include both region-fixed effects and year-fixed effects. The former allow us to control for all time-invariant differences across regions (such as geography, climate, history or economic structure etc. that have been constant over our sample period). Time-fixed effects on the other hand ensure that our estimates are not confounded by general country-wide reforms that have been undertaken in 1989. This is important as they allow to control for macro-shocks and policies enacted by the central authorities affecting the situation in the whole country. In order to further address the omitted variables problem, we carefully control for a host of alternative determinants of milk output. In particular, we control for a number of socio-economic characteristics from 1989 to capture the potential effect of initial conditions. To allow these factors to have a time-varying effect we interact each of them with time dummies. In addition, to address potential concern that there are important differences between larger groupings of regions, in some specifications we identify the effect of supply chain's disruptions using only within-macroregion variation. Finally, as an alternative strategy we use the instrumental variables techniques.

Our baseline regression takes the following form:

$$(1) \ln y_{it} = \delta_i + \delta_t + \gamma POST_{it} * Disruptions_i + \beta X_{i,t} + \varepsilon_{it},$$

where the variable on the left-hand side denotes natural logarithm of milk production in region i and time t , δ_i and δ_t are region and time fixed effects respectively, $X_{i,t}$ is a vector of other covariates which will be included in some of the robustness checks and which are described when introduced in the analysis, and ε_{it} is an error term. The key variable is $Disruptions_i$ which captures the dislocation to inter-firm relationships in region i in the early transition and is measured as the relative change in milk procurement between 1989 and 1992. Given the downward trend in milk procurement, this variable is defined as $((p_{1989}-p_{1992})/p_{1989})$ where p_i refers to milk procurement in time t so that it measures the scale of reductions in milk procurement. The binary indicator variable $POST_{it}$ is set equal to 1 in each year after the treatment (so we exclude the event years). The coefficient of interest is γ which measures the additional output effect experienced by regions relatively more affected by disruptions to supply chain (relative to those with smaller disruptions) after the treatment occurred. Under our hypothesis that dislocation to inter-firm relationships negatively affected output, we expect $\gamma < 0$.

An alternative approach that we explore relies on instrumental variables specification. More specifically, we run a following cross-region model:

$$(2) \ln y_{i,1997} = \delta_m + \alpha Disruptions-instr_i + \mu X_{i,1989} + \varepsilon_i,$$

where δ_m denotes macro-region fixed effects, all other variables are defined as before and $Disruptions-instr_i$ are instrumented with the share of milk procured by dairy industry in total milk production in 1989 (p_{1989}/y_{1989}). The assumption is that this share, while affecting the scale of supply chain disruptions between 1989 and 1992, is unaffected by the level of milk production in 1997. We expect that in regions with higher share of milk procured in 1989 reductions in milk procurement in the early years of transition should be smaller. The rationale behind this expectation is predicated on the notion that in regions with higher commercialisation of milk production farmers will incur higher costs of supply chain disruptions as they are more dependent on selling their milk to the processing industry. Therefore, they should have stronger incentives to avoid adverse effects of supply chain disorganisation. To check the validity of our identification strategy based on using the share of milk procured as an instrument we run a simple falsification test. More specifically, we estimate alternative first-stage equations where the instrument is used to predict past changes in milk procured. This is done in order to check that our first-stage estimates are not confounded by spurious positive trends between share of milk purchased in 1989 and changes in milk procurement. We find no relationship between our instrument and past changes in milk procurement (results not reported). The relationship is statistically insignificant, negative, and very small in magnitude. These results support our identification assumptions.

Data

In total we have data for 49 Polish regions (voivodships). In general, our analysis focuses on the period 1984-1997. Extending analysis to include more recent years is not possible due to the fact that starting from January 1999 the number of voivodships in Poland has been reduced to 16.⁶ Unfortunately, the old voivodships cannot be easily transposed to the new ones. Choosing 1984 as a starting date in turn was dictated by the fact that we wanted to have

⁶ The year 1998 is also not available as the most of the data for this year is already reported for the new administrative division.

a 5 year window before and after the treatment. In some robustness checks, however, we also use older data starting in 1980.

All our data come from the Polish Central Statistical Office (GUS) and were collected from various volumes of either 'Statistical Yearbook - Poland' or 'Statistical Yearbook of the Regions – Poland'.

4. Results

We begin by estimating the equation (1). The results are reported in Table 2 and Table 3. All standard errors in these specifications are robust against arbitrary heteroscedasticity and serial correlation at the region level. Specifications presented in Table 2, except for the full set of region and time fixed effects, include only the lag of number of cows per hectare of agricultural area (logged) to control for the main production input. We use the lagged rather than contemporaneous number of cows as one may argue that at the regional level adjustments in the cow herd may potentially reflect changes in total production. Besides, lagged cow herd serves as a proxy for lagged production so to capture persistency in output and potentially mean-reverting dynamics (i.e. the tendency of the output variable to return to some equilibrium value for the region). In column (1) we report the results based on 1984-1997 sample (excluding event years i.e. 1990,1991 and 1992). They suggest that disruptions in supply chain negatively affected milk output. According to the estimate, increasing the reduction in milk procurement by 1 percent decreases milk production by 0.17 percent on average.

Table 2 The dislocation of dairy supply chain & milk output: baseline results & falsification tests

	Baseline results		Falsification tests	
	(1)	(2)	(3)	(4)
	Sample:1984-1997 Event: 1989-1992	Sample:1980-1985 Event:1983	Sample:1982-1988 Event:1985	Sample:1980-1989 Event:1985
<i>Disruptions * POST</i>	-0.173** (0.080)	0.0311 (0.052)	-0.00694 (0.036)	0.0267 (0.039)
Constant	2.626*** (0.29)	3.131*** (0.61)	2.980*** (0.30)	2.755*** (0.32)
Observations	490	196	245	392
R-squared	0.98	0.99	1.00	0.99

Notes: Robust standard errors in parentheses clustered at the region level, *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is always the log of total milk production of the region measured in litres. The key explanatory variable measures the relative reduction in milk procurement between 1989 and 1992. *POST* is a binary variable set equal to 1 for all years after the event as indicated in the table. The event years themselves are excluded. All regressions include full set of region and time fixed effects as well as the lag of the number of cows per hectare of agricultural area (logged). Sample period covered in the analysis is reported in the table.

One important concern with all difference-in-differences estimates is the possibility that pre-existing trends are correlated with changes in the variable of interest. If our measure of the supply chain's disruptions is correlated with region-level trends in milk production the estimates presented in column (1) may reflect spurious correlation. To make sure that our results are not just capturing some other region-specific trends, in columns (2)-(4), we report the results from a falsification tests where we check whether the changes in milk procurement between 1989-1992 are correlated with changes in milk production from various periods before 1989. The coefficient estimates for *Disruptions*POST* in all these regressions are close to zero and insignificant. These results suggest that the results from column (1) are driven by the specific events we focus on rather than by unobserved trends.

In Table 3 we further check the robustness of these results to the inclusion of various explanatory variables that aim to capture the effects of initial conditions. If not written otherwise, they all refer to 1989. To allow these factors to have time-varying effect each of these covariates is interacted with time-fixed effects. In column (1), we include the variable measuring the share of milk procured from state-owned and cooperative farms. This is done to control for the fact that part of the reduction in milk production is due to the collapse of state-owned and cooperative farms. As reported in the table, the effect of the supply chain's disruptions is still significant and of similar magnitude as before. In column (2), we additionally include various price-variables. To control for farmer's outside options we include milk procurement price relative to the price farmers could obtain in private sales. Further, we include the ratio of milk procurement price to wheat procurement price and the ratio of milk procurement price to the beef cattle procurement of price. By doing so we hope to control for farmers' outside options. Wheat price may also serve as a proxy for input prices. The effect of supply chain's disruptions is still significant at about 7% level and the point estimate is now a little higher (in absolute value). In column (3), we try to additionally control for farmers' relationships with input suppliers. Therefore, we add a variable measuring the share of cow herds inseminated and a variable measuring forage consumption (logged). Again, our results appear robust to this inclusion. Finally, in column (4), we control for initial grassland in hectares (logged), the number of people employed in agriculture (logged) and the share of milk samples disqualified due to low quality by the sanitary control. As these variables are not available for 1989 we use the data for 1990. What is important in this specification we also add macroregions-year fixed effects. This is done in order to check whether our results are not driven by the fact that some macroregions (we have them 6 in the sample) were more prone for milk production reductions and/or disruptions in supply chain. By including macroregions-years fixed effects we now estimate the impact of supply chain's disruptions only from within-macroregions variation. Therefore, they are not affected by potential differences between macroregions. Thanks to this we also control for any potential shocks that worked at the macroregion level. Again, our estimates are of similar magnitude as before and significant at 6% level.

Table 3 The impact of dislocation of supply chain on milk output: robustness to additional covariates

	(1) Sample:1984-1997 Event: 1989-1992	(2) Sample:1984-1997 Event: 1989-1992	(3) Sample:1984-1997 Event: 1989-1992	(4) Sample:1984-1997 Event: 1989-1992
<i>Disruptions * POST</i>	-0.175** (0.078)	-0.209* (0.11)	-0.242* (0.14)	-0.276* (0.14)
<i>Other control variables</i>				
Share of milk from state-owned farms	Yes	Yes	Yes	Yes
Prices	No	Yes	Yes	Yes
Input suppliers	No	No	Yes	Yes
Land, workforce, sanitary control	No	No	No	Yes
Macroregion-year fixed effects	No	No	No	Yes
Constant	3.121*** (0.37)	3.117*** (0.44)	3.119*** (0.66)	3.155*** (0.57)
Observations	490	490	490	490
R-squared	0.98	0.98	0.98	0.99

Notes: Robust standard errors in parentheses clustered at the region level, *** p<0.01, ** p<0.05, * p<0.1. The dependent variable is always the log of total milk production of the region measured in litres. The key explanatory variable measures the relative reduction in milk procurement between 1989 and 1992. *POST* is a binary variable set equal to 1 for all years after the event as indicated in the table. The event years themselves are excluded. All regressions include full set of region and time fixed effects as well as the lag of the number of cows per hectare of agricultural area (logged). Sample period covered in the analysis is reported in the table.

It is interesting therefore to see how much of the observed decrease in milk production could be attributed to the disruptions in supply chain. We calculate it in the following way. Our most conservative estimate of the impact of supply chain's disruptions is -0.173 (column 1, table 2). The aggregate observed milk production in 1997 (logged) was 261.7 and it was by 17.9 lower than in 1989. The counterfactual aggregate milk production (excluding the impact of supply chain's disruption) in 1997 can be then computed. It is equal to the sum of the following operations done for each region: from the actual production in a given region we subtract the estimated impact of disruptions times the relative change in milk procurement between 1989-1992 in this region. This counterfactual production is equal to 265,4 and is by 3.7 higher than the actual one. It seems therefore that the contribution of supply chain's disruption to the output fall was roughly 20% ($3.7/17.9$).

5. Conclusions

This paper tries to contribute to the debate about the importance of the rules shaping inter-firm relationships in processes involving at least two production stages. Examining a natural experiment of changing the institutions governing the Polish dairy supply chain in the late 1980s and early 1990s, we make an attempt to highlight some important mechanisms through which a radical reorganisation of the vertical linkages between upstream and downstream producers can affect economic outcomes. A specific channel that we isolate, through which this effect may occur, is the dislocation to inter-firm relationships. The latter arises from the fact that a dramatic change in governance structures may produce, at least in the short run, a sort of institutional vacuum where the old institutions cease to exist and the new ones are not yet in place. As the old system of exchange stops to function, the existing relationships between buyers and suppliers break-up. Forging new relationships in turn is very costly, due to lack of appropriate institutions that would create new coordination mechanisms responsible for governing specific economic relations, disseminating information or supporting the functioning of input and output markets.

Consistent with this line of reasoning, based on within country variation, we find that the dislocation to relationships between farmers and milk processors negatively affected milk production. Regions that experienced the largest decline in milk procurement by dairy industry were also regions which experienced the largest decline in milk output. This result is robust to various estimation techniques and different covariates included in the regressions. According to our most conservative estimates, this channel accounts for approximately 20% of the fall in milk output that was witnessed in the early years of transition.

Our interpretation of this finding is as follows. The collapse of the communist vertical coordination system has dramatically affected the relationships between food industry and farmers. Especially in the early phase of transition, this resulted in a decreased procurement of agricultural products by downstream sector. As farmers' outside options were limited, they were left with no other possibility but to reduce their production.

What should be noted is the fact that due to data problems we do not discriminate between different reasons for the decrease in milk procurement. This could be related, for example, to bankruptcy of procurement companies, cash-flow problems throughout the agro-food chain or the emergence of non-official sales opportunities for milk producers. Further investigation that would try to assess the importance of these reasons could be a possible line for future research.

There is yet another point that has to be clearly stated. Our empirical evidence comes from Poland during the specific period of transition from a centrally planned to a market economy. Thus we must exercise caution in making claims about external validity. That said, we believe that the mechanisms which we tried to emphasise could be useful in providing a richer explanation for the economic consequences of reorganising supply chain. Further, as argued by many scholars (see e.g. Pistor, 2013), there is still a large demand for policy relevant lessons from transition processes in the past as the new transitions have been already happening (Arab Spring or institutional changes in the developed countries forced by the tensions related to financial crisis). We hope that this paper may provide some insights in this respect.

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