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Asymmetric Price Transmission in Dairy Supply Chains

DairyCo

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Executive Summary

Recent years have seen significant levels of commodity price volatility. This means the interaction of prices in the dairy supply chains is of critical importance to the competitiveness of participants within those chains. This study considers whether prices move in a broadly symmetric¹ fashion in the chains and, if not, which market participants are likely to benefit or be penalised by asymmetric price movements. It is important to remember that asymmetric price movements will not always represent a problem – cost-related contracts, for example, are designed so that they do not track prices in other parts of the supply chain and hence we would not expect symmetric pricing in these cases.

The study considers price movements in the milk commodity, cheese and liquid milk supply chains using data from as far back as 1990. It finds at least some evidence of asymmetric pricing in all of the supply chains investigated. The strength of the evidence in each chain varies, with some only demonstrating asymmetric pricing for a small part of the period investigated and others showing it for much longer periods. The incidences of these types of price movements also vary between the parts of the supply chain considered – with some illustrating asymmetric movements between farmer and processor while examples are also highlighted between processor and retailer.

A key message from the investigation is that, where asymmetric price movements have been identified, they are never to the benefit of the farmer. This is mainly because the study shows that, in all cases, farmers are price takers who are unable to influence relevant wholesale prices. Instead, the greater bargaining power of other market participants in the chains means that, at times, they can ensure they benefit from price movements by taking certain actions.

A policy maker who is keen to avoid the effects of asymmetric price transmission on farmers in the dairy markets would need to consider ways in which their bargaining power could be increased. One method by which this could be achieved is assessing the standard structure of contracts between farmers and milk buyers. Current contracts that exist between processors and farmers often omit details on agreed price levels and/or price-setting formulas, have long notice periods and do not specify how future changes in terms and conditions are to be negotiated. Current contracts are more akin to a “licence to supply”. Contracts would be less likely to lead to asymmetry if the mechanism for setting prices was known and agreed by both farmer and milk buyer. Any subsequent changes to this system or the price paid are also then agreed by both parties (with the contract ending or not being renewed if that is not the case) and appropriate, agreed notice periods existed throughout.

¹Where prices interact as part of a supply chain, a symmetric price reaction would mean that a movement in one price would lead to an equivalent movement in a related price after a standard delay. If the related price fails to move, moves at a different rate or moves after an unusual delay period, the reaction can be thought to be “asymmetric.”

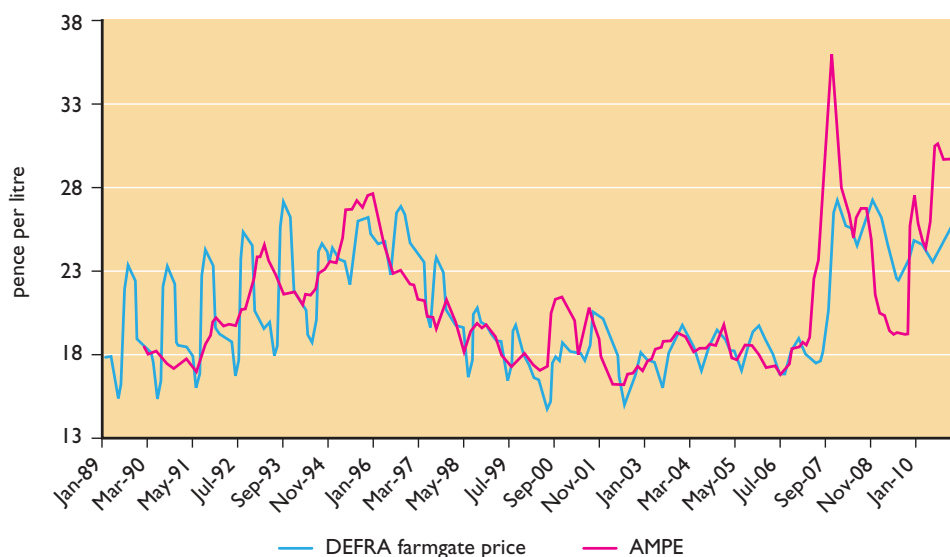
Section 1: Introduction

A well-functioning supply chain is essential for a market to operate efficiently and equitably. For this to be the case, it requires information on the market to be effectively transmitted from one part of the chain to another. Information on market conditions faced by all parts of the chain ideally should be available to all. This study focuses on dairy supply chains and considers whether price signals are flowing effectively from one part of a chain to another and hence whether some parties are able to benefit from price movements at the expense of others.

Market participants will be interested in this for two reasons. In the short term, relative profits can be heavily influenced by such phenomena and this can make a large difference to a market participant's bottom line. In the longer term, the ability of a particular actor in the supply chain to benefit disproportionately from price movements may damage investment and innovation in other parts of the supply chain to the ultimate detriment of customers – for instance, farmers may take less risks in their investment decisions if they know that they may not be able to capture all of the benefits of a future price increase and this may affect future production and price levels.

The study also looks at whether the ability of certain market participants to benefit relatively more than others from price movements has altered over time. In Graph 1, Actual Milk Price Equivalent (AMPE), which measures returns made from butter and SMP in pence per litre (ppl), is plotted against the UK average farmgate price. The graph shows that the relationship between the two prices altered after 2007, with a much larger separation between the two prices, and this reflects the large increase in volatility seen in the market in this period. This is one example of how the pricing dynamics in the market have changed over time. Hence, in addition to establishing whether or not asymmetric price transmission occurs, this report also considers whether the amount of disproportional benefits that can be accrued by certain market participants as prices move, has changed in recent years.

Graph 1: AMPE vs UK farmgate price



Source Dairy Co/Defra

The report will be structured as follows. After this short introduction, Section 2 will introduce the concept of price asymmetry and discuss how it may occur. Section 3 briefly sets out the study methodology before a summary of key results is provided in Section 4. Section 5 provides conclusions and recommendations.

Section 2: Price “Asymmetry”

Prices in a supply chain can be defined as “asymmetric” if they move in the same direction but not at the same time.

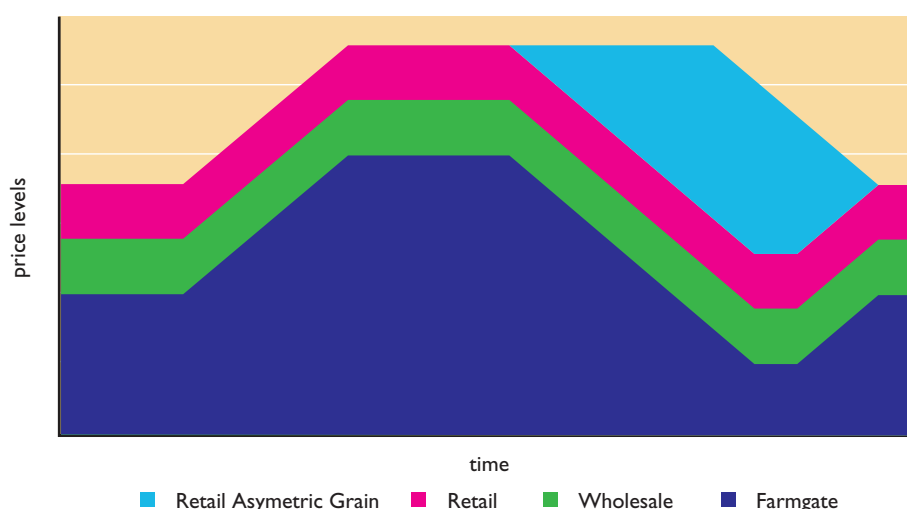
Usually, a price movement in one part of a supply chain will result in a similar price movement in another related part of the supply chain, after a typical delay or “lag” period. Some sort of lag period of this kind is to be expected – for instance, the costs involved with changing prices (often called “menu costs”) often discourage supply chain participants from doing this until the price change has reached a particular level or has been sustained for a certain period of time. However, *asymmetric* price movements occur when this lag period is unusual (for instance, a price in one part of the chain takes a very long time to react to a change in another) and/or when price changes occur at different rates in different parts of the supply chain.

The simplest example of price asymmetry is when the reaction of one price to movements in a related price is delayed. For instance, Graph 2 shows farmgate and wholesale prices falling but there is a period of time where retail prices remain unchanged. Over that period, retailers will be benefitting from the price fall and, unless the same happens when prices rise again, prices have moved “asymmetrically.”

Price movements of this kind can occur for a number of reasons. It is often suggested that they are a result of the market power that a particular market participant possesses. While this may be the case in certain supply chains, it is certainly not the only reason for asymmetric pricing. It can reflect differing access to market information or different cost structures, to name just two. A key example of where asymmetric pricing is not a result of differences in bargaining power is in the presence of dedicated, production-cost based farmgate contracts, such as those currently offered by Tesco. The drivers of prices in these contracts are designed to be separate from the drivers of AMPE, for example, and so it would be logical to expect asymmetric pricing to occur in the case of AMPE v price on this contract.

The example of dedicated, production-cost contracts also shows that asymmetric pricing may not always cause an efficiency problem in the supply chain. However, given that in 2010 these contracts only covered circa 9% of the raw milk produced in GB², we would expect that in many cases asymmetric pricing *will* result from some form of market failure and will disadvantage one or some parts of the supply chain. The key issue from a policy-makers point of view is whether the damaging cases of asymmetric pricing are systematic and whether something can be done to reduce occurrences of them.

Graph 2: Asymmetric pricing – An example where the retailer gains



Source AHDB/Dairy Co

²Plus those on production cost-based contracts may still have some market-related elements in the agreement with the purchaser, which may affect the milk price received. They may also produce milk above the contract requirements, in particular periods, which will then be paid a market-determined price.

Section 3: Study Methodology

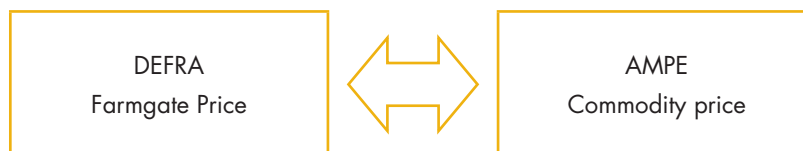
A detailed account of the statistical framework which produced the results of the study can be found in the University of Portsmouth's technical report (available via www.dairyco.org.uk). The framework generally looked at four areas:

- The causality of price changes – e.g. do wholesale prices determine farmgate prices or vice-versa?
- The timing of price changes – is there a normal time “lag” that we would expect for changes in wholesale prices to be reflected in farmgate prices?
- Short-term price asymmetry – is there evidence of “pockets” of asymmetric pricing where particular market conditions have prevailed?
- Long-term price asymmetry – is there statistical evidence that there are sustained periods where prices movements are not proportionate?

Data was analysed using a number of different data sets, of varying length. Some datasets cover 1990-2010 while others only cover the 2007-2010 period. Generally, the longer the dataset, the more robust the results. Three main supply chains were investigated and details of these are set out individually below.

Farmgate and AMPE

This relationship is being tested both to gain insight into the relationship between farmgate raw milk prices and butter/SMP values and also to investigate the link between farmgate values and commodity prices more generally. AMPE provides an indicator of the floor of the wholesale milk market and is seen to be a good indicator of current market sentiment, since it is sensitive to variations in milk supply and demand at an EU or global scale. This is because butter and SMP are storable and tradable products and not as perishable as liquid milk. AMPE measures the value of milk at the factory gate for producing butter and SMP. Although the two products account for less than 10% of UK raw milk usage, that usage is often the marginal part of the market so can have a strong influence on prices



The period from 1994 to 2010 is investigated. The data used to represent the UK farmgate price is the Defra average farmgate price. It is the average of the actual price that all UK dairy farmers receive when selling ex-farm milk. It should be noted that this average will mask some important variations between farmers, especially in the last few years.

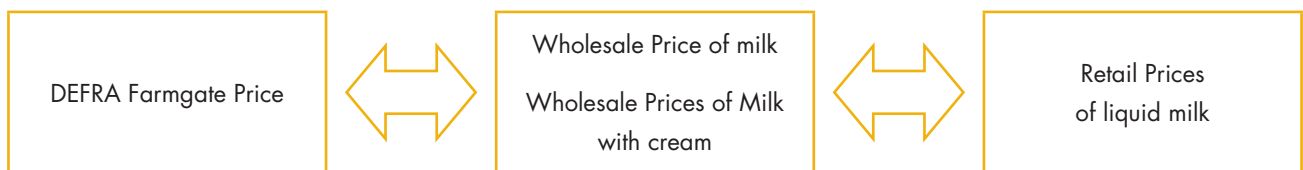
Cheese



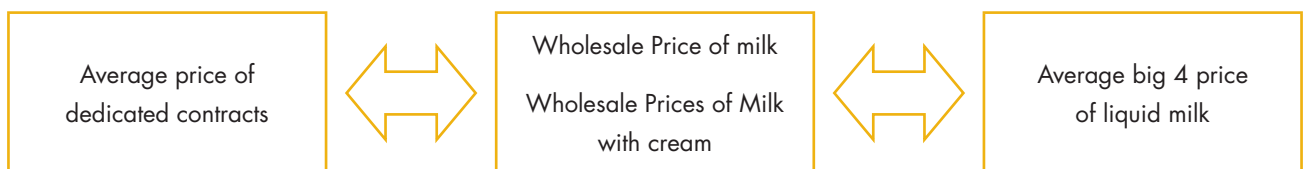
In the case of cheese (and also the liquid milk chains) we are interested in the links between actual market values throughout a working supply chain. To achieve this, we consider a number of different linkages involving the Defra farmgate price, the average price of the four largest contracts at the farmgate level³, the mild and mature Cheddar wholesale prices and the mild and mature Cheddar retail prices. We are also looking at the link between these farmgate and retail prices and the Milk for Cheese Value Equivalent – MCVE⁴. Datasets in the cheese area vary in size with some covering the whole 1990-2010 period (e.g. the Defra farmgate price) and others only focusing on 2005-2010 (e.g. the average price of the four cheese contracts). The longer the dataset, the more robust the results from that dataset are likely to be.

Liquid Milk

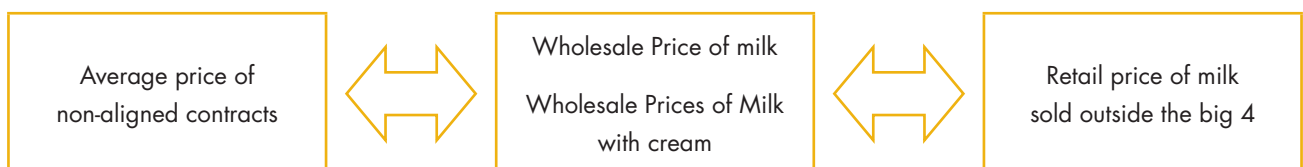
Finally, the third group of tests looks more specifically at the liquid milk market: over the period of 1995-2010, the UK Defra farmgate price has been tested against the wholesale prices of milk, the wholesale price of milk with cream and the average retail price of liquid milk using Kantar data. Liquid milk travelling through this supply chain accounted for 52% of the milk produced in the UK in 2010/11.



With most of the larger retailers having set up aligned supply chain with farmers from 2007, it was decided to investigate further how these changes have impacted the market for that period. Split into two sub-groups, one series of tests looks into the dedicated supply chains using an average price between the largest retailer aligned contracts: Asda, Tesco, Sainsbury's and Morrison's representing around 40% of the raw milk going into the liquid milk market. This average price has been tested against the wholesale price of milk, the wholesale price of milk and cream and the average retail price of liquid milk in Asda, Tesco, Sainsbury's and Morrison's. As the dataset in this area only covers 2007-2010, compared to the much-longer dataset for cheese and butter/SMP, it means that the aligned milk results are likely to be less robust than others in the study.



The second sub-group concerns the non-aligned market, consisting of Arla non-aligned, Dairy Crest Liquid and Wiseman Partnership or around 20% of the raw milk going into the liquid milk market. This is tested against the wholesale price of milk, the wholesale price of milk and cream and the average retail price of liquid milk, excluding the big 4 (Tesco, Sainsburys, Asda and Morrisons). Again, data in this area is only available from 2005-2010 and so results must be treated with caution.



³Based on the Dairy Co standard litre, the four largest cheese contracts: Dairy Crest Davidstow, First Milk cheese contract, Milk Link manufacturing and the Lactalis/Caledonian cheese contract account for approximately 60% of milk processed into cheese in the UK. A total of 27% of UK milk was used to produce cheese in 2010/11.

⁴MCVE provides an indication of the value returned by processing milk into mild Cheddar and its associated by-products. It is based on the mild Cheddar wholesale price and hence calculates the returns from the bottom of the cheese market. It is important to remember that cheese production involves two by-products – whey powder and whey butter – which are not sold on to retailers but can be sold to other food manufacturers and therefore may affect pricing decisions.

Section 4: Study Results

This section will set out the highlights from the study results, including discussion on the direction of price setting, the presence of asymmetry and the time period that it exists. For detailed results, please refer to the University of Portsmouth full technical report.

Farmgate against AMPE

Results show that the usual direction of price setting for this relationship is from AMPE (i.e. the value of the dairy products on the wholesale market) to farmgate and this would seem logical since milk is a perishable product. Asymmetry in price movements from AMPE to farmgate is detected from 2000 onwards.

The asymmetry suggested by the results for this direction of price flow suggests that farmers may have been relatively disadvantaged by price movements since 2000, compared to other parts of the chain. The results also suggest that the level of asymmetry has risen since prices became more volatile in the post-2007 period. Farmgate prices are often believed to track AMPE very closely and while these results reinforce this assumption for the period before 2000, they call it into question for the period after this date.

The year 2000 coincides with the dismantling of Milk Marque, a farmer co-operative which collected more than 50% of the milk in the UK. This may provide some explanation as to why price transmission became asymmetric from 2000. Milk Marque included a large number of milk producers and its size and influence meant that it had a significant level of bargaining power. This increased the ability of farmers to receive a price in line with returns from the commodity market. Without Milk Marque, farmers may have lost some of that bargaining power and hence become weaker stakeholders in the supply chain. This may partly explain why since 2000, farmers are losing out on commodity market returns.

The model also suggests that the asymmetry has become stronger since 2007. There could be two reasons for this. The first reason is that commodity prices have become much more volatile in the last three years. Increased volatility in prices provides more opportunities for a stronger stakeholder in a supply chain to exert its market power, which can lead to asymmetric price movements. This sort of asymmetry is likely to disadvantage farmers, relative to processors.

The second reason is that a few cost-based contracts have arisen since 2007 and the design of these is likely to result in at least some level of asymmetric pricing compared to AMPE. This is because, by nature, these contracts are strongly related to farmgate production costs and are less related to the wholesale market and other prices in the supply chain. Hence, it would be no surprise if farmgate prices do not respond symmetrically to other price changes in the supply chain – as they're not set up to do so. These contracts are designed to ensure a sufficient farm return to guarantee future supply for retailers and so are likely to be of much less concern to policy makers. In 2010, approximately 9% of the raw milk produced in GB was done so under a cost-related contract.

Cheese market

After having investigated the price transmission between farmgate price and market returns from commodity markets, we now consider two examples of actual supply chains: cheese and liquid milk, which together represent more than 75% of the milk collected in the UK. In the cheese supply chain, farmers will supply raw milk to a processor with its equivalent value being represented by the Milk for Cheese Value Equivalent (MCVE) or the actual market value being represented by the wholesale prices for mild and mature Cheddar. The cheese that is produced is then sold to retailers or food manufacturers.

Farmgate and Wholesale prices

The results show that, as for the farmgate and AMPE relationship, the direction of price setting in the first part of the chain flows from processor to farmer. So, changes at wholesale level will lead to changes at farmgate level. The results suggest that the influence of wholesale prices over farmgate prices is seen to be even stronger in the cheese market than it was in the farmgate/AMPE relationship.

There is partial evidence of price asymmetry in the cheese supply chains investigated. For instance, comparing the mild Cheddar wholesale price or MCVE with the four cheese contracts price suggests some periods of asymmetry from 2007 to 2010. Overall, there is evidence of some price asymmetry between farmer and processor in the cheese market but it is by no means consistent over time and throughout the whole market.

Wholesale and Retail prices

In this part of the chain, the direction of price setting appears to run from retailer to processor for mild Cheddar but in the other direction for mature Cheddar. This could be a function of the different level of bargaining power that processors possess in the two markets. For mild Cheddar, production periods are shorter and imports are more prevalent – meaning that retailers have plenty of other options if UK processors do not supply them with cheese at the price they want. Conversely, some strong brands exist in the mature market and are related to the processors and production processes of the cheese involved with them. This restricts the ability of retailers to substitute away from a particular processors' cheese, if it is being offered at a less attractive price. This inability to substitute transfers some bargaining power to processors.

It is important to note that it is bargaining power *relative* to retailers that is being discussed here. This will also be a function of the structure of the retail market. For instance, the level of bargaining power of all processors in all chains will be relatively lower if there is a highly powerful and consolidated retail sector. This does not prevent processors in one chain having more influence than processors in another chain however, depending on the prevailing market conditions and as is indicated by the mild and mature Cheddar results.

Occurrences of asymmetry were sporadic in the cheese markets. There was evidence in the mild Cheddar supply chain, where asymmetry was seen to exist between retailers and processors before 2002 and between 2005 and 2006. However, many of the relationships tested showed no evidence of price movements of this kind.

Liquid milk

The liquid milk supply chain sees liquid milk produced by farmers, delivered to processors and then bought by retailers for consumer purchase. Processing of raw milk, as part of this chain, also leads to the production of cream, which is why some of the relationships tested include "milk with cream" prices. Also included in the tests, are dedicated and non-dedicated supply chains – these have become more common in recent years and the study also considers if they have had an impact on occurrences of price transmission.

Farmgate and Wholesale prices

The price relationship between farmer and processors can be measured in a number of ways, given the number of different types of product and contract in the market. In this study, we consider wholesale milk, wholesale milk with cream, non-aligned contracts, dedicated contracts and the average of a set of dedicated contracts. In all cases and similar to the cheese market, the direction of price setting in this part of the chain flows from processor to farmer and not vice-versa. Hence, farmgate prices are likely to take the lead from wholesale prices to a large extent and not the other way round.

There is evidence of price asymmetry when Defra farmgate prices are compared with wholesale liquid milk and liquid milk with cream values over the period of 1995-2010⁵. However, where the average of aligned/non-aligned farmgate prices are compared with wholesale milk (and milk with cream) prices, there is no evidence of asymmetry detected at all. This could be a result of smaller datasets – the aligned/non-aligned datasets cover a maximum of five years only, while the Defra farmgate dataset covers 15 years. It is more difficult to find evidence of statistically-significant price asymmetry where smaller datasets are considered. Equally, it could also be a result of the liquid milk market becoming a distinct segment with no direct link to the commodity market. This would suggest that there are barriers to raw milk from farmers moving between the different markets.

Wholesale and Retail prices

In the long term, within the processor and retailer parts of the chain, price direction is usually seen to flow from processor to retailer. Looking at the total market over 1995-2010, there are examples of asymmetry that can be identified in this part of the chain, relating both to the rate of change of prices and the time periods price changes occur in. These examples occur when wholesale milk, wholesale milk with cream and the weighted average of retail milk prices are considered.

Considering segments of the market over the 2007-2010 period, there is no evidence of asymmetry in cases involving the big 4 (Tesco, Sainsburys, Asda, Morrisons) retailers' prices or the total retail market minus the big 4 retail prices. This could be a function of smaller datasets for these parts of the liquid milk market and may mean that the results for them are less robust. Equally, it could be a genuine trait of these parts of the market which would be confirmed if a larger dataset was examined. Prices change a little slower in the big 4 retail market segment when these contracts are considered, compared to other cases in this part of the chain and this may reflect the longer-term nature of the contracts.

⁵This asymmetry is related to the rate of change of prices only. Refer to the University of Portsmouth technical report for more details.

Section 5: Conclusion and Recommendation

The major conclusion to this study is that where asymmetric price transmission does occur across the dairy supply chain, it is never to the benefit of UK farmers. This applies in the AMPE/farmgate relationship, the cheese supply chain and the liquid milk supply chain.

It is clear that UK farmers have been affected by asymmetric price transmission over the time period investigated. This may not always be a problem, especially in the case of recent dedicated, production cost-based farmgate contracts, such as those offered by Tesco. However, it can be expected that, in the majority of cases, asymmetric price movements have disadvantaged farmers in the related supply chain, in the long run. The question posed by this is what farmers can do to reduce occurrences of price asymmetry in the various supply chains.

If the policy maker is looking to reduce the occurrences of asymmetric price transmission, one option could be to consider the structure of contracts between market participants. This is because underpinning the ability to react in an unequal way to price movements in other parts of the chain is the level of bargaining power the market participant holds. Bargaining power in supply chains can be seen to be a function of the relative size of the firms involved and the conditions in which they trade, among other factors.

Contracts and the conditions that are stipulated in them affect the environment that the dairy industry trades in, and hence contribute to the level of bargaining power market participants possess. Current contracts that exist between processors and farmers often omit details on agreed price levels and/or price-setting formulas, have long notice periods and do not specify how future changes in terms and conditions are to be negotiated. Current contracts are more akin to a “licence to supply”. Contracts would be less likely to lead to asymmetry if the mechanism for setting prices was known and agreed by both farmer and milk buyer, any subsequent changes to this system or price are also then agreed by both parties (with the contract ending or not being renewed if that is not the case) and appropriate, agreed notice periods existed throughout.

Hence, if the policy maker was looking to reduce the likelihood of asymmetric pricing, addressing these types of issues in the standard terms and conditions that exist in dairy contracts would go some way towards meeting this objective.

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