Economic effects of reorganising an agro-food supply chain: some evidence from Poland

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Abstract

Purpose – Much has been said about the nature of the agro-food supply chain. Yet, the consequences of reforming supply chain institutions have less often been studied, especially from an empirical perspective. The purpose of this paper is to examine the economic consequences of a radical reorganisation of the system of exchange in the agro-food sector in Central and Eastern Europe, during the process of transition from a centrally planned economy to a market economy. By considering a historical example from the dairy sector in Poland, the author provides evidence that the disorganisation of vertical linkages between upstream and downstream producers can be very costly. The most conservative estimates suggest that the dislocation of inter-firm relationships accounted for approximately 20 per cent of the drop in milk production observed in the early-transition phase in question.

Design/methodology/approach – The empirical approach is based on econometric analyses. The empirical strategy the author adopts is similar in spirit to a standard difference-in-differences method. More specifically, to study the outcomes of the disruptions in supply chain the author adopts an event-study approach. Thus, the author compares 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.

Findings – The most conservative estimates suggest that the dislocation to inter-firm relationships accounted for approximately 20 per cent of the fall in milk production observed in the early-transition phase.

Originality/value – Two key features distinguish the approach from the previous studies. First, through the use of a more direct measure of problems affecting vertical relationships between farmers and processors the author has access to higher quality proxies for the supply chain disruptions. To this end, the author focuses on the dislocation to milk procurement system that arose in the very early phase of transition, manifesting itself in the break up of vertical linkages between farmers and dairy industry. Second, in contrast to the existing studies which exploit variation between transition countries, the author focus on within-country evidence. To best of the author knowledge, this paper is the first to investigate agricultural output during transition using within country variation.

Keywords Poland, Transition, Agriculture, Milk, Supply chain reorganization

Paper type Research paper

1. Introduction

There is now growing consensus among economists that the organisation of transactions has important implications for economic outcomes and the efficiency of resource allocation. This particularly seems to be the case for production processes that are sequential in nature and involve at least two production stages. A reflection of

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this belief can be found in the exciting body of literature that has emerged in recent years, which investigates various aspects of vertical relationships between upstream and downstream firms[1].

One topic that has received special attention is that of the institutions that govern supply chains. Overall, extant 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. Furthermore, especially at the macro level, there are many blind spots in our understanding of the relative roles of different institutional arrangements that determine inter-firm relationships, and thus the aggregate workings of the economy. Finally, questions remain about the economic consequences of changing the rules that govern supply chains. This can be understood as of particular importance if one recognises that while transacting parties may find ways to avoid the adverse effects of weak contracting institutions, radical reform that reorganises a system of exchange can be very costly, especially over the short run. In a multiple equilibria scenario, one could ask whether changing the organisation of supply chains may cause a movement from one equilibrium to another. In contrast, in a scenario with a unique stable equilibrium, one could consider the temporary impact. In this context, it is worth noting that institutions affecting vertical linkages between upstream and downstream producers are not only shaped by evolutionary processes, but are often subject to revolutionary changes. The latter can be driven by a number of factors, 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.

Interestingly, despite recent advances in our understanding of the roles of how sequential production processes are organised, systematic empirical evidence on the effects of reorganising supply chains' coordination mechanisms has been very limited. This paper is an attempt to fill this gap. To achieve this goal, we provide a quantitative analysis of a unique example of radical reorganisation, involving a supply chain in Central and Eastern Europe during the transition from a planned economy to a market economy (Kornai, 2006). More specifically, we provide a quantitative analysis of the reform in institutions governing the agro-food supply chain in Poland after the collapse of the communist system in 1989. Under communism, the agroindustry was highly concentrated, with food processing, distribution, and input supplies monopolised by the state (Brooks *et al.*, 1991). This also included the procurement of raw agricultural products, which was organised through state-owned rural collection points. With the end of central planning, this system of exchange collapsed. Food processors lost their guaranteed supplies and farmers had to find new ways to market their products, without the state acting as an intermediary. 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 was thoroughly reorganised, with bureaucratic coordination mechanisms replaced by market coordination mechanisms (Kornai, 1994). This case of emergence of the different coordination mechanisms following the transition from a planned economy to a market economy offers a unique opportunity to evaluate its impact.

Below, we focus on the Polish dairy supply chain and investigate the consequences that its reorganisation might have had for milk output, which experienced a dramatic decline in the early phase of transition[2]. Although the effect of disturbances in supply chain coordination mechanisms may occur through a number of different channels, in addressing this case we focus on one that the literature highlights as very important,

namely the dislocation of inter-firm relationships (Kornai, 1994; Blanchard and Kremer, 1997; Roland and Verdier, 1999; Swinnen and Rozelle, 2006).

The rationale for investigating this particular channel is based on the fact that the elimination of bureaucratic coordination in this case was not gradual, and proceeded very quickly. As a result, when the old institutions ceased to exist, the new ones came into being only after some time. In consequence, at least in the early period of transition, institutions responsible for governing specific economic relations, disseminating information, or supporting the function of input and output markets were either absent or worked inefficiently. In such an environment, decentralised bargaining systems and searches for new trading partners involved considerable transaction costs, which were often so high that the gains from exchanges were more than offset by the expenses of the required 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 outputs (see, e.g. Swinnen and Rozelle, 2006; Liefert and Liefert, 2012).

This argument has strong theoretical foundations, and draws on agency theory, transaction costs theory, and property rights theory (Blanchard and Kremer, 1997; Roland and Verdier, 1999). It also seems to have obvious appeal. However, quite surprisingly, in empirical work to date, the effect that these disruptions may have had on economic performance in the agricultural sector has hardly been documented[3]. As such, the empirical validity of this idea and its relationship to the situation of agro-food chains during transitions remains largely untested.

This paper is an attempt to provide such testing. Based on detailed historical data from the early years of transition in Poland, we investigate the short- to medium-term effects that this process of disorganisation had on milk output[4]. To measure disruptions to inter-firm relationships, we exploit regional variations in the evolution of milk transactions among farmers and members of the dairy industry around the time in which the central planning system broke up. Specifically, we take advantage of the fact that the transition to a market coordination mechanism affected milk procurement in each region with a different level of intensity. Therefore, we can evaluate the impact of the supply chain reorganisation on milk output by comparing milk production in regions that were affected by greater reductions in milk procurement to those that were less severely affected by reductions, before and after the most dynamic adjustments in the sector took place. Our basic finding is that dislocation in the supply chain had a negative effect on milk production. Our estimates are robust across different specifications, and control for a number of alternative determinants of milk output. According to our results, changes in milk procurement in the early years of the transition period accounted for at least 20 per cent of the decrease in milk production.

The paper is organised as follows. In Section 2, we review the relevant literature and present the motivations for our paper. Section 3 provides background information about the Polish dairy sector during the period under study. Section 4 presents our empirical strategy and data, while in Section 5 we present and discuss our results. Finally, Section 6 summarises our work and presents our main conclusions.

2. Literature review and motivations

Existing economic literature addresses a wide range of topics concerning agro-food supply chains. A number of studies have tried to describe and explain various developments in vertical linkages between agricultural producers and downstream sectors. Several of these studies are particularly relevant to this paper. First, our work

relates to a large body of literature on agro-food supply chain restructuring. Numerous scholars have stressed the need to recognise the vertically linked nature of the food marketing system (for a literature review see Sexton and Lavoie, 2001). In addition, there is a considerable amount of existing research on the main driving forces behind changes taking place within the agro-food chain (for an excellent collection of recent work in this field see Swinnen, 2007). These studies build a very comprehensive picture of the main developments occurring in the agro-food chain and the potential impact that they may bring about. Nevertheless, systematic evidence on the relationship between the reorganisation of agro-food supply chains and economic output is still very limited. Moreover, we have only a poor understanding of the mechanisms through which potential impacts may be transmitted. This paper fills this gap by looking at the historical experience of Poland, and provides a rigorous quantitative analysis of the effects of a radical reform in the local dairy supply chain.

There is also a large body of literature investigating the effects of specific innovations introduced to agro-food chains, much of which is based on microeconometric evidence. Examples of studies on the dairy sector in transition countries include the work of Dries and Swinnen (2004), Gorton and White (2007), Dries *et al.* (2009) and Fałkowski (2012). These papers certainly improve our understanding of the roles of particular institutional solutions to agency problems and high transaction costs. They also help to explain many organisational decisions undertaken by downstream and upstream producers. However, to gain more general lessons from this literature, we would have to assume that the micro-level relationship that it documents applies identically to more aggregated contexts. Furthermore, the aforementioned studies often focus on a single aspect of governance, and have only limited potential to capture variations in policies and institutions (with the exception of those that use samples that are large enough and distributed across a wide enough geographical area). As a result, the scope of their analyses is limited. Therefore, they have only limited application to the study of the economic consequences of complex, multidimensional, radical reforms of the coordination mechanisms governing supply chains. We believe that our strategy, which uses an extensive data set at the regional level, is far better suited to this purpose.

The second strand of literature that is relevant to our work investigates the patterns of agricultural output during transition from a centrally planned economy to a market economy. A number of papers have tried to provide explanations for the decreases in quantity and quality of output that were witnessed shortly after the collapse of communism (for an overview of this research, see Rozelle and Swinnen, 2004). Interestingly, while existing analyses often mention supply chain reorganisation as an important causal factor, they rarely attempt to verify this empirically (see the discussion in Swinnen and Rozelle, 2006). Clearly, this is primarily due to problems with the data. Existing research either involves the case study approach (Gow *et al.*, 2000; Gorton *et al.*, 2006) or is based on cross-country variation, and only highlights essential correlations in the data, without establishing causality (Macours and Swinnen, 2000a, 2002). Moreover, it uses very rough measures to control for organisational changes in vertical linkages between upstream and downstream producers. The notable exception is a study by Macours and Swinnen (2000b), which uses a seven-year panel for eight countries from Central and Eastern Europe. The authors try to link changes in agricultural output with disruptions caused by the processes of decollectivisation and the redistribution of property rights over land. To do so, they measure the share of agricultural land that has been transferred to individual farms, which they use as a proxy for the share of farms in the process of radical restructuring. In accordance with

expectations, they find that this factor negatively affects agricultural output. While important, this result is at least partly unsatisfactory. This is because it seems to emphasise the significance of a broad cluster of varied institutional aspects and hardly allows for a full understanding of the specific types of institutions that are important. More precisely, it seems plausible to assume that through the use of their proxy, the authors capture not only the effect of contracting institutions, but also, and perhaps predominantly, the effect of property rights institutions and other market imperfections. In fact, in justifying the usage of their measure, Macours and Swinnen (2000b) link it to both "the break-up of contracting relationships and suboptimal factor allocations because of land and capital market imperfections" (p. 183). As these different phenomena are likely to have distinct effects, it is difficult to determine to what extent the documented effect is really due to the breakdown of systems of exchange between farms and processing industry.

Furthermore, there is no doubt that linking supply chain disruptions during transition to land reform and land privatisation is a suitable means of describing the phenomena occurring in a number of transition countries that experienced a dramatic shift toward individual farming (see Brooks *et al.*, 1991; Swinnen *et al.*, 1997; Lerman *et al.*, 2004). However, the usefulness of this explanation for the decline in agricultural output in countries such as Poland is somewhat questionable. This is because, in contrast to most transition countries, the share of state-owned/collectivised land in Poland was very limited and local agriculture remained largely based on small individual holdings throughout the communist period. It therefore appears that any explanation that simply relies on changes in land ownership structure is, at some level, incomplete. This suggests that such explanations should be augmented by those taking other causes into account, in order to explain why and where the drop in agri-food production occurred. In this context, investigating the effects of disorganisation in the linkages between upstream and downstream producers may offer an additional perspective that improves our understanding of the issue in question.

In this paper, we aim to expand on existing evidence. Two key features distinguish our approach from those of previous studies. First, through the use of a more direct measure of the problems affecting vertical relationships between farmers and processors, we have access to higher quality proxies for supply chain disruptions. To this end, we focus on the dislocation in the milk procurement system that arose in the very early phase of transition, manifesting itself in the break up of vertical linkages between farmers and the dairy industry. Second, in contrast to existing studies, which tend to exploit variations between transition countries, we focus on within-country evidence. Focusing on one specific country ensures that we do not confuse or misinterpret the effects of changes in a whole set of complex and differing institutions, which is likely to occur in multi-country analyses and transition contexts. 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 and exploiting within-country variation. Thanks to this, we are able to avoid the problem of measuring various economic and political reforms, as these were common for the whole country that we examined. Furthermore, working with regional data allowed us to overcome the strong assumption that is implicitly made in cross-country studies: namely, that institutions and policies have uniform effects over a whole country. In fact, as has been made clear in many studies, institutions and their impact on economic performance may vary substantially within national boundaries (see Gibson, 2005; North *et al.*, 2009; Bardhan, 2010). To the best of

our knowledge, this paper is the first to investigate agricultural output during a transition by using within-country variation.

Finally, the arguments presented in this paper also have some relevance to extant literature on institutional change and the role of historic events in shaping economic outcomes (for an overview of recent research along these lines, see Nunn, 2009). By addressing a historical example in this paper, we aim to document the economic consequences of a radical change in the rules governing supply chains. In examining the frictions between downstream and upstream producers that have arisen in response to institutional change, we also attempt to identify a particular channel through which the effects of this change may occur. Thus, we hope that our paper will not only be of historical relevance, but will contribute to ongoing debate about the role of reforming governance structures in influencing economic performance.

However, it should also be taken into account that our approach has a potential shortcoming, in 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 the possibility 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, however is that our results seem to be robust across different specifications, after controlling for a number of factors that have been identified in the literature as important potential determinants of agricultural output during transition periods. Moreover, we present additional evidence that supports our points and suggests that what we have uncovered is not simply a coincidental relationship.

The next section briefly discusses the main developments in the Polish dairy sector during the process of transition from a centrally planned economy to a market economy. This sets the context for the empirical analysis that follows.

3. Background information

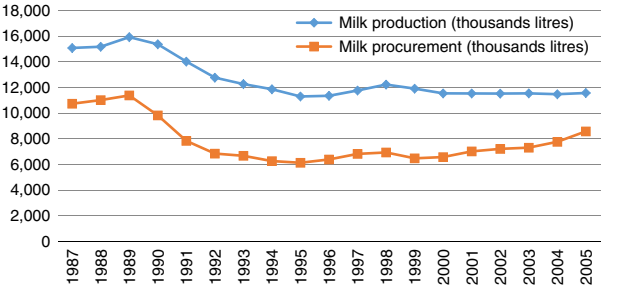
At the outset of the transition addressed in this study, the dairy sector in Poland was characterised by particularly strong linkages between farmers and the processing industry. For example, in 1989, the share of total milk production purchased by the dairy processing industry was roughly 71 per cent. In comparison, in the crop sector, this share was much smaller: for potatoes 11 per cent of total production went to the potato processing industry, whereas for cereals, the figure was roughly 20 per cent (GUS, various volumes). The dairy sector also held the largest value share of the total procurement of agricultural products in Poland. In 1988, it accounted for approximately 22 per cent, exceeding the 19.7 per cent contribution of pig farming and the 12.5 per cent contribution of beef. Based on these observations, one can assume that any disruptions to inter-firm relationships would have a major impact on the dairy sector's performance. As illustrated in Figure 1, which presents main changes in milk purchases by the dairy industry and total milk production over the transition period at the country level, this was indeed the case.

Our focus is especially on the period 1989-1997, which we refer to as the early phase of transition. Two observations concerning this period are particularly noteworthy. First, a sharp decline in both milk procurement and total milk production can be noted. In 1989, which was the year of reform, the total milk purchases by the dairy industry amounted to 11.4 billion litres (GUS, various volumes). During the first six years of the post-reform period, purchases dropped by 46 per cent, or 5.2 billion litres (Figure 1). Interestingly, the decrease in milk procurement was mainly visible in the first three years following reform, from 1989 to 1992. In fact, this period accounts for 86 per cent of the total reduction in

milk procurement observed over the 1989-1995 period. This fact is important for our identification strategy, and we return to it later. The decline in total milk production was slightly smaller, but still large, and amounted to roughly 4.6 billion litres. In relative terms, this meant a 29 per cent reduction. These downward trends were only reversed in 1996. From that year onward, milk production stabilised within the range of 11.5-12 billion litres, whereas milk purchases by the dairy industry started to slowly increase, and from 2005 onward fluctuated within the 8.5-9 billion litre range.

These developments led to a dramatic decline in the share of total milk production purchased by the dairy industry, which is the second key point to consider. While in 1989, this share amounted to 71 per cent, in 1992, it amounted to only 54 per cent. In 1997, it was only slightly higher (58 per cent). However, the pre-reform level was restored in 2005, and levels have been relatively stable since. This suggests the existence of a unique stable equilibrium in the milk procurement/milk production ratio.

Practically speaking, the downward tendencies mentioned above were noticeable all over the country. Despite this, at the regional level, important variations could be observed. Table I provides some descriptive statistics to illustrate this point. For example, depending on the region, the share of total production milk procured in 1989 (1992) ranged from 37 per cent (15 per cent) to 87 per cent (91 per cent). Furthermore, while the relative decrease in milk procurement during the 1989-1992 period averaged 43 per cent across regions, in some regions it far exceeded 50 per cent. An exception to this rule was Lomżyńskie *voivodship*, where milk procurement actually increased, by roughly 2 per cent. Similar variation was observed in the relative changes in milk production.



Source: GUS (Var. vol.)

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

	No. of obs.	Mean	Min.	Max.	SD
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
Reduction in milk procurement (%) 1989-1992[a]	49	43.60	−1.89	69.58	15.32
Reduction in milk production (%) 1989-1996[b]	49	30.74	−6.07	62.76	15.17

Notes: [a]Reduction in milk procurement was calculated as: $100 \times (proc_{89}\text{-}proc_{92})/proc_{89}$ 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; [b]Reduction in milk production was calculated as: $100 \times (prod_{89}\text{-}prod_{96})/prod_{89}$ 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

Source: Own calculations based on GUS (various volumes)

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

During the first seven years after the communist system was overthrown, the average milk production across regions decreased by 30 per cent. At the maximum, however, declines reached almost 63 per cent. Once again, Lomżyńskie *voivodship* was the exception, and was the only region to experience growth in milk production (by 6 per cent).

Given our focus, two points of particular importance emerge from the statistics above. First, in the period under discussion, we can observe a significant collapse in milk procurement, which we treat as a direct evidence of serious disruptions in the 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. In the next sections of this paper, we try to more systematically analyse this relationship and establish its causal link. Before doing so, however, we provide some descriptive evidence that might be helpful in supporting the argument that farmers reduced milk production in response to the dislocation of their relationships with the dairy industry, and not necessarily due to other reasons.

It is useful to illustrate the scale of agro-food chain reorganisation that related to the shift in the coordination mechanism governing the exchange between farmers and the processing industry. We can start by observing that before the collapse of the communist regime, the purchase of agricultural produce in Poland was centrally organised. A central authority decided how much to buy and from whom. It also provided control and enforcement systems that governed transactions within the agro-food chain. The scale of the monopolisation of agricultural purchases by the state can be seen in the fact that, according to official statistics, in the 1970s and the 1980s, the decentralised procurement system accounted for only about 1 per cent of the value of procured agricultural products (GUS various volumes). This concerned all production, including milk. For milk specifically, the procurement system was mainly organised through rural collection points operated either by the state or by dairy cooperatives, which although cooperatives by name, were part and parcel of the centralised system until 1989.

The changes that transition brought to this system were not only on a massive scale but also very rapid. As a consequence, the role of the state in managing the purchase of agricultural produce was very strongly marginalised. For example, in 1996, public entities were responsible only for 8 per cent of raw agricultural materials procured (in value terms, GUS various volumes). A major role was then played by newly established private companies and individual entrepreneurs, which accounted for 68 per cent of procured materials. The remaining 24 per cent was managed by cooperatives that, while initially created as part of the collectivist economy, had to start functioning on a market basis. Even cautious estimates therefore suggest that the majority of purchases, and thus relations between farmers and purchasers, had to be organised anew.

It could be argued that this scenario, although valid in general, does not hold true for the milk production sector. This is because the dairy industry, during both pre- and post-reform times, has been dominated by farmer cooperatives. Indeed, while in 1989 these cooperatives' share of milk purchases was 100 per cent, in 1995, it was still very high and amounted to 86 per cent. Based on this, one could argue that traditional exchange relationships between dairy farms and the milk processing industry were maintained during this period. However, below, we provide evidence that proves this assumption to be unwarranted.

First, as indicated in several sources, the early years of transition witnessed a considerable increase in the number of small dairy companies employing less than 50 employees (Zalewski, 1995; Seremak-Bulge, 2005; Kawa and Kuźniar, 2009). According to Zalewski (1995), by 1994, approximately 100 companies had been newly established,

whereas Kawa and Kuźniar (2009) suggest an even larger increase. This is quite impressive given the fact that, according to official statistics, in 1989, the industry consisted of only 340 dairy companies. While parts of these newly established companies were small milk processors, there is some evidence that others were set up precisely to act as middlemen between farmers and the dairy industry and thus to fill, at least partly, the institutional vacuum in the vertical coordination system that arose with the departure from the old governance structure. Whichever way we look at it, new relationships between farmers and these new companies had to be institutionalised.

A second point that suggests that disruptions to vertical linkages between downstream and upstream sectors might have played an important role in the development of the Polish dairy sector concerns the structure of milk production, which was incredibly fragmented. Interestingly, while under communism, the procurement system was monopolised by the state, milk production was not. In fact, more than 80 per cent of the milk purchased by the dairy industry was delivered by roughly two million individual farmers[5]. Importantly, most of these were either small or very small farmers[6]. This suggests that any destructive effects of disorganisation in the procurement system could not be fixed overnight, since they must have affected a large number of milk producers. Consequently, overcoming the negative impact of these disruptions meant incurring high transaction costs, as a potentially large number of relationships had to be (re-)established. One can thus assume that these distractions entailed not only very short run, but also medium-run costs.

Clearly, other factors than change in the governance of the dairy supply chain could also affect the level of milk procurement. For example, it is commonly argued (see Seremak-Bulge, 2005) that in the first half of the 1990s, dairy companies were in particularly dire straits, with financial constraints forcing them to reduce milk purchases from farmers. This implies that the mechanism behind the radical decline in milk procurement may not necessarily have been related to the break up of vertical linkages between processors and farmers. It is certain that price liberalisation and the departure from subsidising dairy cooperatives had important repercussions for their functioning, and required them to make important adjustments and engage in restructuring. That said, it must be noted that according to data presented by the Polish Central Statistical Office, between 1989 and 1992 (when milk procurement dropped the most) the number of dairy processors employing more than 50 employees did not decrease at all (GUS, various volumes). In fact, while in 1989 there were 340 such companies, in 1990 there were 348 of them, in 1991 there were 347 of them, and in 1992 there were 341. This suggests that, notwithstanding some difficulties, the great majority of the industry managed to survive the first years of reform. Moreover, as explained by Dróżdż and Urban (2004), the dairy industry maintained financial liquidity over the whole transition period. According to their estimates, in 1991, the dairy industry was also characterised by a positive net profitability.

Another explanation for the reduction in milk procurement could be related to the fact that once the transition started, farmers had better outside options to market their produce. Consequently, they might have preferred to sell their milk to final consumers rather than to the dairy industry. Indeed, during the 1989-1991 period, we can observe an increase in direct sales to consumers. However, three aspects suggest that this increase should be seen as a result rather than a cause of the decrease in milk procurement. First, while direct sales increased in the first two years after reform, in the third year (1992), they already began gradually decreasing. Second, quite surprisingly, annual changes in direct sales moved in the opposite direction from what one would

expect, based on changes in the ratio between prices that farmers could have obtained in market transactions and prices that farmers received when delivering to the dairy industry. For example, an increase in direct sales took place at the country level between 1990 and 1991, notwithstanding the fact that over the same period, the abovementioned price ratio deteriorated in 41 of 49 Polish regions[7]. Between 1992 and 1993 and between 1993 and 1994, direct sales at the country level decreased, despite the fact that the price ratio improved in all but two and 11 regions, respectively. A third point suggests that direct sales to consumers provided farmers with very few outside options and were a necessity rather than an opportunity. This is the fact that during the early years of transition, in addition to increasing direct sales to consumers, farmers also considerably increased self-consumption. This particularly applied to the quantities of milk used for feeding animals. While in 1989, roughly 0.7 million tonnes of milk were used for this purpose, during 1990-1994, they averaged twice as much (Seremak-Bulge, 2005). This, however, was only a temporary phenomenon, as in 1995, the milk output used for feeding was already very close to the level recorded before reform (GUS, various volumes). All of these observations suggest that the increase in both direct sales to consumers and self-consumption were only temporary adjustment mechanisms, and were not sustainable even over the short run. As such, they were unlikely to be responsible for the dramatic two-year reduction in milk procurement. Instead, it seems much more plausible to assume that they were used by farmers as tools to absorb production surpluses, which resulted from limited opportunities to transact with the dairy industry. In order to address this potential issue more rigorously, we return to it in our econometric analysis. In particular, we include among our covariates the ratio between prices that farmers could have obtained through market transactions and prices from transactions with the dairy industry. In addition, to take into account the fact that other relative prices might have changed (e.g. the ratio of input/output prices), in some regressions we also control for the ratio between milk procurement prices and wheat or beef cattle procurement prices.

Furthermore, one could argue that milk procurement and milk production dropped due to the collapse of state-owned and collective farms. As explained in Section 2, this argument is less convincing when applied to Poland, because the role of those farms in milk and agricultural production was much smaller than in other countries in the region. For example, before the transition started, these farms accounted for only 17 per cent of milk procurement. This share remained the same in 1990, only slightly dropped to 16 per cent in 1991, and was still 13 per cent in 1992. Therefore, it is rather unlikely that the sharp decline in milk procurement and milk production could simply be explained by the collapse of state-owned or collective farms. We address this concern in our econometric analysis, in which we carefully control for the changes in milk procurement in state-owned and collective farms.

Another potential explanation for the decline in the quantity of milk purchased by the dairy industry involves changes in the demand for milk. In fact, in the period from 1989 to 1995, milk consumption per capita dropped by 25 per cent (Seremak-Bulge, 2005)[8]. While this is indeed a remarkable change, and thus cannot be neglected, it should be noted that changes in milk procurement were not only much greater, but also much faster. This suggests that some other factors must have played a role. Furthermore, if adjusting to new equilibrium in demand was the only, or even the main, driving force behind changes in milk procurement, it would be difficult to explain the increase in milk purchased by the dairy industry that started in 1996, despite the fact that milk consumption per capita was still following a downward trend[9]. This line of

reasoning is also supported by other studies, which have argued that the recession in the early phase of the transition away from communism could not be explained solely in terms of insufficient demand (see Kornai, 1994).

With the above considerations in mind, we have carried out more systematic analysis, investigating the relationship between the dislocation of the dairy supply chain and milk output. We begin the section below by presenting our empirical strategy and data, followed by our results.

4. Empirical strategy and data

Empirical strategy

The empirical strategy that we adopt is similar in spirit to a standard difference-in-differences method. More specifically, to study the outcomes of disruptions in the supply chain, we adopt an event-study approach. Thus, we compare the relative changes in milk production in the post-treatment period relative to the pre-treatment period among regions that were more or less exposed to disruptions to the supply chain. Based on the discussion presented above, as a proxy for these disruptions, we focus on 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 were broken up. As shown in Figure 1, disruptions in the dairy supply chain occurred almost entirely during the first three years of the transition period, 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 terms of the contrast with a standard difference-in-differences strategy, our treatment uses a continuous measure, rather than a zero-one dummy variable.

In this study, we had to overcome two key empirical challenges. The first is the issue of reverse causality. Disruptions in the dairy supply chain might have contributed to changes in milk production, but it is also possible that changes in milk production contributed to changes in milk procurement. The second concern is that of joint determination. During the period under analysis, milk production may have changed for many reasons, which may well have been co-determined by the forces that affected changes in the supply chain. In other words, developments in both milk procurement and milk production may have been driven by some unobserved factors. We take a number of measures to address these concerns. First, all of 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, which are constant over our sample period). The use of time-fixed effects, on the other hand, ensures that our estimates are not confounded by the general country-wide reforms that were undertaken in 1989. This is important, as they allow us to control for macro-shocks and policies enacted by the central authorities that affected the situation in the whole country. In order to further address the problem of omitted variables, we carefully control for a host of alternative determinants of milk output. To take into account the fact that the regions that experienced the most pronounced changes in the milk procurement system could already have differed in their economic performance from other regions before the transition, we try to include pre-transition characteristics in our specifications. In particular, we control for a number of socio-economic characteristics from 1989, in order to capture the potential effects of the initial conditions. To allow these factors to have a time-varying effect, we interact each of them with time dummies. We also check whether the relationship between changes in milk procurement and milk production could be observed for the pre-transition

period, and discuss the results of a placebo test. In addition, to address the potential concern that there may be important differences between larger groupings of regions (i.e. macroregions), in some specifications we identify the effect of supply chain disruptions by using only within-macroregion variation.

Our baseline regression takes the following form:

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

where the variable on the left-hand side denotes the natural logarithm of milk production (in litres) in region i and at time t, δ_i, and δ_t are region and time-fixed effects, respectively, X_{it} is a vector of other covariates that are 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 period, and which 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 at time t, measuring the scale of reductions in milk procurement. The binary indicator variable $POST_{it}$ is set to equal 1 in each year after the treatment and equal 0 in each year before the treatment. As such, we exclude the event years. The coefficient of interest is γ, which measures the additional output effect experienced by regions that were relatively more affected by disruptions to the supply chain after the treatment occurred (compared to those with smaller disruptions). Based on our hypothesis that dislocation to inter-firm relationships negatively affected output, we expect $\gamma < 0$.

Data

As mentioned earlier, for the purposes of this analysis, we worked with region-level data. During the process of transition from communism, Poland was divided into 49 regions (*voivodships*), and our data set covers all of these regions. In general, our analysis focuses on the 1984-1997 period. Extending it to include more recent years is not possible due to the fact that in January 1999, the number of *voivodships* in Poland was reduced to 16[10]. Unfortunately, the old *voivodships* cannot be easily transposed to apply to the new ones. In addition, our choice of 1984 as a starting date was in turn dictated by the fact that we wanted to have a five-year window before and after the treatment, which applies to the 1989-1992 period. In some robustness checks, however, we also use older data, dating back as far as 1980.

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

5. Results

Table II reports our baseline estimates of γ. Throughout the paper, all standard errors in our regressions are robust against arbitrary heteroscedasticity and serial correlation at the region level. The specifications presented in Table II, 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), in order 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 numbers serve as a proxy for lagged production,

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

Notes: Robust standard errors in parentheses clustered at the region level . 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 headings of each column 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 heading of each column in the table. ** $p < 0.05$; ***$p < 0.01$

Table II.
The dislocation of dairy supply chain and milk output: baseline results and falsification tests

and thus allow us 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 results based on the 1984-1997 sample, excluding the event years of 1990, 1991, and 1992. These results suggest that disruptions in the supply chain negatively affected milk output. According to our estimates, increasing the reductions in milk procurement by 1 per cent decreased milk production by 0.17 per cent on average.

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 supply chain disruptions is correlated with region-level trends in milk production, the estimates presented in column (1) may reflect spurious correlations. In order to make sure that our results do not just capture some other region-specific trends, in columns (2)-(4), we report the results from falsification tests, in which we checked whether the changes in milk procurement between 1989 and 1992 are correlated with changes in milk production during various periods before 1989. The coefficient estimates for *Disruptions* × *POST* in all these regressions are close to zero and insignificant. These results, in turn, suggest that the results from column (1) are driven by the specific events that we focus on rather than by unobserved trends.

In Table III, we further check the robustness of these results, by including various explanatory variables that capture the effects of initial conditions. As mentioned in several studies, these initial conditions (encompassing pre-reform distortions and socio-economic characteristics) have had an important impact on output developments in the transition context (Macours and Swinnen, 2000a; de Melo *et al.*, 2001; Falcetti *et al.*, 2002). To allow these factors to have time-varying effects, each of the covariates is interacted with time-fixed effects. Again, all of our models, except for various covariates, include region-fixed effects, time-fixed effects, and lagged numbers of cows per hectare of agricultural area (logged).

In column (1), we check whether our results are robust to controlling for the fact that part of the reduction in milk production might have been due to the collapse of state-owned and cooperative farms. As mentioned above, this was motivated by the

	(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	(5) Sample: 1984-1997 Event: 1989-1992
Disruptions × *POST*	−0.175**	−0.209*	−0.266**	−0.243*	−0.312***
	(0.078)	(0.11)	(0.12)	(0.12)	(0.12)
Other control variables (interacted with time-fixed effects)					
Share of milk from state-owned farms	Yes	Yes	Yes	Yes	Yes
Prices	No	Yes	Yes	Yes	Yes
Input suppliers	No	No	Yes	Yes	Yes
Grassland, workforce, sanitary control	No	No	No	Yes	Yes
Macroregion-year-fixed effects	No	No	No	No	Yes
Constant	3.121***	3.117***	3.119***	3.311***	3.712***
	(0.37)	(0.44)	(0.66)	(0.63)	(0.50)
Observations	490	490	490	490	490
R^2	0.98	0.98	0.98	0.98	0.99

Notes: Robust standard errors in parentheses clustered at the region level. 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 headings of each column 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). All other covariates included in subsequent specifications are interacted with time-fixed effects. For definitions of these explanatory variables see the main text. Sample period covered in the analysis is reported in the headings of each column in the table. *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

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

many studies that indicate that land privatisation was one of the main reforms undertaken in a number of transition countries (see the overview in Rozelle and Swinnen, 2004). To capture the potential impact of this phenomenon on milk output, we include in our specifications the variable measuring the share of milk procured from state-owned and cooperative farms in 1988, interacted with time-fixed effects. As reported in the table, the effect of the supply chain disruptions is still significant in this case, and is of a similar magnitude[11].

In column (2), we additionally include various price variables (again, interacted with time-fixed effects). This is done to control for the effect of price liberalisation, which resulted from the freeing of prices (initially determined by the state) and cuts in subsidies. As a consequence of these phenomena, important adjustments in relative prices were observed. We control for these by using several variables. First, in our regressions, we include the milk procurement price relative to the price that farmers could have obtained in private sales. This measure allows us also to control for farmers' outside options. As the data for prices in market transactions are not available for 1989, this variable refers to 1990. Furthermore, we include the ratio of the milk procurement price to the wheat procurement price and the ratio of the milk procurement price to the beef cattle procurement price. These variables refer to 1989. With these two variables we aim to capture the relative profitability of various agricultural enterprises. In addition, controlling for the milk/wheat price ratio can also serve as a proxy for

relative input prices. As reported in Table III, after we included these variables, the effect of supply chain disruptions was still significant, at roughly the 7 per cent, level and the point estimate was higher in absolute value.

In column (3), we additionally control for farmers' relationships with input suppliers. Therefore, we add in a variable measuring the share of cow herds being inseminated. This variable refers to 1989. Again, our results appear robust to this inclusion, which allows the effects of supply chain disruptions to be estimated slightly more precisely.

In column (4), we additionally control for initial grassland in hectares (logged), the number of people employed in agriculture (logged), and the share of milk samples disqualified due to their low quality by a sanitary control board. As these variables were not available for 1989, we used the data for 1990. The former two variables capture other production inputs than the number of cows. Sanitary control can be used to control for milk quality issues, which could also importantly affect the level of production. However, our main results remain qualitatively the same, and show that the effect of supply chain disruptions is statistically significant, at 6 per cent.

Finally, in column (5), we add in the interaction between macroregions (larger groupings of the six regions in the sample), fixed effects, and time-fixed effects. This is done in order to check whether our results are driven by the fact that some macroregions were more prone to milk output reductions and supply chain disruptions than other macroregions, for reasons not directly related to dairy production. By including macroregions' year-fixed effects, we could estimate the impact of supply chain disruptions based on within-macroregion variation alone. These impacts were not affected by potential differences between macroregions. This approach also allowed us to control for any potential shocks at the macroregion level. Again, our estimates were robust for this exercise. In fact, the point estimate was slightly higher, at the 1 per cent significance level, which reflects the fact that within-macroregion variation is greater than cross-macroregion variation.

As indicated above, our results robustly demonstrate that the dislocation of vertical linkages between upstream and downstream dairy producers negatively affected milk output. It is therefore interesting to see how much of the observed decrease in milk production could be attributed to the disruptions in supply chain. We calculated this in the following way. Our most conservative estimate of the impact of supply chain disruptions was −0.173 (see column (1), Table II). The aggregate observed milk production for 1997 (logged) was 261.7, which was 17.9 lower than in 1989. The counterfactual aggregate milk production for 1997 (excluding the impact of supply chain disruption) was computed as follows. For each region, from the actual production figures, we subtracted the estimated impact of disruptions, multiplied by the relative change in milk procurement between 1989 and 1992. We then aggregated this counterfactual production across all regions. The result was 265.4, which was 3.7 higher than the actual result. It seems, therefore, that the contribution of supply chain disruption to the decrease in output was roughly 20 per cent (3.7/17.9).

6. Conclusion

This paper contributes to the debate on the importance of the rules shaping inter-firm relationships in processes involving at least two production stages. By examining the natural experiment of changing the institutions governing the Polish dairy supply chain in the late 1980s and early 1990s, we have highlighted 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 of inter-firm

relationships. This dislocation arises from the fact that a dramatic change in governance structures may produce, at least over the short run, a sort of institutional vacuum, in which old institutions cease to exist and new ones are not yet in place. As the old system of exchange stops functioning, existing relationships between buyers and suppliers break up. Forging new relationships is then very costly, due to the 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.

As is consistent with this line of reasoning, based on within-country variation, we find that the dislocation of relationships between farmers and milk processors negatively affected milk production in the case addressed in our study. Regions that experienced the largest decline in milk procurement by the dairy industry were also those regions that experienced the greatest declines in milk output. This result is robust across various estimation techniques and the inclusion of different covariates in the regressions. According to our most conservative estimates, this channel accounts for approximately 20 per cent of the fall in milk output witnessed in the early years of the transition from communism in Poland.

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

One issue that should be noted is the fact our empirical evidence comes from Poland during a specific period of transition from a centrally planned to a market economy. Thus, we must exercise caution in making claims about external validity. Even so, we believe that the mechanisms that we have explored could be useful in providing a richer explanation for the economic consequences of reorganising supply chains. Furthermore, as has been argued by many scholars (see Pistor, 2013), there is still a great demand for policy-relevant lessons from the transition processes of the past, as new transitions continue to occur (e.g. the Arab Spring or the institutional changes in developed countries forced by tensions related to the recent financial crisis). We hope that this paper may provide at least some insights in this respect.

Notes

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

2. While we do not provide a general literature review of the restructuring of Central and Eastern European agriculture in the 1990s, we refer the reader to existing reviews. An excellent survey of the literature on agricultural transition is that of Rozelle and Swinnen (2004). Other studies giving broad overviews include those of Swinnen *et al.* (1997), Lerman *et al.* (2004) and Swinnen and Rozelle (2006). Interested readers may also want to consult shorter papers, such as those of Sarris *et al.* (1999), Csaki (2000) and Lerman (2001).

3. 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), and Marin and Schnitzer (2005).
4. Analysing long-run effects is not possible since the most recent region-level data are not comparable to the data for earlier years. This is due to the administrative reform that took place in Poland in the late 1990s, which transformed the previously existing 49 regions into 16 larger administrative units.
5. The remaining part was sourced from state and collective farms. We return to this point below.
6. According to the Polish Central Statistical Office, in 1991, farms with less than six cows accounted for roughly 83 per cent of the total cow herds, and for roughly 95 per cent of all farms producing milk. As reported by Seremak-Bulge (2005), the average number of cows per farm in 1990 was roughly 2.7.
7. Unfortunately, conducting a similar analysis for the shift in direct sales between 1989 and 1990 is impossible, due to a lack of data on prices in market transactions in 1989.
8. These estimates do not include milk used for butter production.
9. In fact, this trend was reversed only in 2006 (GUS, various volumes).
10. Data on the year 1998 is also not available, as the Polish Central Statistical Office reported most of the data for that year under a new administrative division.
11. As an alternative, in other specifications (not reported) we focused on the pre-reform share of agricultural land operated by state and collective farms. Our results remained robust after the inclusion of this variable.

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