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ESTABLISHMENT OF FARM PRICES AND DEGREE OF LINKAGE WITH CONSUMER PRICES[*]

submitted to the

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ESTABLISHMENT OF FARM PRICES AND DEGREE OF LINKAGE WITH CONSUMER PRICES

1. INTRODUCTION

Real agricultural producer prices have been declining during the last one hundred years at an impressive rate. It is generally accepted that this trend can be attributed to rapid technological change that makes supply increase faster than demand (*e.g.*, Gardner, 1992, p.63). However, the size of price spreads in agri-food markets has been a controversial issue in the recent past. A lot of attention has been devoted to the evolution of the farm share in each dollar of food purchases (*e.g.*, Elitzak, 1996; and Martz, 2004).

The high degree of concentration at the retail, food processing and farm input manufacturing levels are often identified as the most important contributing factors to explain increases in retail-to-farm price spreads. Agriculture and Agri-food Canada red meat market information website[*] reports that the market share of the four largest firms, known as CR4, has increased from 53% to 88% between 1992 and 2004 in the Canadian beef packing industry. Similarly, the CR4 went from 51% to 74% between 1992 and 2004 in the pork packing business. In Quebec, the two largest pork processors have agreed to merge. If the merger is approved by Canada's Competition Bureau, the new entity will slaughter in excess of 70% of the provincial hog supply.[†] A similar trend is present in the United States. Hendrickson and Heffernan (2005) report that the CR4 is 83.5% for the U.S. beef packing industry, 64% for the U.S. pork packing industry, 34% for the U.S. animal feed industry and 63% for the flour milling industry. They also

[*] Information is available at: www.agr.gc.ca/misb/aisd/redmeat/almrcalendar.htm (April 18, 2005).

[†] One problem with the CR4 is that a given score can be achieved through very different market configurations. For example, a CR4 of 0.8 may arise when the four largest firms have identical market shares of 20% or with a dominant firm with a market share of 71% and identical market shares of 3% for the second, third and fourth largest firms. It is generally believed that the latter scenario is more conducive of non-competitive business practices.

report that Monsanto and Pioneer control 60% of the U.S. corn and soybean seed market and that the concentration ratio for the three largest firms (CR3) for the U.S. soybean crushing industry is 71%.

At the retail level, the situation is not much different. Two or three retailers get most of the Canadian consumers' food dollars in any given region. The CR4 statistic at the Canadian food retail level was 61% in 2002 (Lambert, Criner and Rancourt, 2004). On the other hand, Wal-Mart Stores, Kroger Co., Albertsons, Safeway and Ahold USA had a combined share of the U.S. food retail market of 54%, which is more than twice the 1997 CR5 of 24%.[‡] It is also worth noting that U.S. food retailers have secured large market shares in other countries. Wal-Mart is the third largest retailer in the United Kingdom and second in China while Ahold is number one in the Netherlands. French food retailer Carrefour is also a global retailer, being the second largest retailer in Brazil and the top retailer in Argentina and China. This portrait of the agri-food complex is a far cry from a competitive sector involving large numbers of buyers and sellers sometime found in introductory economics textbooks.[§] Still, imperfect competition does not mean no competition and firms with large market shares may face strong challenges from existing firms or from potential new entrants.

The evolution of the processors' and retailers' margins has been most topical in all regions of Canada in the wake of the Bovine Spongiform Encephalopathy (BSE) crisis. Many agricultural economists were called to explain why the prices received by beef and dairy producers had declined so much more than the prices received by processors and retailers for

[‡] Note that the CR4 is likely to overstate the actual degree of competition as it is often the case that all of the grocery stores in a given town are owned by one or two companies. Moreover, concentration ratios are dependent on the geographical boundaries used to measure market shares. Market size should be determined by the relevant market for a specific commodity and thus concentration ratios can vary considerably depending on the assumptions used.

[§] One can also wonder why agricultural economists are so keen to analyze domestic and trade policies with the standard three-panel apparatus.

ground beef and other beef cuts. The market for culled cows literally crumbled after the announcement of the first BSE case in May of 2003 and it has not recovered since. The prices paid since May 2003 by the only slaughterhouse in Quebec are about 25% of the prices observed in 2002. Rumours of above normal profit motivated Quebec dairy producers to buy a controlling stake in the enterprise, but the announcement of a takeover in October 2004, have been followed by long and difficult negotiations. The situation in Western Canada was very similar at the beginning of the crisis, but the opening of the border for boneless meat produced from animals less than 30 months old has put significant upward pressure on prices. The closing of the border to live bovine animals has created a capacity problem all across Canada and this is why the Federal government has decided to encourage expansion through a $66.2 million program.[**] Federal and provincial investigations were also launched to determine whether meat packers profited unfairly from the mad cow crisis. While the BSE crisis has revived concerns about margins throughout the food supply chain in Canada, it should be emphasized that such concerns have a long history as they have been the driving force behind the creation of powerful marketing boards, large cooperatives and state trading enterprises like the Canadian Wheat Board.

To some, the increasing concentration at various levels of agri-food marketing chains is simply a natural response to increasing global competition and technological advances that keep on increasing the minimum efficient scale of production. In this context, increased concentration levels can bring about welfare improvements through lower average costs passed on to consumers and to agricultural producers. On the other hand, increases in concentration in domestic markets can have adverse consequences because of the market power that could potentially be exploited. Much of the empirical literature on market concentration has focused on

[**] The interested reader can get details at: www.agr.gc.ca/cb/index_f.php?s1=n&s2=2004&page=n40910a.

this trade off (*e.g.*, Azzam and Schroeter, 1995; Azzam, 1998; Lopez, Azzam and Lirón-Espana, 2002). However, the role of government, to improve efficiency along the food supply chain, or to alter the redistribution of the gains from trade, is typically ignored.

The specific objectives of the current research project are:

1) to review the theoretical and empirical aspects of the literature pertaining to the determinants of price spreads;
2) to analyze the evolution of prices at the farm, wholesale, and retail levels for selected commodities and regions;
3) to determine whether retail prices have grown at a faster rate than farm prices using a trend analysis.

To achieve the first objective of our study, we will discuss the impact of trade openness, exchange rates changes, the likelihood of "hold ups" in light of long production lags and the perishable nature of many agri-food products, collusion, price cycles and dumping, and product differentiation. The second and third objectives will illustrate the degree of control, if any, that agricultural producers have over their share of consumers' food expenditures (both within and outside of supply management sectors). Price spreads will be measured from a number of different farm, wholesale and retail products and trend analyses will be conducted to assess the extent by which the rates of growth of prices along various supply chains have diverged over the years. The commodities covered in the empirical analysis are: 1) butter, cheese and raw milk; 2) chicken; 3) hogs and pork meat; 4) cattle and beef 5) grains and bakery and cereal products; and 6) fresh vegetables. The OECD Producer Support Estimates (PSEs) for one commodity (pork) will be used to account for per unit commodity specific government payments when analyzing

price spreads. The objective is to determine whether including per unit commodity specific government payments into price spreads analysis is a defensible measure and what it measures.

2. MARGIN DETERMINATION: THEORETICAL CONSIDERATIONS AND EMPIRICAL EVIDENCE

The "one-size fits all" approach

The early literature on price and margin determinants in the agri-food sector was dominated by contributions from Fox (1951), Buse and Brandow (1960), Waugh (1964) and Gardner (1975). Wohlgenant (2001) provides an exhaustive review of marketing margin determinants in a perfectly competitive framework. Marketing margins (m) can be loosely defined as the difference between retail (m) and farm (f) prices: $m = p - (Q_f / Q_r) f$; where the ratio of farm output to retail output (Q_f / Q_r) is assumed constant.[††] An analysis of marketing margin determinants should focus on the determinants of farm and retail prices because the difference between these two prices yields the equilibrium price spread. For all practical matters, price spreads and marketing margins are equivalent concepts are used interchangeably in the document.

The difference between the retail and farm prices (adjusted for yield) equals the unit costs of assembling, processing, distributing and retailing foods plus profits at the wholesale and retail levels of the market. The concept of price spreads is closely linked to the concept of value added functions in the economics literature (Wohlgenant, 2001 and references therein). The nature of unit costs that firms must recover in these price spreads are different across sectors (retail versus

[††] Wohlgenant (1989) and Goodwin and Brester (1995) tested the assumption of a constant farm to retail output ratio. They found significant evidence that there is substitutability between farm products and marketing inputs. Input substitution can occur because of the reduction of wastage of the raw product when the price of the farm input raises. Substitutability can also occur because firms have the opportunities to choose among different production processes or technology.

processing) and vary across commodities. Generally speaking, input costs include expenses in capital, labor, material, energy and other production factors.

The purpose of this section is to gradually introduce the many factors that influence price spreads besides the obvious exogenous variables such as input costs and demand shifters.[‡‡] Unlike Wohlgenant (2001) who first considers perfectly competitive markets, we start off with a stripped-down model of imperfect competition at one level of the market. It seems most pertinent to immediately admit the presence of imperfect competition given the overwhelming evidence of increased concentration at the processing and retail levels.[§§]

There are many papers on the market power-efficiency trade-off that arises when industrial concentration increases. Many of these papers are discussed in Whitley's (2003) review of the gains and losses from agricultural concentration. We will begin our discussion with his model which is representative of what has typically been done. Assuming a fixed proportion technology[***], Cournot conjectures, product homogeneity and absence of international trade, the profit of a representative marketing firm can be written as:

$$p(Q)q_i - cq_i - f(Q)q_i \qquad (1)$$

[‡‡] Input costs are often times considered exogenous to the retail and wholesale food sectors because firms. For example, individual retail firms do not have any impact in the labour market equilibrium and are thus price takers in terms of wages. Similar arguments can be made for packaging materials and other inputs. Demand factors are also deemed exogenous to the industry because they are thought to be function of consumers' structural preferences. However, firms can try to influence consumers' preferences through advertising and other promotional efforts.

[§§] Besides the concentration trends identified in the introduction, there is growing evidence of market power in some agri-food supply chains. Fulton and Yang (1999) found significant market power in the Canadian chicken industry although they were unable to exactly pinpoint the nature of the market power along the supply chain. Chen and Weerahewa (1998) examined the implications of oligopolistic behaviour by Canadian dairy processors. Gohin and Guyomard (2000) found market power in French retail dairy markets. Liu, Sun, and Kaiser (1995) found evidence of market power exercised by U.S. fluid and manufactured dairy processors. Conversely, an earlier study by Holloway (1991) found no departure from perfect competition for eight commodity groups in the U.S. The previous studies constitute an incomplete list of reports that analyze and test for imperfect competition in agri-food supply chains.

[***] This implies that there is an input that is necessary to have to produce the output. For example, it takes live hogs to produce pork meat or milk to produce cheese. Live hogs and milk are used in fixed proportion with a bundle of other inputs, like capital, labour, energy and materials, which might be substitutes or complements for one another.

where the output price $p(Q)$ depends on industry output *Q*, which is the sum of the individual firms' output $\left(Q \equiv \sum_j q_j\right)$ and $w(Q)$ the farm inverse supply. The *n* marketing firms offer a marketing service for the farm products that can involve a combination of processing, distributing and retailing activities. For simplicity, the marginal cost of the marketing firms is constant at *c*. This parameter takes account of all marketing input costs such as transportation, labour, machinery, *etc.*

For further reference, define $\varepsilon^D \equiv (\partial Q/\partial p)(p/Q) < 0$ as the elasticity of demand and $\varepsilon^S \equiv (\partial Q/\partial f)(f/Q) > 0$ as the elasticity of agricultural producers' supply. The demand elasticity is function of consumers' taste parameters (*e.g.,* seasonality) and other shifters (income, price of substitute goods) that are thought to influence demand at the retail level. Similarly, the farm supply elasticity includes parameters and shifters that likely influence farm supply (input costs, etc.)

Imposing the concept of symmetric firms after the derivation of the first order conditions (*i.e.,* $Q = nq$), the behaviour of the representative firm can then be captured by:

$$p\left(1+\frac{1}{n\varepsilon^D}\right) = c + f\left(1+\frac{1}{n\varepsilon^S}\right) \tag{2}$$

which implies the following marketing margin :

$$p - f = c - \left(\frac{p}{n\varepsilon^D} - \frac{f}{n\varepsilon^S}\right) \tag{3}$$

The above allows the marketing firms to exploit the demand from retailers and the supply of producers. For example, it can be shown that an increase in ε^D (which implies that the demand is more inelastic given it is a negative number) will increase the marketing margin. Marketing firms will be able to extract more surplus from consumers if the demand becomes

more inelastic. Conversely, if the farm supply becomes more elastic (*i.e.*, an increase in ε^S), the marketing margin will shrink. It can also be shown that an increase (decrease) in marketing costs (through a change in the parameter *c*) will increase (decrease) the marketing margin, albeit in lesser proportion. Hence, if marketing firms face higher costs, they will pass on this increase to retailers and producers in the form of higher and lower prices respectively. However, market conditions and the nature of competition (*e.g.* number of firms) will influence the degree to which the change in input costs will be passed back. For example, if markets are perfectly competitive in the sense that the marketing firms are facing perfectly elastic supply and demand functions from retailers (remember that we are assuming a closed economy), the change in input costs will result in an identical variation of the retail to farm price spread. Finally, a decrease (increase) in the number of firms will increase (decrease) the marketing margin. The rationale is that an increase in the number of firms will stiffen competition and thus will increase the incentive to produce more; in turn yielding higher prices to producers and lower prices to retailers/consumers.[†††]

The welfare effect of an increase in concentration (*i.e.*, a decrease in *n*) can be evaluated by adding up the changes in consumer surplus, producer surplus and processors' profit. Efficiency gains can be simulated by reducing the parameter *c*. Relaxing the Cournot and symmetry assumptions, eq. (2) can be rewritten as:

$$p\left(1+\frac{\theta_i}{\varepsilon^D}\right)=c_i+f\left(1+\frac{\gamma_i}{\varepsilon^S}\right) \qquad (4)$$

where $\theta_i \equiv \left(\partial Q/\partial q_i\right)\left(q_i/Q\right)$ and $\gamma_i \equiv \left(\partial Q/\partial q_i\right)\left(q_i/Q\right)$ are the so-called conjectural elasticities (Bresnahan, 1989). The idea is that these parameters can replicate a number of different

[†††] A proof of these statements can be obtained by totally differentiating the set of *n* first-order conditions in order to find the impact of an exogenous shifter on the equilibrium output of the marketing firms. In a second stage, we use the fact that the retail and farm prices are respectively negatively and positively correlated with output.

equilibria in imperfectly competitive settings. Replacing c_i, θ_i, γ_i by "average parameters" $\bar{c}, \bar{\theta}, \bar{\gamma}$, the marketing firm's mark-up in (4) can be estimated simultaneously along with demand and input shares equations on industry-level data. Parameter estimates for $\bar{\theta}$ and $\bar{\gamma}$ of zero imply that processors behave competitively. As such prices paid to producers and received from retailers are not distorted by the existence of market power. Values for $\bar{\theta}, \bar{\gamma}$ of 1/*n* are consistent with the symmetric Cournot equilibrium since $\partial Q / \partial q_i = 1$ is the Cournot conjecture while values of 1 replicate a monopoly-monopsony equilibrium.

Lopez, Azzam and Lirón-Espana (2002) used the above framework to evaluate the market power-efficiency trade off for 32 agri-food processing industries in the United States and found that in most cases the market power effect dominated the efficiency effect or reinforced negative efficiency effects to lower welfare. Conversely, Azzam and Schroeter (1995) and Morrison Paul (2001a, 2001b) had sided on the side of cost efficiency in their analysis of the effect of increased concentration on the U.S. beef packing industry. Cost efficiency can be also induced by technological change. Brester and Marsh (2001) studied the impact of technological change on beef and pork wholesale-to-farm marketing margins. Cost savings generated by improved meat packing technologies have reduced margins in real terms. Technological change at the farm level has also led to significant declines in real cattle prices.

While the above approach provides some insights into margin determination, it suffers from many drawbacks. First, game theorists strongly object to the concept of conjectural variation, arguing that it is not theoretically consistent (Lindh, 1992; Nevo, 1998). From an empirical standpoint, nothing guarantees that the conjectural variation estimates will fall within

the 0-1 bounds.[‡‡‡] However, the biggest drawback of the approach described above is that it does not take into account the particularities (like the domestic policies and marketing institutions) of each sector. For example, if collusion is a concern, one should investigate how such behaviour can be sustained, in light of what is known about the environment in which the firms operate. Certain marketing mechanisms are more vulnerable to collusion than others (Klemperer, 2004). Alternatively, if it is common knowledge that a dominant firm is active in a given market, its ability/constraints to exploit its leadership must be modeled explicitly rather than through a "one-size fits all" approach.

Another drawback with the framework presented above is that it considers behaviour in one level of the market and ignores additional downstream markets.[§§§] For example, suppose that the behaviour modeled in (1) through (4) corresponds to wholesale firms' behaviour (e.g., processors). Given the concentration ratios presented in the introduction, it is not difficult to imagine that there can be deviations from perfectly competitive behaviour at the retail level as well. Without going into the fundamentals of modeling imperfect competition at both levels of the market, it is instructive to discuss the variables that affect price transmission between the

[‡‡‡] From an econometric standpoint, there exist many promising avenues of research that are currently unexplored. Bayesian methods could be used to restrict the conjectural variation estimates to stay within the 0-1 bounds; but they are not applied in practice. Conjectural variation empirical models assume linear price transmission mechanisms. New theoretical and applied advances in non-linear time series econometrics (e.g., Hansen, 1999 and 2000) seem a logical path to follow to try to improve the explanatory power of the empirical models.

[§§§] The modeling of all interactions along marketing chains (primary input suppliers-producers, producers-processors, processors-retailers, retailers-consumers) is rarely achieved because of a lack of data and the difficulty in modeling strategic interactions between traders when there are a few traders on both sides of a market. Food processors and retailers engage in frequently repeated transactions and one could infer that their behaviour would be best represented by bargaining models. Unfortunately, most of the bargaining literature focuses on bilateral situations. As Muthoo (1999, p.336) puts it "…the literature on multilateral and coalitional bargaining that uses the (strategic or non-cooperative) game-theoretic methodology is extremely small (albeit growing) and under-developed". For example, two large grocery chains dealing with hundreds of suppliers may potentially negotiate with only two or three pork meat processors. We know little about the conditions under which exclusivity deals would arise. The modeling of the retailers' optimization problem is most challenging as thousands of items change prices every week. On the up side, the fact that there are a large number of food items, many of which perishable and that food is essential for survival imply that the negotiating framework used by retailers and processors must be simple. The identification of these simple "rules" and their updating, when proved inefficient, should be a research priority.

different market levels in general terms. Schroeter, Azzam and Zhang (2000) estimated the degree of market power in the U.S. beef market by modelling a bilateral oligopoly structure. Their model considered three possible market structures: bilateral price-taking, seller price-taking, and buyer price-taking. While their data set seems most consistent with the notion of price taking behaviour on the part of beef packers, it failed to account for the possibility that both packers and retailers could have market power. If market power is present at both levels of the market, it is extremely difficult to infer anything about price transmission along the supply chain. For example, an increase in concentration at the wholesale level (through a decrease in the number of processors) could imply an increase in the wholesale to farm price spread as well as a decrease in the retail to farm price spread. The change in the latter price spread is likely to have an impact on the former, although the extent of that impact is generally ambiguous. Ultimately, the price transmission implications of market power remain an important empirical issue.

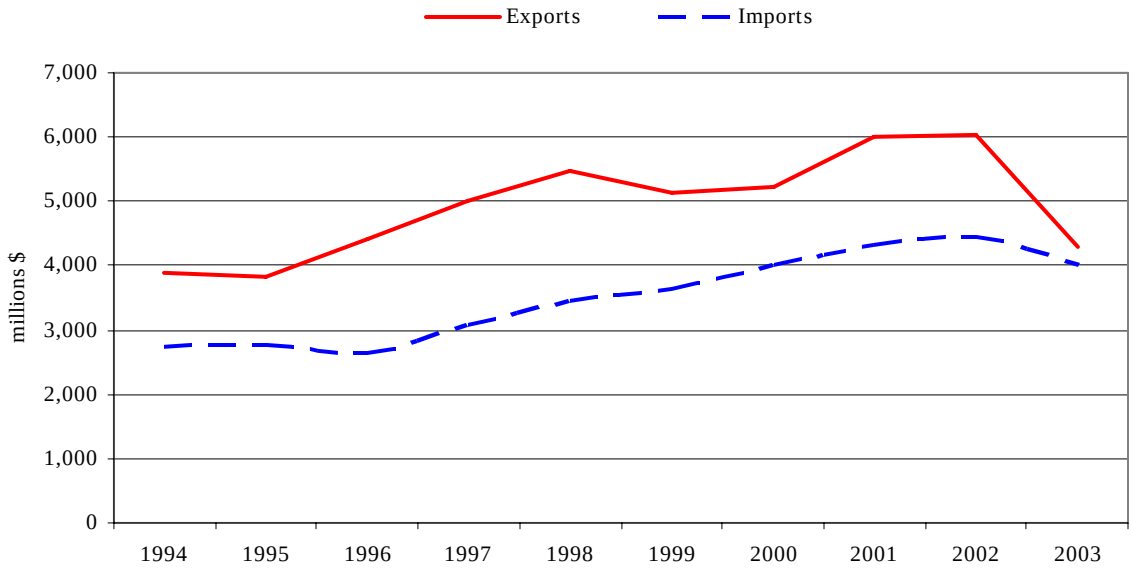
Other criticisms focus on the underlying assumptions of standard models of imperfect competition in food industries. The assumption of fixed proportions between the farm and retail products can lead to misspecification issues when estimating market power because it assumes that there are no substitutability between the farm input and other inputs (Wohlgenant, 2001). Firms can select different production technologies in response to price signals and this can change the ratio of retail to farm prices. Moreover, retail products are not homogenous (even within a given food category such as beef) and thus retailers can substitute between retail products when farm input prices vary. The failure to account for these features can lead to the erroneous conclusions that retailers exercise market power when they are simply responding to market signals (Wohlgenant, 1999).

Finally, the framework is static in that it fails to capture the complex dynamics of firms' conduct. For example, retail firms can change prices relatively often in a short period of time to respond to various market conditions and perceived behaviour from competitors. Price changes are not strictly due to changes in exogenous factors such as input costs; but are reactions to perceptions about a continuously evolving business environment. The main point is that the nature of competition implies frequent price changes that are difficult to capture empirically (and the current study is no exception!) because most of the analyses rely on average price indices. In what follows, we discuss some aspects of margin determination that are important in the context of Canadian agri-food supply chains by getting out of the restrictive "one size fits all" approach.[****]

International trade and margins

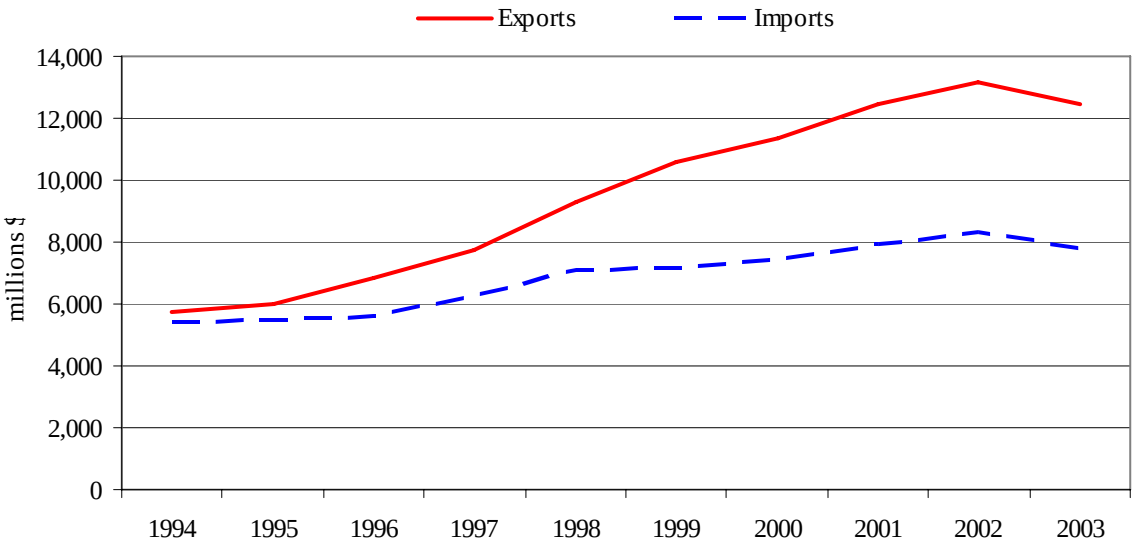
Canada is a small open economy very much involved in international trade and the United States is by far its largest trade partner. Canada is known as a large exporter of primary agri-food products, like wheat and livestock. Figure 1 reveals that exports of primary agricultural commodities have increased at a similar rate than imports of raw commodities. Conversely, Figure 2 reveals that exports of processed commodities have grown at a faster pace than imports. Combining the findings in Figures 1 and 2, it is easy to show that Canada is increasingly becoming an exporter of processed products as the trade balance of processed commodities is increasing while the trade balance of primary commodities is shrinking (Figure 3).

[****] Some factors will be voluntarily left out of our analysis as they appear not to be related in any particular way to the Canadian agri-food sectors. The impact of risk, technical change and seasonality are discussed in Wohlgenant (2001).



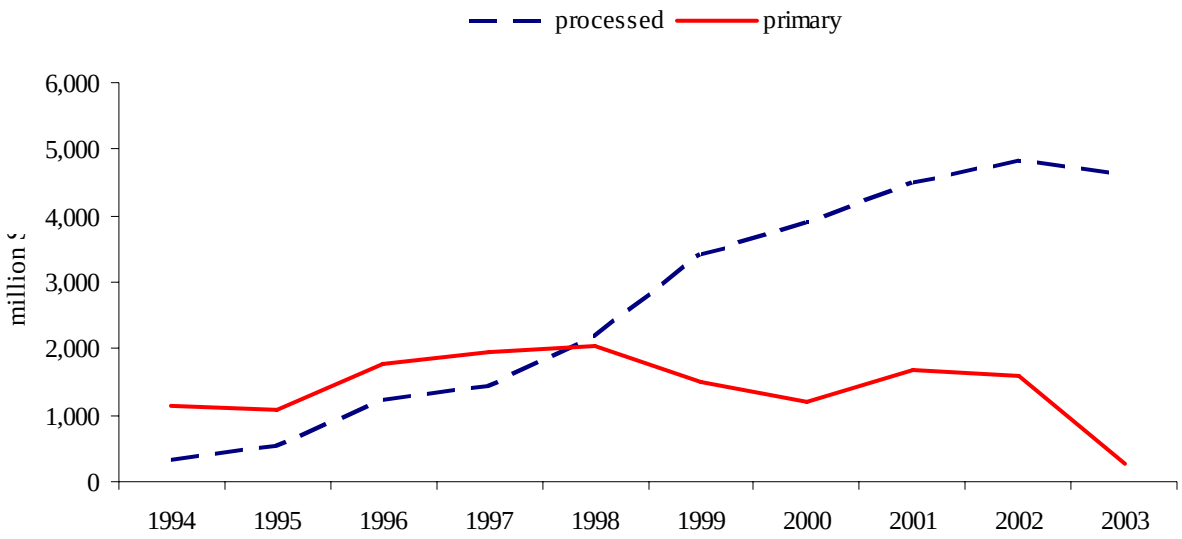
Source: Statistics Canada, 2004. Authors' computations

Figure 1. Canada's exports and imports of primary agricultural products (in millions$), 1994-2003.



Source: Statistics Canada, 2004. Authors' computations

Figure 2. Canada's exports and imports of processed agricultural products (in millions$), 1994-2003.



Source: Statistics Canada, 2004. Authors' computations

Figure 3. Canada's trade balance in processed and primary agricultural products (in millions$), 1994-2003.

Processors that sell on their domestic market and on at least one export market make at least two marketing decisions that are related to one another and to the marginal cost.[††††] This means that the margin on domestic sales cannot be measured independently from the margin on the export sales. Thus, marketing equations must be added and the specifications of the marketing equations must embody information about all destinations.[‡‡‡‡]

When a homogenous primary or a processed product is domestically produced and could be exported, the domestic price for the good cannot fall below the world price diminished by trade taxes, transport costs and other transaction costs. Similarly, when domestic goods compete with imports, the domestic price is the minimum between the autarky price (the price that would

[††††] For example, let us suppose that a Canadian processor has market power on the domestic market and exports on the U.S. market at a fixed price outside of its control, say ep^{US}, where e is the exchange rate defined in terms of $Can/$US. The price-discriminating processor will set its domestic price or quantity marketed in terms of the converted U.S. price.

[‡‡‡‡] Larue, Gervais and Rancourt (2004) make a similar point about the pricing-to-market equation. Generally, the exchange rate pass through in an export price equation cannot be estimated without a domestic price equation. The conditions supporting a single-equation framework are quite restrictive.

prevail in the absence of trade) and the world price augmented by trade taxes and transport costs. Therefore, trade imposes arbitrage conditions which constrain the ability of domestic firms to exploit their market power. In a small open economy like Canada, prices received by agricultural producers are directly linked to world-established prices. Figures 1, 2 and 3 documented how agri-food trade has increased during the last ten years and it can be inferred that the overall impact of world markets on Canadian agri-food prices has increased unequivocally.

To show how producers can be locked into a world established farm price, let us assume that there is a single processor, as in Larue, Gervais and Lapan (2004) and many domestic primary producers who can sell their primary products to the single domestic processor or to foreign importers. The domestic processor can get part or all of the primary inputs at the world price adjusted by transport costs. The possibility of trade (it does not have to take place to matter) imposes a minimum on the domestic price for the primary product. Depending on the manner with which primary products are marketed and the market conditions, it could be in the interest of processors to offer more than the minimum price to secure a large enough quantity of primary products. Larue, Gervais and Lapan (2004) also show that it might be in the interest of a government to step in and subsidize domestic producers to counter the propensity of an imperfectly competitive processor to buy too few primary products.

International trade policies play an extremely important role in making markets more efficient. The protection of primary producers through trade taxes or import bans put domestic processors at a disadvantage and this is why processed products often end up being heavily protected as well. The extent by which processors are protected when processed and primary products are protected through trade taxes can be measured with the so-called effective

protective rate developed by Corden (1966).[§§§§] The phenomenon of tariff escalation arises when nominal tariff rates increase with the degree of processing. Hoekman *et al.* (2001) contend that tariff peak products tend to be heavily concentrated in agriculture and food products and in labour-intensive sectors such as apparel and footwear. Naturally, tariff escalation allows processors and further processors to enjoy larger margins. Lindland (1997) contend that tariff escalation in rich countries is a major impediment to the development of food processing facilities in less developed countries.

It is also easy to see how negotiations between domestic processors and retailers could be influenced by trade policies as tariffs on the retailers' imports reinforces the bargaining power of domestic processors and foreign tariffs on domestic processors' exports ed reinforce the position of the retailers.

Tariffs and other trade policy instruments play a critical role in the determination of margins and so does the exchange rate. Exchange rate changes affect the prices of traded farm inputs, raw products and processed foods. Incomplete pass through and pricing-to-market are about how price discriminating firms adjust domestic and export prices to exchange rate changes. These phenomena are commonly observed (Larue, Gervais and Rancourt, 2005). For example, a large U.S. input supplier may respond to a depreciation of his currency relative to the Canadian dollar by increasing his price in U.S. dollars, but not enough to completely offset the currency depreciation. The new import price, once converted in Canadian dollars, would be cheaper for

[§§§§] The typical formula to compute the effective tariff for processed product *j* that uses *n* primary products is: $g_j = \left(t_j - \sum_{i=1}^{n} a_{ij} t_i \right) \Big/ \left(1 - \sum_{i=1}^{n} a_{ij} \right)$, where t_j is the tariff on the processed product, t_i is the tariff on primary product *i* and a_{ij} is the fixed proportion input-output coefficient that indicates how much primary product *i* is needed to produce one unit of processed product *j*. If a primary product is used rather intensely, the weight on its tariff will be high and it will have a strong negative impact on the effective protection accruing to processor *j*. One property of the effective rate of protection is that if $t_j = t_i$ then $g_j = t_j = t_i$.

Canadian producers. However, the input price decrease would be less than the variation the relative value of the two currencies. This example illustrates that despite well integrated markets, large firms can exploit their market power and retail-to-farm margins might not follow patterns that are coherent with free trade and perfect competition assumptions.

Production lags, capacity constraints and hold ups

A key characteristic of many primary agri-food products is that much time must elapse between the moment production and marketing decisions are made. Calves and pigs must be fed for months before reaching the appropriate weight for slaughter. Production decisions must be made in terms of expected prices and the speed at which production adjustments can be made is inversely related to the length of production lags. To make things worse, the physical characteristics of agri-food products implies that in many instances producers, processors and retailers must market their products within a relatively short period of time beyond which their products depreciate quickly. This is the case with fresh products like meats and fruits and vegetables. As a result, it is often said that the supply function is very inelastic in the short run. Having a fixed stock of quickly depreciating goods makes a seller vulnerable to a hold up, a situation in which the seller must almost give away its entire stock.[*****] Complete hold ups are rare, but partial ones do occur.

Dairy producers are getting extremely low prices for culled dairy cows in eastern Canada since the beginning of the BSE crisis. Their inability to export live cows puts them at the mercy

[*****] The argument can be reversed as a buyer without any other option/alternative supplier might be held-up if his supplier has options/alternative buyers. We focus on hold-up of producers because they have received more attention lately.

of the only specialized slaughterhouse.[†††††] Prices have been very low, but one might wonder what was preventing them from going even lower. There may not be regional arbitrage anymore, but the packer is still confronted to the inter-temporal arbitrage constraint of the dairy producers who have the option of selling their cows now or at a latter date. Therefore, today's prices reflect expectations about future prices and the probability that trade of live animals older than 30 months would resume. A second reason for "some restraint" is the fear of a political backlash.

Larue, Gervais and Lapan (2004) argue that Quebec hog producers were also partially held up prior to the implementation of a pre-attribution/formula pricing system. Back then, the Quebec price for hogs was consistently below the U.S. price. The intuition is that the processor does not have an incentive to offer high hog prices because domestic supply is fixed in the short run, due to production lags. Producers anticipate the low prices offered by the processor and adjust their production accordingly. The processor and the producers end up in a "low-price low-capacity trap" unless the processors can credibly commit to give producers higher prices.

Capacity constraints at the processing levels can also play an important role. Consider a case in which producers collectively sells their output through a first-price auction. Let us suppose that there are only two processors competing for the entire supply of primary products sold in two halves (*1*,*2*). The processors (*a*,*b*) know each other's valuations of the halves and assume that they are such that: $v_1^a > v_2^a > v_1^b > v_2^b$. In other words, processor *a*'s valuation of the two halves is larger than processor *b*'s. If processor *b* is capacity-constrained in the sense that it can process at least one half of the supply, but not both halves without incurring major costs (*e.g.*, having to set up a night shift), v_2^b could be very low, especially if resale is prohibited. It is

[†††††] Not surprisingly, the packer has made investments to increase its capacity. This is why the *Fédération des Producteurs de Bovins du Québec* (FPBQ) has made an offer to purchase a controlling stake in the existing facility instead of building a new facility. Lags in building a new facility helped the packer secure a high price.

easy to check that both halves will be sold at v_2^b if the gain for processor *a* to let processor *b* win one half exceeds the gain from winning both halves which implies: $2v_1^b > v_2^a + v_2^b$.[‡‡‡‡‡] Thus, the two firms can secure a profit in equilibrium even though the larger/more efficient firm has the means to get all of the supply. Unlike the textbook Bertrand duopoly model, this example shows that two firms is not sufficient to get competitive outcome. Furthermore, this occurs without collusion which shows that care must be taken in choosing a marketing mechanism.

Collusion

Given that there are interactions between producers, input suppliers, processors and retailers every day, the marketing "games" are repeated and in this context collusive equilibria can arise. Collusion at the processing and/or retail level can have significant repercussions on the retail-to-farm price spreads. Klemperer (2004, p.135) argues that firms are more likely to collude if: 1) firms can identify an efficient division of the market; 2) firms can easily agree on a division; 3) firms can easily detect defection from an agreement; 4) firms can credibly commit to punish any observed defection; and 5) firms can discourage entry in the market. It would be tempting to infer from this list of conditions that collusion equilibria can only be supported by a small number of firms, but recent anti-trust cases involving Archer-Daniel-Midland have shown that collusion schemes involving a large number of firms cannot be dismissed (Lieber, 2002).

[‡‡‡‡‡] For processor *a* to win both halves, he must bid $v_1^b + \varepsilon$ for the second half , provided he won the first half, to counter processor *b*'s dominant strategy to bid v_1^b. Anticipating this, processors *a* and *b* would follow the same strategy for the first half. Setting $\varepsilon \approx 0$, the payoff for processor *b* would be zero and that for processor *a* would be: $\left(v_1^a - v_1^b\right) + \left(v_2^a - v_1^b\right)$. However, if processor *a* lets processor *b* get the first half of the supply, processor *a* would secure a payoff of $v_1^a - v_2^b$. For the first object, processor *a* would bid v_2^a, because if he wins, he secures $v_1^a - v_2^b$. Processor *b* knows that he can win if he bids a hair over v_2^b to secure a gain of $v_1^b - v_2^b$. If processor *b* wins the first half, he will bid his evaluation for the second half, and processor *a* can beat that by bidding a hair over that. This explains why the price is the same for both halves.

Collusion can be sustained only if credible threats of punishments can be made to discourage cartel members from deviating from the cartel's market share agreement. If collusion is done to obtain reduced input prices, punishments, in terms of increased input prices, must be severe and conducted over a long enough period to be part of an effective "trigger strategy". One way to counter this trigger strategy is to impose a ceiling or maximum price just low enough to render the threat of punishment ineffective. Of course, the imposition of a fairly low maximum input price tends to increase (reduce) the margin of processors (producers), but it would be better than the lower collusion-induced input prices from the producers' standpoint.

Canada's supply management policy used in the dairy and poultry sectors is often presented as a legalized collusion operation[§§§§§] that has been sustainable since the late 1960s because it meets the five conditions discussed above, including the ability to punish observed defection and to discourage entry (through domestic and international trade policy instruments). In essence, primary production is restricted to achieve a farm price target by taking into account the behaviour of processors and retailers. Naturally, the margins are high and the supply very low along the supply chain as firms at each level attempt to exploit their market power. This problem is known as double marginalization. The imposition of minimum and maximum prices in some provinces mitigates the problem.[******] Still, the fact that the average dairy farm is small and that production rights (known as quotas) are very expensive implies that the profit margin on a hectolitre of milk is high. Whether or not producers can have grater control of the share of

[§§§§§] Most analysts model the policy as if decisions were made by a constrained monopolist *(e.g.*, Larue, 1994; Gervais and Rude, 2003).

[******] For example, as of January 25, 2005, retail milk prices in the province of Quebec (4-litre format, 2% partially skim milk) cannot be set lower than 4.53$ and higher than 5.35$. (Source: Régie des marchés agricoles du Québec, available at: www.rmaaq.gouv.qc.ca/decision/decision_2005/8205.pdf.

retail expenditures within supply management than without supply controls is an empirical issue that will be discussed in section 3.

Price cycles and dumping

Livestock prices are notoriously cyclical and this has implications for margins. When prices are low, margins are negative as unit costs exceed prices. Sales take place because supply is very inelastic in the short run. This is due to production lags and the fact that it is costly to delay the marketing of live animals that have reached the appropriate weight. Producers can sustain negative margins because the price cycles generate period of high prices and positive margins. This phenomenon forces producers to be careful in managing their cash flow and it makes accusations of dumping more likely. Canadian beef exports have been the object of an anti-dumping action in 1999[††††††] while Canadian hog exports have been targeted over a long period starting in 1985 and ending in 1999. A new petition against Canadian hogs was initiated in April of 2004, but it was recently rejected. Between 1995 and 2004, Canada has responded to 126 requests for anti-dumping actions against the imports of a given product from a given country. Out of these 126, 14 were agri-food products. For the United States and Europe, the proportions are respectively 32/350 and 5/287.[‡‡‡‡‡]

There have been large variations in Canadian farm prices recently, along the cycle or due to unforeseen events, that have not triggered substantial changes in retail prices. Several factors can be invoked to explain this. However, the most compelling one is the inelastic nature of the demands for individual food items at the retail level over short periods of time. Plainly speaking, large decreases in price bring about small increases in demand. This is so because fresh food

[††††††] For an analysis of the impacts on US and Canadian slaughter and feeder cattle prices, the interested reader is refered to Brester, Marsh and Smith (2002).

[‡‡‡‡‡] Source: WTO (2005). Available at: www.wto.org/french/tratop_f/adp_f/adp_f.htm.

items are perishable and cannot be stored over long periods of time and consumers value variety in their diet. Therefore, a rebate on beef offered over an extended period might induce consumers to buy more beef than "usual" during the first week, a bit more than "usual" in the second and perhaps far less than "usual" in the third week because consumers crave for chicken or fish.

Good retail and wholesale data is rare and obviously expensive. As a result, there are few studies that have investigated the cyclical behaviour of retail-wholesale margins for a large number of food items. The study of Chevalier, Kashyap and Rossi (2003) is an exception. They analyzed 7.5 years of weekly retail and wholesale prices of Chicago's second largest supermarket chain and found that prices and retail margins fall on average during seasonal demand peaks for a product. This empirical finding is inconsistent with responses under perfect competition which posits increases in demand either trigger price increases or leave prices constant. They tested three models capable of generating countercyclical mark ups. The first one is based on the presence of cyclical demand elasticities arising from economies of scale in consumer search while the second is about implicit collusion in a context of changing demands. The third one which is more consistent with the data is a "loss leader/advertising" model in which it is profitable for the retailer to discount and advertise food items in high relative demand.

Product differentiation and margins

Trade models based on monopolistic competition, increasing returns and free entry (e.g., Krugman, 1979) were developed in large part to explain the increasing volume of intra-industry trade that was taking place in the 1970s. Canada is large exporter of wheat and livestock due to its endowment of land and its climate that is especially suitable for the production of high-protein wheat. Therefore, trade in primary agri-food products can easily be related to factor abundance (agricultural land, thermal units, etc.). However, trade in processed products is

growing more rapidly than trade in primary agricultural products and the bulk of Canada's exports (imports) of agri-food products goes to (comes from) the United States, which, like Canada, is known for its abundance of agricultural land and capital. Processed agri-food products can be differentiated in the usual sense or by appealing to the values of consumers who might be concerned about production processes (*e.g.,* organic versus conventional versus genetic modification) or the way products are marketed (*e.g.,* fair trade coffee). If monopolistic competition is a reasonable assumption, then freer trade should induce some domestic food processors to exit the market while inducing remaining food processors to produce more and to lower their margin (due to economies of scale).

3. REGIONAL PRICE SPREADS IN CANADA

This section describes the movements in farm, wholesale and retail prices for selected farm and retail commodities in different Canadian provinces. It is certainly not the first study that attempts to document the evolution of price spreads in Canada. For example, Coffin, Romain and Douglas (1989) provided a detailed study of pricing patterns in the poultry industry. Among other things, they showed that there was no significant trend in the real farm to retail margin for chicken between 1974 and 1987 (p. 119). Martz (2004) analyzed nominal price changes in Canada for various commodities. She concluded that increases in retail prices were greater than farm price increases for all commodities. This difference between retail and farm price movements was the smallest for dairy products which seem to validate the argument that supply managed sectors are better positioned to obtain a larger share of the food dollars spent by consumers.

The current document extends the current literature in two important ways. We illustrate the broad relationships that exist between farm, wholesale and retail prices. In that regard we extend the analysis of Martz (2004) who only included the wholesale market level for chicken.

Unfortunately, data availability with respect to wholesale prices restricted the regional and commodity focus of the study. Second, we focus on real price spreads and use statistical methods to determine the global behavior of price spreads. Any empirical analysis of farm and retail prices requires data transformations of one sort or another and our study is no exception. There are a large number of figures that we relegated at the end of the document along with our description of data transformations and sources to improve the readability of the manuscript.

3.1 Farm, wholesale and retail prices

A) Pork

Figure 4 presents the trends in monthly hog prices, wholesale and retail pork prices in Quebec between 1988 and 2003. It also presents the evolution of the hog price when adjusted for domestic support in the hog sector. Domestic support is approximated by the Producer Support Estimate (PSE), a global measure of support computed by the Organization for Economic Cooperation and Development (OECD). This measure is computed at the national level and includes all monetary transfers from government and consumers in support of farm income in the hog sector. The ad-valorem PSE $(PSE\%)$ multiplied the market price at the farm level (f) to yield an estimate of the domestic support price: $f(1+PSE\%)$. The introduction of domestic support in the analysis of price spreads serves two objectives. First, the addition of government support to the per-unit market revenue of producers provides for a more accurate estimate of the true purchasing power of producers. Second, we can analyze whether government support is countercyclical, that is on the rise when market prices are low and declining when prices are trending upward. Table 1 reports hog PSE measures in Canada from 1988 to 2003. The second highest PSE level was realized in 1999, a year characterized by financial turmoil for the North American hog/pork market.

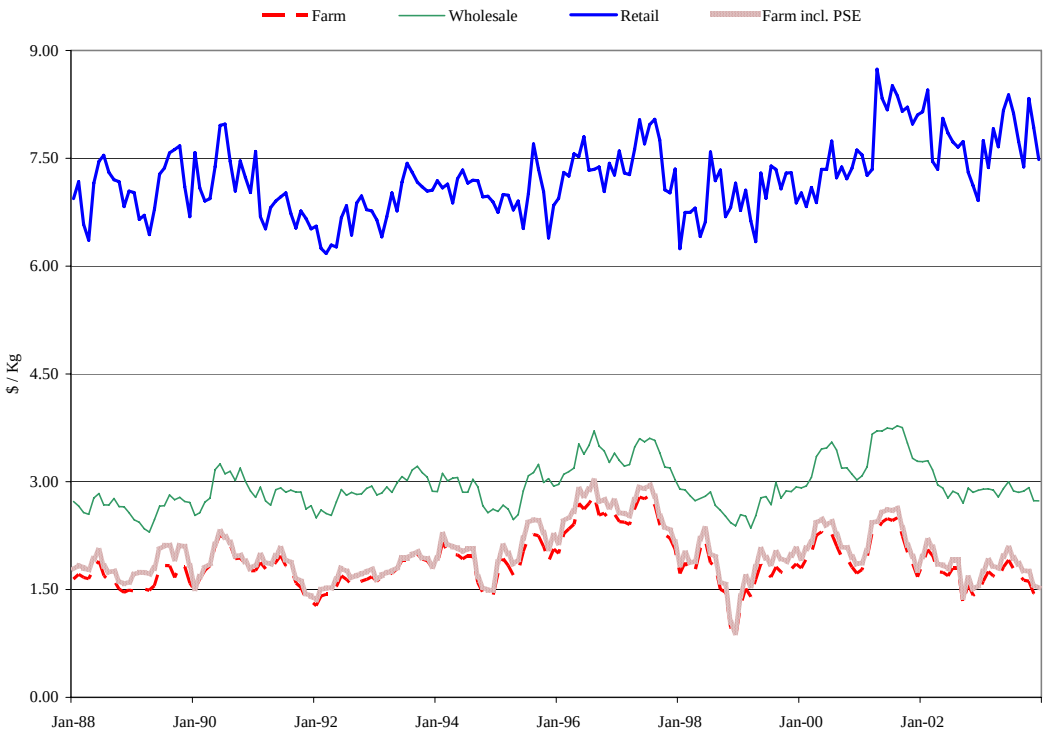


Figure 4. Monthly hog farm prices (excluding and including producer support), wholesale and retail pork prices in Quebec from January 1988 to December 2003.

Table 1. Annual producer support estimate (PSE) for pork in Canada in %, 1988 – 2003

Year	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03
PSE	8	15	2	5	6	1	5	9	7	5	7	11	8	5	6	8

Note: The entry for 2003 is a preliminary estimate.

From a glance at Figure 4, it is difficult to gauge whether there are stable relationships tying the three prices. It is also difficult to make an inference about the potential smoothing of prices arising from government support. Figure 5 illustrates the wholesale-to-farm and retail-to-wholesale price spreads in real terms (1992 dollars). Price spreads in real terms are obtained throughout by weighting nominal price spreads by the Consumer Price Index (CPI) computed by Statistics Canada. A quadratic trend is also plotted to more clearly illustrate how these two margins evolved over time. The R^2 measure for the trend in the wholesale-to-farm price spread is

particularly low; and it suggests that the spread was fairly constant over the 1988 to 2003 period. The trend in the retail-to-wholesale price spread exhibits a U-shaped form. Overall, it is difficult to assert whether the spread between the farm and retail prices has significantly increased during the past fifteen years. However, the data indicates that there could be a recent upward trend in the retail-to-wholesale price spread.

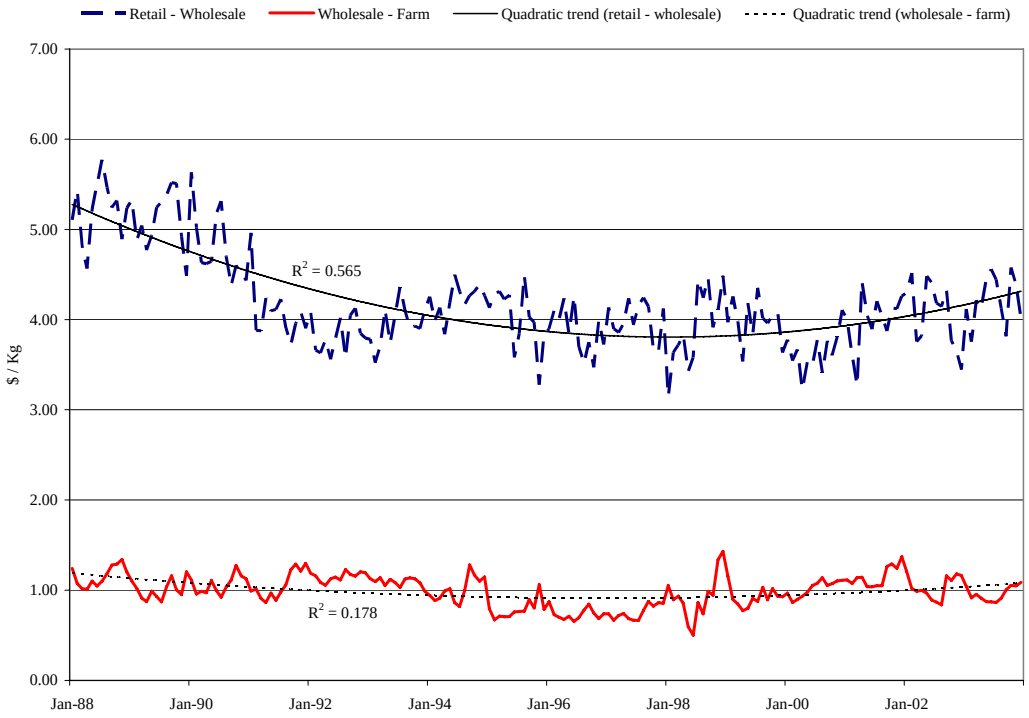


Figure 5. Monthly pork retail to wholesale and wholesale to farm price spreads (in 1992 dollars) in Quebec from January 1988 to December 2003

Figure 14 in the appendix combines the two margins in Figure 5 and plots the retail-to-farm price spread in real terms (1992 dollars) as well as the retail-to-farm price spread when government support is included in the farm price. A quadratic trend is fitted to the retail-to-farm price spread. The quadratic trend explains 64% of the variations in the price spread as indicated by the coefficient of determination of the regression $\left(R^2\right)$. The retail-to-farm price spread has

decreased in real terms between 1988 and 1996. There seems to be an upward trend in the retail-to-farm margin beginning in 1998, although it is not significant in a statistical sense. The analysis in the subsequent section should provide further insights regarding the behavior of the margin over time.

B) Beef

Figure 6 plots monthly cattle prices, wholesale and retail beef prices that were observed in Quebec between January 1996 and December 2003. Wholesale prices for red meat are computed for the Montreal market by the red meat markets analysis division of Agriculture and Agri-food Canada. The available sample begins in 1999. There are clear upward trends in retail beef prices starting in 2001 and the price impacts of the BSE crisis are evident, as farm prices plummeted in May 2003. There are also significant lags between changes in wholesale and retail prices and changes in the farm price. Figure 7 presents wholesale-to-farm and retail-to-wholesale price spreads in real terms. The fitted quadratic trend in these two series identifies a sustained growth in these price spreads over time. The upward trend is perhaps more evident in Figure 15 in the appendix which measures the retail-to-farm price spread in real terms (1992 dollars). The quadratic trend fits well the pattern of the margin.

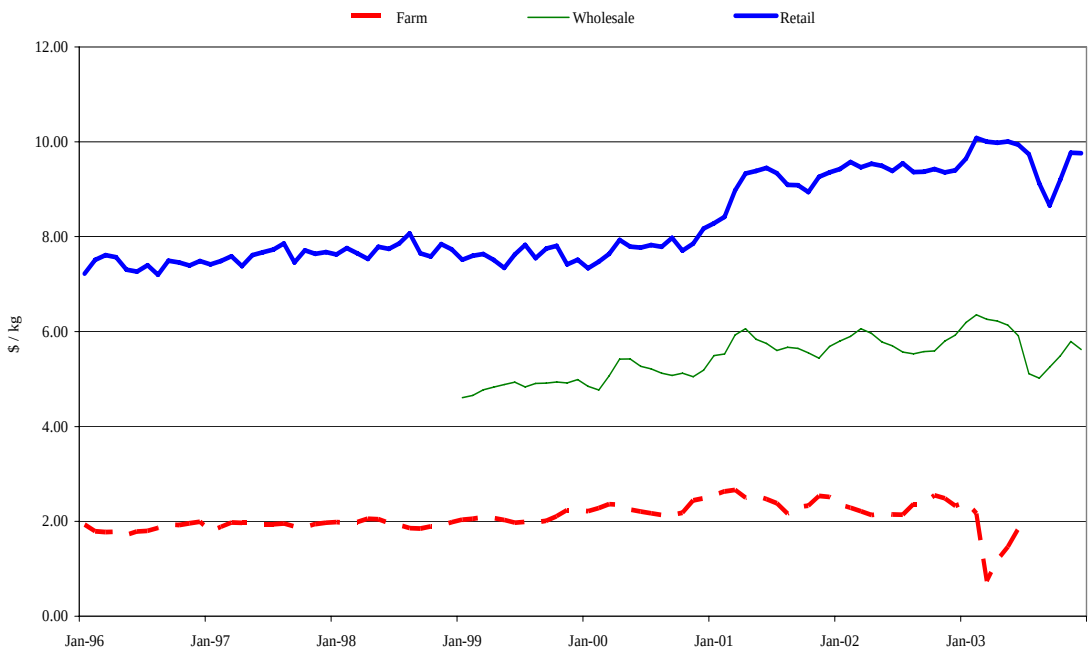


Figure 6. Monthly farm cattle price, wholesale and retail beef prices in Quebec from January 1996 to December 2003.

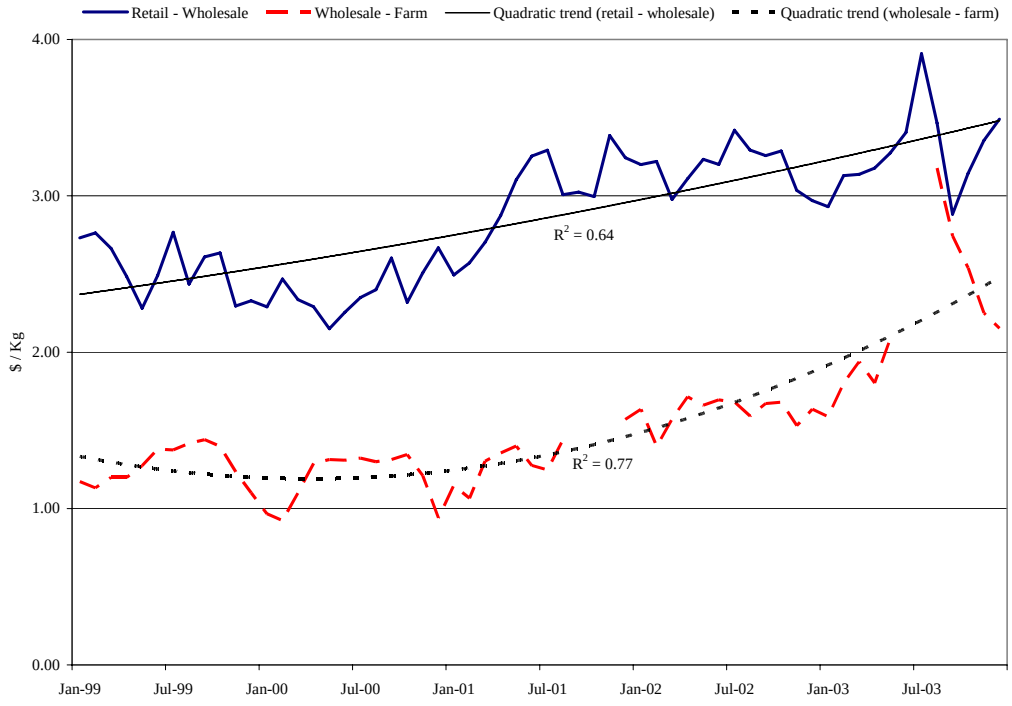


Figure 7. Monthly beef retail to wholesale and wholesale to farm price spreads (in 1992 dollars) in Quebec from January 1999 to December 2003.

C) Chicken

Figure 8 presents monthly farm, wholesale and retail chicken prices in Ontario between April 1992 and December 2003. The plots reveal a higher degree of price volatility at the wholesale and retail levels than at the farm level. The real wholesale-to-farm price spread in Figure 9 is fairly constant over time while the retail-to-wholesale price spread exhibits the now familiar U-shape. These findings are strikingly similar to the findings in Figure 5 for the pork case. This is interesting because the two sectors rely on very different marketing institutions. Chicken production is constrained through the supply management policy and protected by high tariffs while hog production is more market-oriented. Still, there are similar features in pricing mechanisms. Ontario chicken prices used to be determined through a negotiation process between the producers' marketing board and the Association of Ontario Chicken Processors (AOCP).[§§§§§§] Hog prices in Quebec are determined by a hybrid marketing mechanism that relies on auctions and U.S. spot markets (see Larue *et al.*, 2000, for greater details).

The important point is that hog marketing rules are negotiated between processors and producers on a regular basis. The parameters of the marketing system have changed over time. Larue, Gervais and Lapan (2004) argue that hog marketing institutions have endogenously evolved in Quebec to solve market failures associated with biological lags in production and marketing. One important conclusion that can be drawn from the above anecdotal evidence is that supply management by itself is not a necessary condition to have "fair pricing practices" in any given industry as coordination between packers and farmers can be achieved without such a

[§§§§§§] At the beginning of 2003, the chicken industry in Ontario has moved away from the bilateral price bargaining framework and now relies on a cost based pricing mechanism that is negotiated once every year.

rigid structure.[*******] As for the pork case shown in Figure 14, Figure 16 in the appendix illustrates that a U-shaped time trend fits quite well the pattern of the retail-to-farm price spread (measured in 1992 dollars).

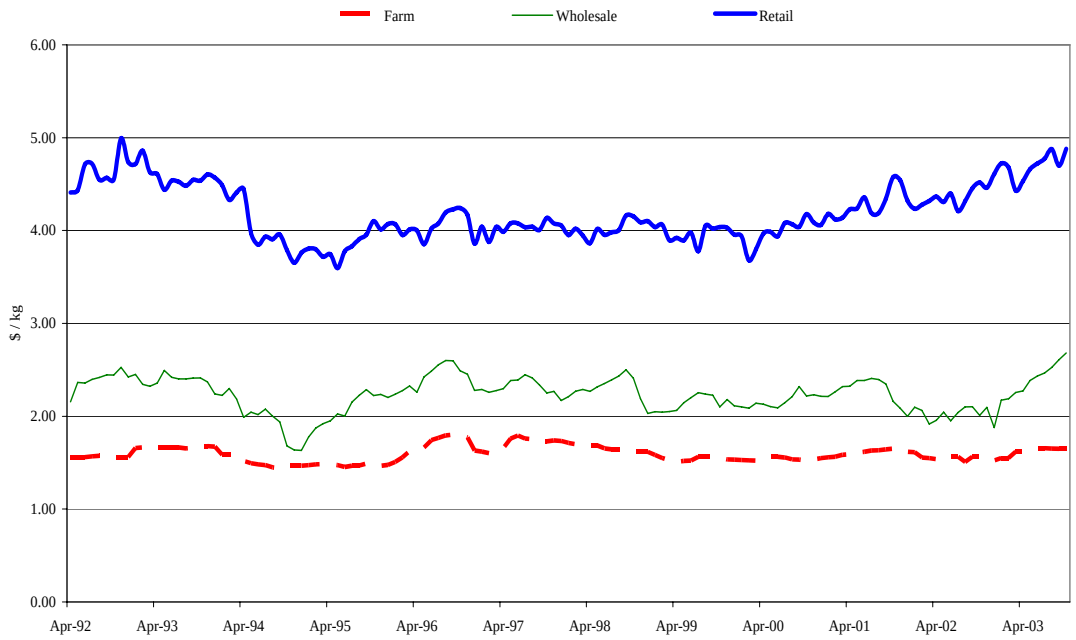


Figure 8. Monthly farm, wholesale and retail chicken prices in Ontario from April 1992 to December 2003.

[*******] Price transmission in the supply chain can be analyzed using empirical bargaining models formally rooted in bargaining theory. Raper, Love, and Shumway (2000) estimate market power exertion between sellers and buyers in the U.S. tobacco leaf industry. Gervais and Devadoss (2005) estimated relative bargaining weights of Ontario chicken producers and processors. They find that movements in the price of live chickens are closely linked with movements in feed prices. Despite the supply management system, producers were not successful in bargaining higher prices when wholesale prices were rising.

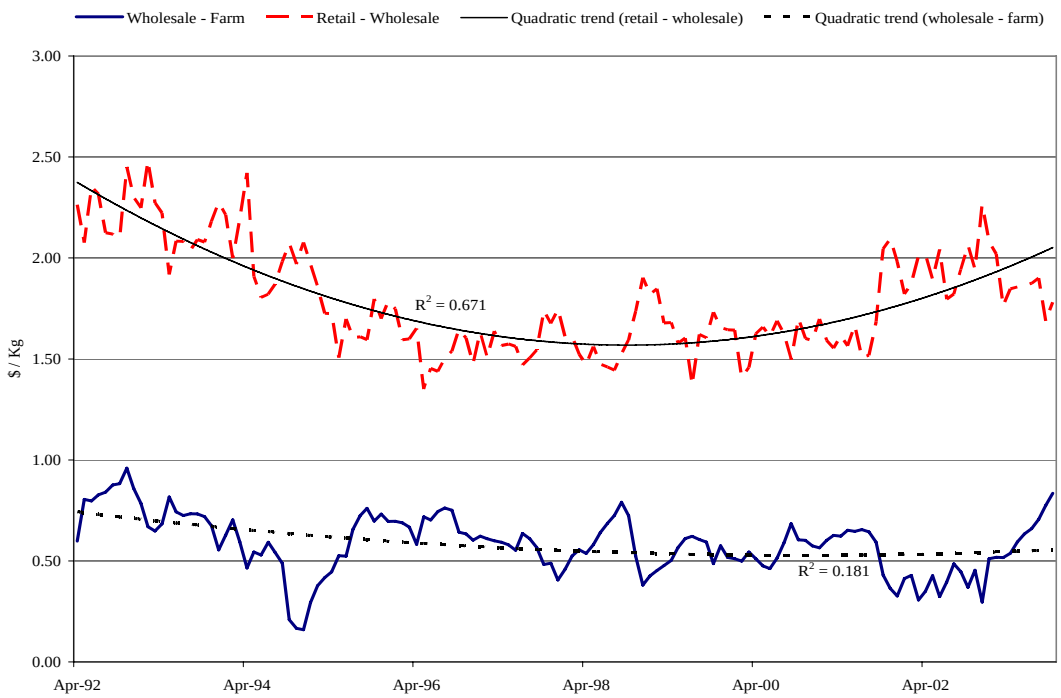


Figure 9. Monthly chicken retail to wholesale and wholesale to farm price spreads (in 1992 dollars) in Ontario from April 1992 to December 2003.

D) Butter

Figure 10 illustrates the monthly milk farm price, and wholesale and retail butter monthly prices from January 1993 to May 2004. It is important to note that there seems to be a problem with the concordance in the data at the wholesale and retail levels because the wholesale price exceeds in some instances the retail price. This happens at the beginning of the sample and in 2000. Wholesale prices are reported as an interval of prices and the wholesale price plotted in Figure 10 corresponds to the arithmetic average of the bounds of this price interval. Nevertheless, it is possible to see that retail prices have started to increase significantly during the late 1990s.

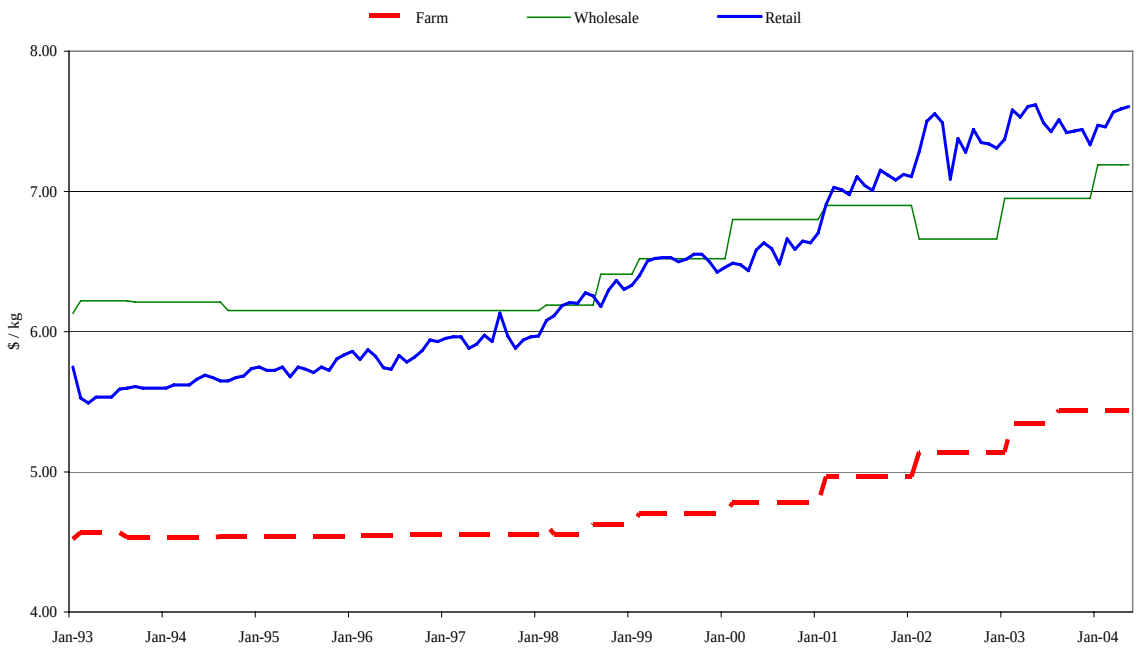


Figure 10. Monthly farm, wholesale and retail butter prices in Quebec from January 1993 to May 2004.

Figure 11 presents the wholesale-to-farm and retail-to-wholesale price spreads in real terms. The spread between wholesale and farm prices has increased over time while the retail to wholesale is fairly constant. These findings contrast with our conclusion for the chicken and pork sectors. Figure 17 in the appendix presents the retail-to-farm price spread of butter measured in 1992 dollars. There is a statistically significant positive trend in the margin. Once again, this underscores the importance of pricing mechanisms in determining the share of the farm income in total retail dollars spent by consumers.

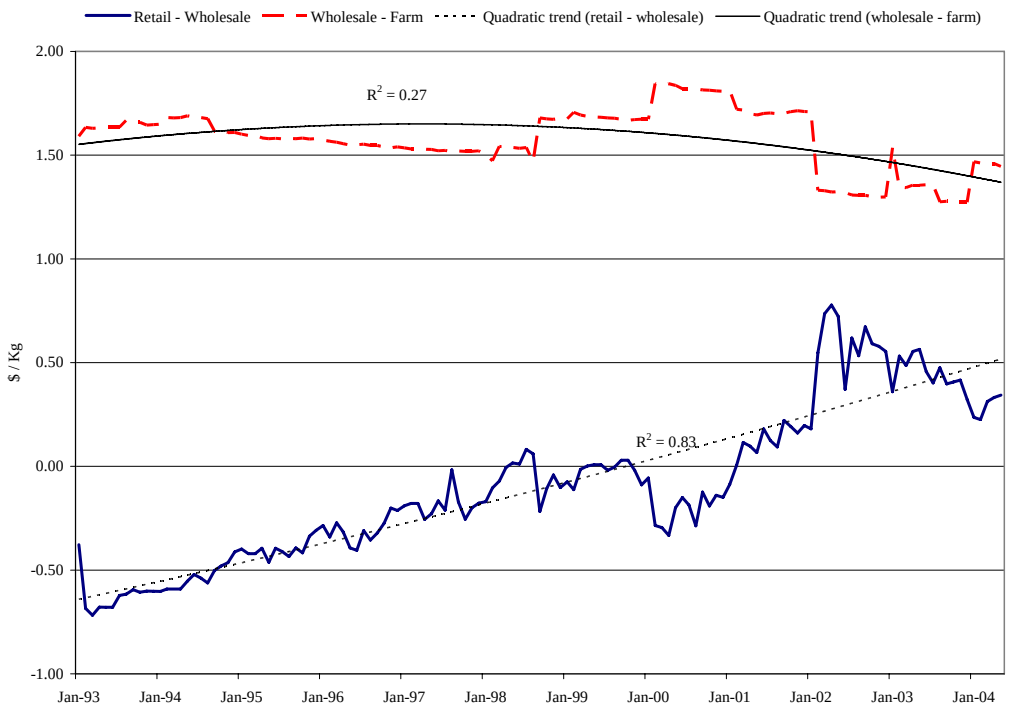


Figure 11. Monthly butter retail to wholesale and wholesale to farm price spreads (in 1992 dollars) in Quebec from January 1993 to May 2004.

E) Cheese

Figure 12 illustrates the patterns followed by the Quebec monthly farm price for milk and the wholesale and retail cheddar cheese prices from August 1993 to May 2004. All prices follow an upward trend. Figure 13 illustrates the decline of the retail-to-wholesale price spread as well as the increase in the wholesale-to-farm price spread (both measured in real terms). The R^2 measures are relatively high. When these two price spreads are combined (as shown in Figure 18 in the appendix), there is no statistically significant trend in the retail-to-farm price spread measured in 1992 dollars.

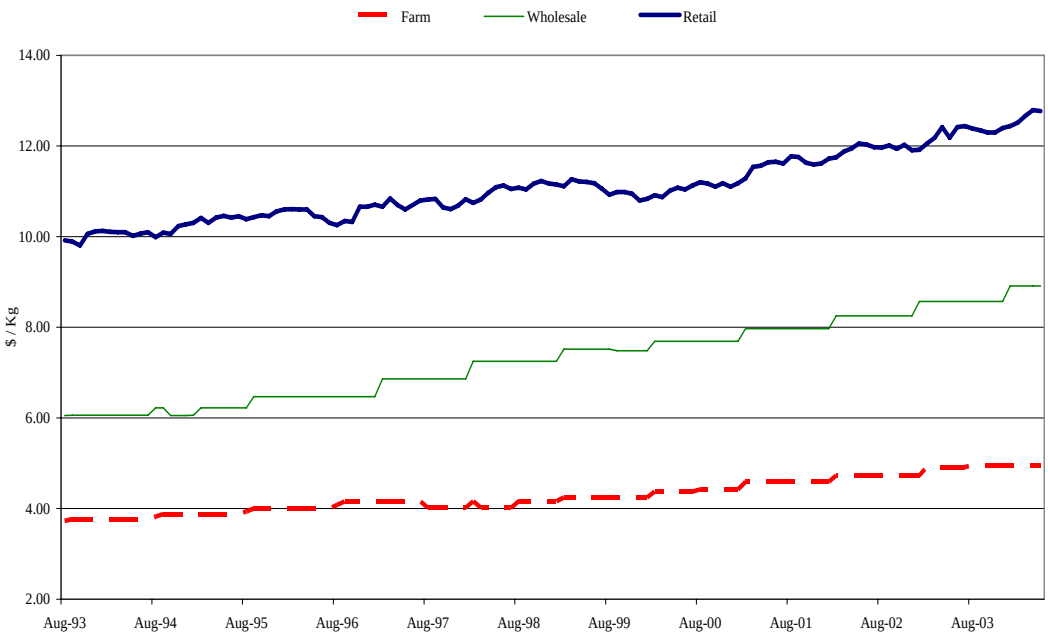


Figure 12. Monthly farm, wholesale and retail cheese prices in Quebec from August 1993 to May 2004.

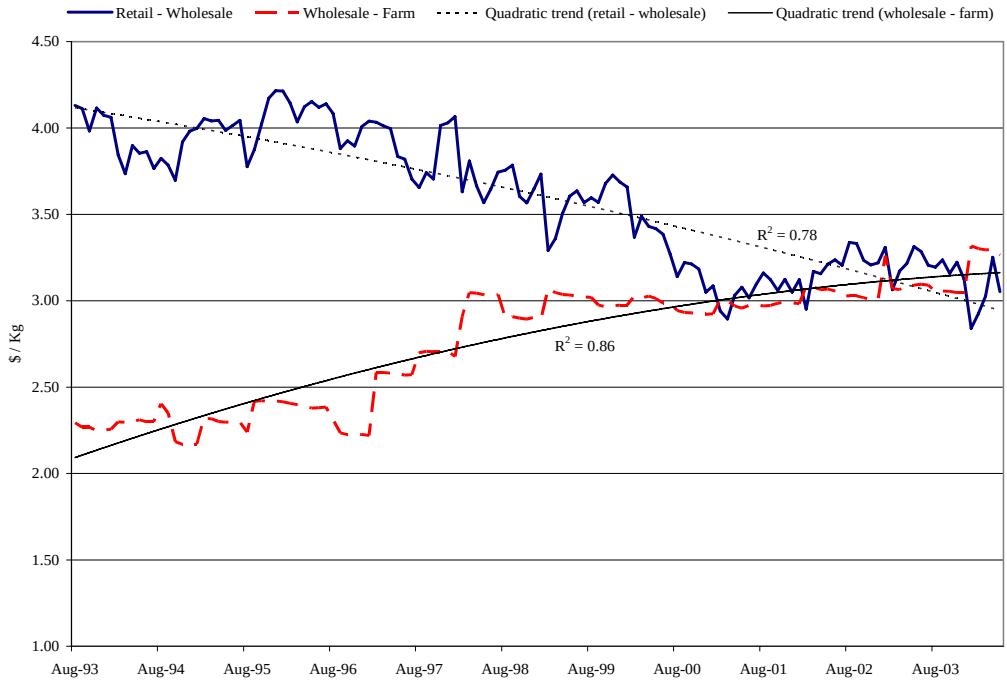


Figure 13. Monthly cheese retail to wholesale and wholesale to farm price spreads (in 1992 dollars) in Quebec from August 1993 to May 2004.

F) Summary

The findings in sub-sections A) through E) are mixed. All graphs relied on a quadratic trend to help visualize the global evolution of prices. However, we did not formally test (in a statistical sense) whether there was a significant trend in prices. Table 2 presents the results of a simple linear trend analysis on the evolution of price spreads between the wholesale and farm sectors and the retail and wholesale sectors. While there seems to be evidence of decreasing spreads between retail and wholesale prices, the retail margin has generally increased in recent years (except in the case of dairy products). The wholesale-to-farm real margins are stable (albeit with a small negative trend) for pork and chicken while it has increased in the beef and dairy sectors.

Table 2. Trend analysis of the wholesale to farm and retail to wholesale price spreads (in 1992 dollars) for selected commodities

Commodity	Wholesale – Farm	Retail – Wholesale	Comments
Pork	Decreasing	Decreasing	The retail to wholesale price spread has increased during the last five years despite the findings that there is a significant and negative linear trend over the 1988-2003 period. The trend in the wholesale to farm margin is negative and significantly different than zero albeit very small.
Beef	Increasing	Increasing	Relatively short sample available which dampens the strength of the findings. The 2003 BSE crisis also introduces structural change in the industry which is difficult to grasp in such a short sample.
Chicken	Decreasing	Decreasing	The retail to wholesale is clearly exhibiting a U-shaped pattern which indicates that the price spreads have increased in the last five years despite the negative linear trend over the 1992-2003 period). Although there is a significant and negative linear trend in the wholesale to farm price spread, it is relatively small.
Butter	Increasing	Decreasing	Wholesale data for butter is not statistically reliable and must be interpreted with caution (see text).
Cheddar cheese	Increasing	Decreasing	Trends are quite strong compared to the other sectors.

We advise readers to refrain from making sweeping generalizations as the above trend analysis covers a limited number of commodities. For instance, grain-based products and horticultural products were not included because their wholesale prices were not readily available. Furthermore, our retail prices were computed using a point estimate in time and updated with consumer price indices. Hence, it seems relevant to further investigate farm-to-retail price spreads directly using price indexes. The latter have the advantage of being available for a greater range of commodities and all Canadian provinces while being consistent with formal statistical data collection methods.

3.2 Farm and retail price indexes

The previous analysis provided a few examples of price transmission along the marketing chain by comparing prices at three different levels (farm, wholesale and retail). It focused on specific geographical areas in Canada and time periods based on data availability. As documented in the data appendix, the reliability of our wholesale data is largely unknown. Moreover, wholesale prices are available for very few geographical areas and, in most instances, only began to be collected recently. It also seems desirable to extend the geographical focus of the previous section to various Canadian regions. The following analysis focuses on the relationship between farm and retail prices in Quebec, Ontario and Alberta. The idea is that if our data reveal similar patterns for these three provinces, then we can be fairly confident that such patterns would be observed in other provinces.

Let R_t and F_t denote respectively the average retail and farm prices in month *t*. The farm and retail price index are defined as: $IR_t = \left(R_t / R_{1992}\right)100$ and $IF_t = \left(F_t / F_{1997}\right)100$; where R_{1992} and F_{1997} are respectively 1992 and 1997 annual average prices. The first obvious challenge in

comparing the two indices is that they are not based on the same period of reference. Hence, we transformed each index such that January 1985 became the base period:[†††††††]

$$IR_t = \left[\frac{(R_t / R_{1992})100}{(R_{Jan/85} / R_{1992})100} \right] 100 = (R_t / R_{Jan/85})100 \qquad (5)$$

$$IF_t = \left[\frac{(F_t / F_{1997})100}{(F_{Jan/85} / F_{1997})100} \right] 100 = (F_t / F_{Jan/85})100 \qquad (6)$$

Hence, the indices defined in (5) and (6) allow us to compare the growth in each price index starting from a common base period. By construction, the two indices start at same value. As a result, the base period (Jan-85) plays an important role in the interpretation of the results (as in any other empirical study relying on indices). The price levels observed in January of 1985 are the benchmarks anchoring the evolution of the indices over time. The trend of an index can be decomposed in two components: a long term trend and a transitory trend. For example, starting from a disequilibrium situation in which the farm price is momentarily below its long term attractor, the growth observed in an index will embody a "catch up" or transitory response to get back along a long term path.

The precedent sections clearly established that it is very difficult to conclude without formal empirical support that the retail and farm prices have grown at different rates. In most instances, the large volatility in one or both prices implies that it is almost impossible to detect any systematic statistical pattern in their behavior. This is why a formal trend analysis on the ratio of the retail price index over the farm price index is needed. Define this ratio to be:

$$\frac{IR_t}{IF_t} = \frac{R_t / R_{Jan/85}}{F_t / F_{Jan/85}} = \frac{R_t}{F_t} \frac{F_{Jan/85}}{R_{Jan/85}} \qquad (7)$$

[†††††††] January 1985 is chosen because it coincides with the first observation available in the sample.

A natural logarithmic transformation of the price index ratio is performed to capture the rate of growth in the ratio from the regression below:

$$\ln\left(\frac{IR_t}{IF_t}\right) = \alpha + \beta t + \varepsilon_t \qquad (8)$$

where t is a time trend that takes on the values of $t = 1, 2, ..., T$ for each month beginning in January of 1985. The coefficient β in (8) can be interpreted as the monthly growth rate in the relative price index. Equation (8) is estimated with the Ordinary Least Squares (OLS) method. To better understand what the trend analysis measures, rewrite (8) as:

$$\ln\left(\frac{R_t}{F_t}\right) = \tilde{\alpha} + \beta t + \varepsilon_t \qquad (9)$$

where $\tilde{\alpha} \equiv \alpha + \ln\left(\frac{F_{Jan/85}}{R_{Jan/85}}\right)$. Hence, while the available data only permits to estimate eq. (8), the above specification tells us that β can also be interpreted as the monthly growth rate in the ratio of the retail to farm prices. A positive coefficient indicates that the retail price has grown at a faster rate than the farm price. Conversely, a negative coefficient suggests that the farm price has increased at a faster rate than its retail counterpart and a coefficient that is not statistically different from zero means that both prices grow at the same pace over time.

A) Pork

Figures 19-21 illustrate the monthly farm and retail price indices (Jan-85 = 100) for pork in Quebec, Ontario and Alberta respectively. Table 3 presents the results of the trend analysis in the ratio of the two indexes. The retail price grows at a faster rate than the farm price in all three provinces. The price spread grows at the highest rate in Ontario.

Table 3. Results of the trend analysis

Commodities	Quebec	Ontario	Alberta
Beef	0.0010*	0.0011*	0.0017*
Pork	0.0011*	0.0022*	0.0006*
Chicken	0.0013*	0.0021*	0.0007*
Dairy products	-0.0004*	0.0001	-0.0007*
Cheese	0.0002*	0.0002	-0.0005*
Butter	-0.0005*	0.0000	-0.0001*
Fresh vegetables	0.0004**	0.0002	0.0010
Bakery and other cereal products	0.0017*	0.0026*	0.0004

Note: the symbols *, ** and *** denote significance at the 1%, 5% and 10% levels respectively. The coefficients reported are the monthly growth rates of the retail-farm price ratios.

B) Beef

Figures 22-24 show the monthly farm and retail price indices (Jan-85 = 100) for beef in Quebec, Ontario and Alberta. The two indices are fairly volatile and overlap significantly in Quebec, which contrasts with the patterns observed for Ontario and Alberta where the retail price has clearly increased faster than the farm price during the last twenty years. This observation is confirmed by the trend analysis reported in Table 3. All three provinces exhibit a statistically significant and positive trend in the relative price. The retail price has grown at a faster pace than the farm price and the growth rate differential is highest in Alberta.

C) Chicken

Figures 25-27 show the growth in the monthly farm and retail price indices for chicken in Quebec, Ontario and Alberta respectively. The chicken retail price grows at a faster rate than the farm price in all three provinces. Once again, the growth in the relative price (retail over farm) is highest in Ontario.

D) Dairy products

Figures 28-30 compare the trend of the monthly farm milk price index to that of the retail dairy product price index for Quebec, Ontario and Alberta respectively. The farm price index seems a little more volatile than the retail price index. The trend in the two indices is quite similar. Our result is consistent with the findings of Gordon and Hazledine (1996) that a one percent increase in the farm price results in a one percent change in the butter retail price. A similar conclusion can be drawn from looking at figures 31 through 37. The monthly farm milk price index and butter price index at the retail level are plotted in figures 31-33 while figures 34-36 show the monthly farm milk price index and cheese price index at the retail level. Results of the trend analysis suggest that the farm price might have grown at a faster pace than the retail price in the dairy sector. For example, the trend coefficient in the Alberta cheese equation is -0.0005 (and significant at the 99% confidence level). This coefficient amounts to a 0.6% difference in the *annual* growth rates of the retail and farm prices.

E) Fresh vegetables

Figures 37-39 present the monthly farm price and retail price indices of fresh vegetables in Quebec, Ontario and Alberta respectively. Both series are quite volatile in each province. Vegetables prices are notorious for their systematic seasonal cycles. There is a significant positive trend in the ratio of retail to farm prices in Quebec but this trend is not statistically significant in the other two provinces.

E) Bakery and cereal products

Finally, figures 40-42 display the monthly grain farm price and bakery and cereal product retail price indices for a sample beginning in January of 1985 and ending in April of 2004. Grain

prices are highly volatile and it is difficult to detect a significant time trend at a glance. Despite this volatility, our regression detected a strong and positive trend in the ratio of the two prices in Quebec and Ontario. In contrast, the trend coefficient is not statistically different from zero for Alberta. However, visual inspection of Figure 42 reveals that there is a positive trend in the retail price index while grain prices exhibit a mean reverting pattern just as in figures 40 and 41.

4. SUMMARY AND POLICY IMPLICATIONS

The objective of this paper was twofold. First, we reviewed the literature on margin determination and presented a stripped down (yet popular) model of price determination that accounts for imperfect competition in a closed economy. We discussed how changes in wholesalers' marketing costs (which include labor, capital services, energy, etc.) and changes in consumer preferences impacted prices at the farm level and in downstream markets. We then proceeded to discuss the implications of a small open economy which is more germane to the actual market conditions for most Canadian commodities. Aside from supply managed commodities, farm prices are established in a global context while retail prices are more closely linked to regional factors even though we presented evidence in the introduction that food retail is truly becoming a global business. Other factors that influence price transmission along agri-food supply chains are: the length of production lags and the perishable nature of foods, hold ups, collusion and product differentiation. Hence, an increase (or decrease) in a price spread can imply a number of things.

The second part of the research provided an empirical analysis of price spreads. We plotted farm, wholesale and retail prices and farm-wholesale and wholesale-retail margins and conducted a formal trend analysis for various sets of related products (*e.g.*, milk versus cheese) for different provinces. The empirical analysis does not allow us to infer anything about the

existence (or absence) of market power at any level of the market. One lesson that emerges from the pursuit of our objectives is that prices and hence margins are affected by many factors, and as a result, it is dangerous to make sweeping generalizations even when similar patterns are observed across some product lines because the factors responsible need not be the same. This is true for trends, as farm prices tend to have grown faster (slower) than retail prices for dairy products (meats), but it also applies to volatility. For example, we often hear that retail prices are sluggish in comparison to farm prices. Our plots confirm this assertion for cereals and bakery products, milk, butter and cheese and pork. However, we found retail price indices to be more volatile than farm prices for chicken and vegetables.

For non supply-managed commodities, the retail-to wholesale price spread has increased in recent years while the farm to wholesale price spreads for the pork and beef sectors have respectively followed negative and positive trends. However, these trends are not very pronounced. In other sectors, wholesale to farm price spreads have generally increased while the retail to wholesale price spread has decreased. Without further in-depth industry-specific analysis to account for trade and domestic policies, productivity growth and market structure, it could be misleading to attempt to impute weights on the factors responsible for these trends and the implications for farm income. The high degree of concentration at the retail, food processing and farm input manufacturing levels is certainly a prime candidate to explain price spreads, but a thorough understanding of the behaviour of all the major players along the marketing chain is needed to make educated inferences about margins. An increase in concentration by itself is not the only underlying cause of increasing margins. After all, there exists evidence in the agricultural economics literature that increases in concentration have improved enough efficiency to offset the effect of increases in market power. In a small open economy like

Canada's, farm prices are generally aligned with world market conditions while regional market features (like supply and demand conditions) are more likely to influence retail prices. Accordingly, it may be difficult for downstream firms to exercise market power at the expense of farmers.

Attempts to by-pass the large players to market new food products are likely to fail. Large processors, distributors and retailers are better positioned than producers to market new lines of products (like bio or organic products or *produits du terroir* that exploit regional attributes).[‡‡‡‡‡‡‡] By the same token, producers-led vertical integration is not likely to be a viable solution either. Beside the "know-how" issue, the ability of producer groups to access credit is limited. The same thing can be said, perhaps to a lesser degree, about coops. Furthermore, competitive pressures would force producer groups to behave like the very people they may wish to replace.[§§§§§§§]

Agricultural trade liberalization can help producers negotiate better prices by given them improved export options. The loss of export options has been dramatic for beef and dairy producers since the beginning of the mad cow crisis. Unexpected trade interruptions of indeterminate lengths are most worrisome as they can be seemingly legitimized by variations on the precautionary principle, without regard for the available information about health and environmental risks. Ironically, trade liberalization might be the "best" tool to mitigate increasing retail-to-farm price spreads as trade and market integration usually discipline the

[‡‡‡‡‡‡‡] Regional differentiation and process differentiation, especially when it emphasizes animal welfare, are more exploited in Europe than in North America. Casual evidence suggests that large French distributors have internalized most of the gains. In Canada, Loblaws is a major player in the distribution of organic foods.

[§§§§§§§] Upon announcing their take-over of the Colbex slaughtering facility, the Quebec dairy producers made it known that they hoped to retain the services of the managers that they had accused of setting immoral prices.

exercise of market power. As trade liberalization progresses, we should witness significant declines in transaction costs that will curb market power and hold-up scenarios.[********]

Tariffs on certain agricultural products and food items are very high (to the point of providing redundant protection). This is the case for dairy products in Canada. In these sectors, trade liberalization would reduce retail, wholesale and farm prices, and more so when it would induce significant changes in domestic policies. Opposition to liberalization from powerful lobbies has been very effective in the past, but there are signs that it will be increasingly difficult to counter international pressures. The impact that trade liberalization would have on margins is difficult to ascertain for many reasons. One aspect to consider is that capacity-constrained firms tend to be less aggressive. Therefore, it could be that the farm-wholesale margin would fall.

[********] Obviously, if liberalization is accompanied by increases in foreign investments and trade becomes concentrated in the hands of multinational subsidiaries, trade liberalization may not be effective in disciplining market power. Whether trade and competition policies are complementary or substitute policies is still being debated in the literature (*e.g.*, Horn and Levinsohn, 2001).

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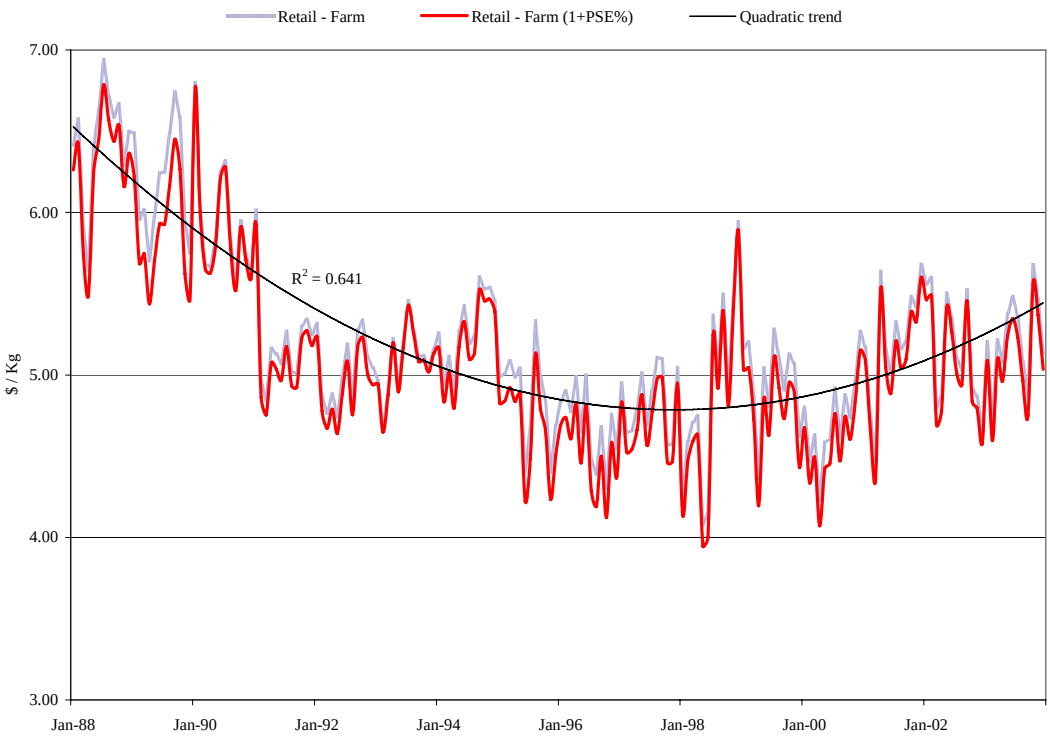

Figure 14. Monthly pork retail to farm price spread (in 1992 dollars) in Quebec from January 1988 to December 2003.

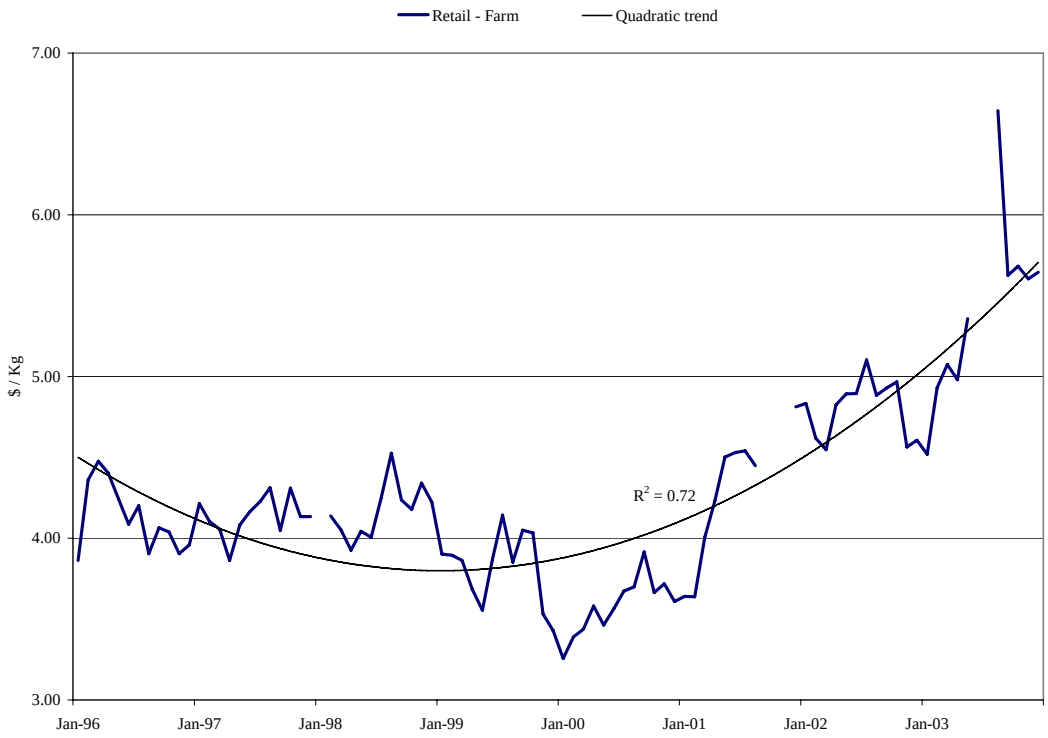

Figure 15. Monthly beef retail to farm price spread (in 1992 dollars) in Quebec from January 1996 to December 2003.

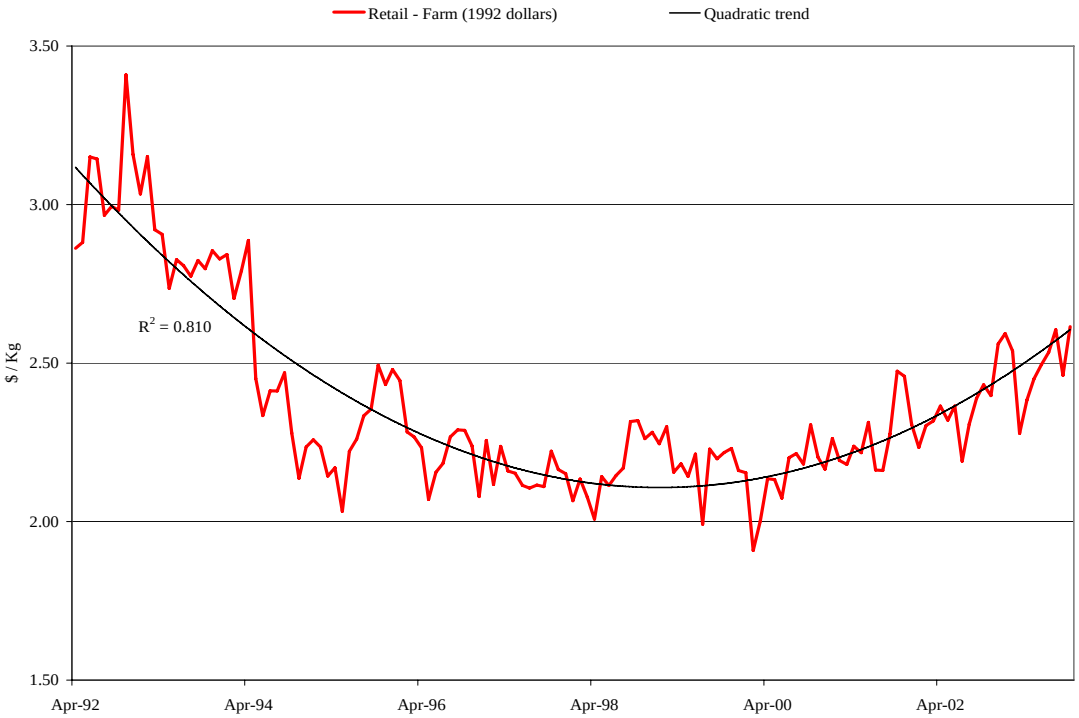

Figure 16. Monthly chicken retail to farm price spreads (in 1992 dollars) in Ontario from April 1992 to December 2003.

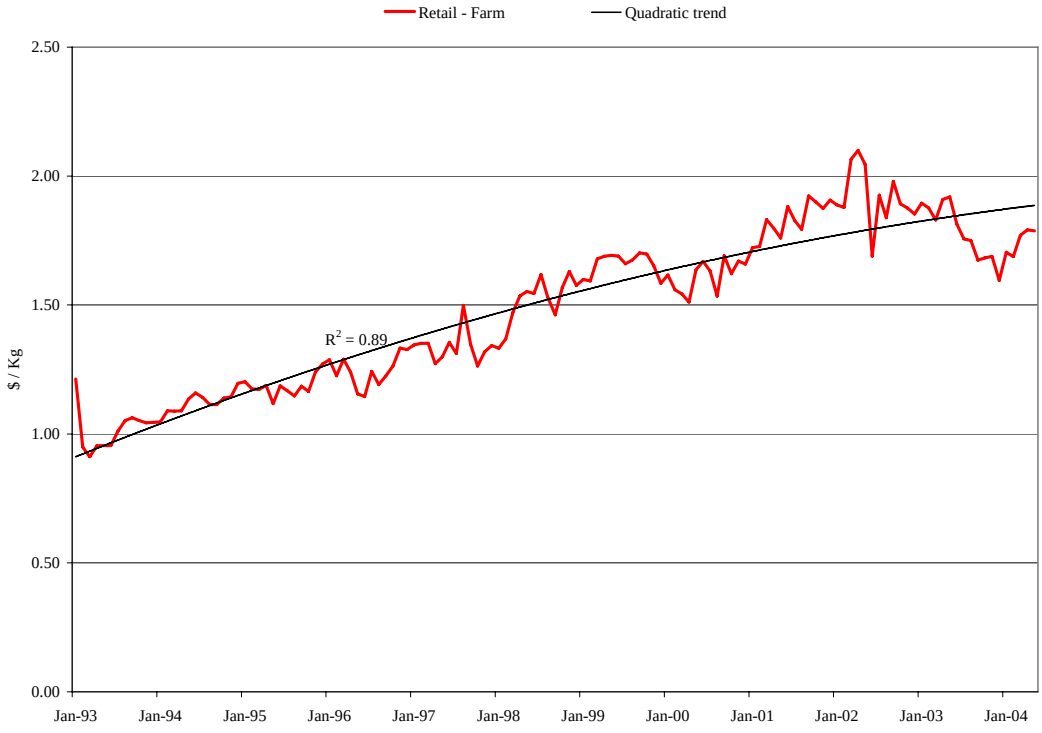

Figure 17. Monthly butter retail to farm price spreads in 1992 dollars in Quebec from January 1993 to May 2004.

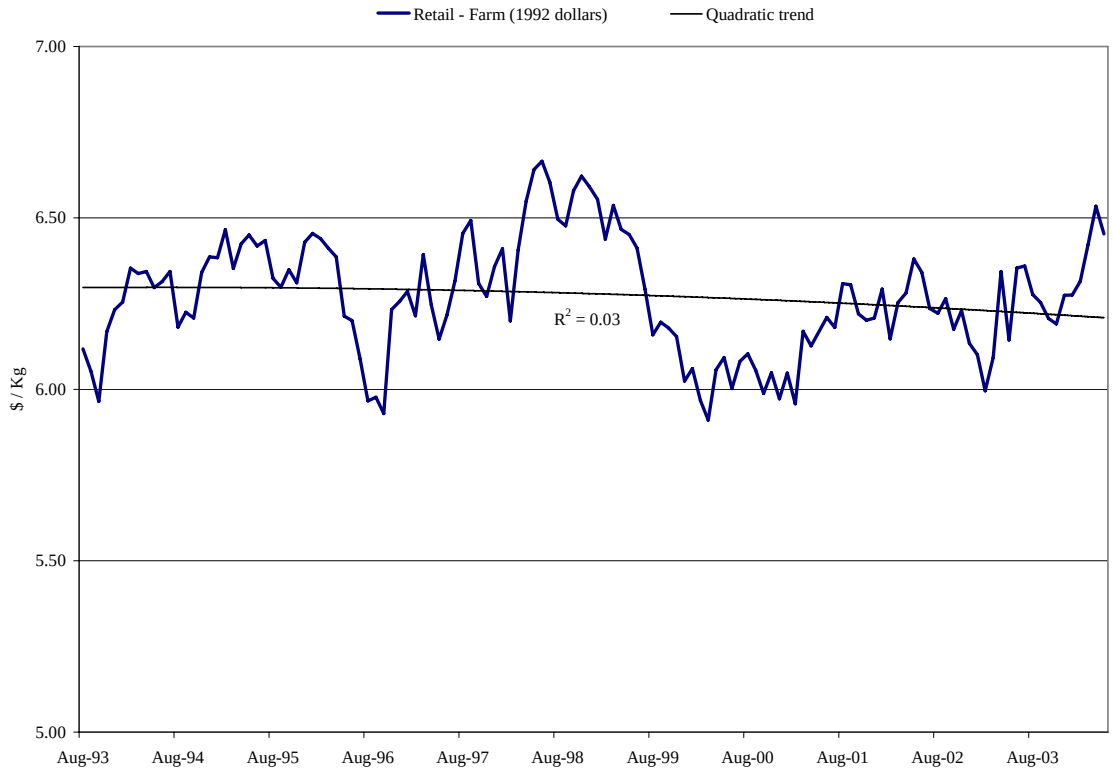

Figure 18. Monthly cheese retail to farm price spreads (in 1992 dollars) in Quebec from August 1993 to May 2004.

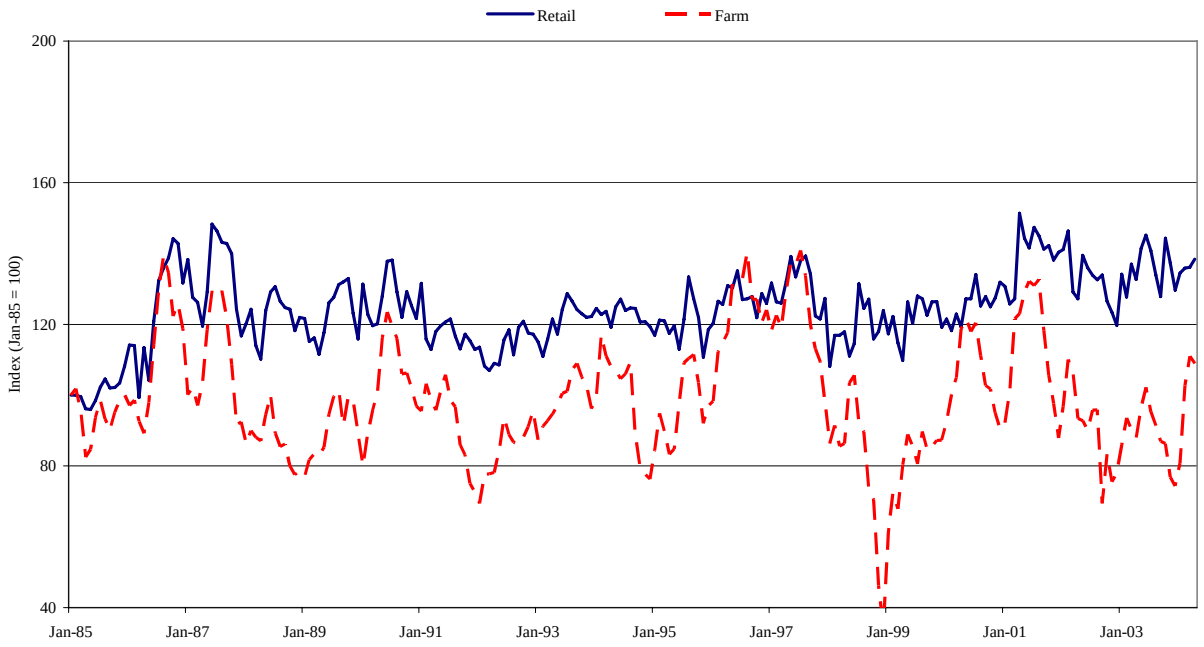

Figure 19. Index of farm and retail pork prices (Jan-85 = 100) in Quebec, January 1985 to April 2004.

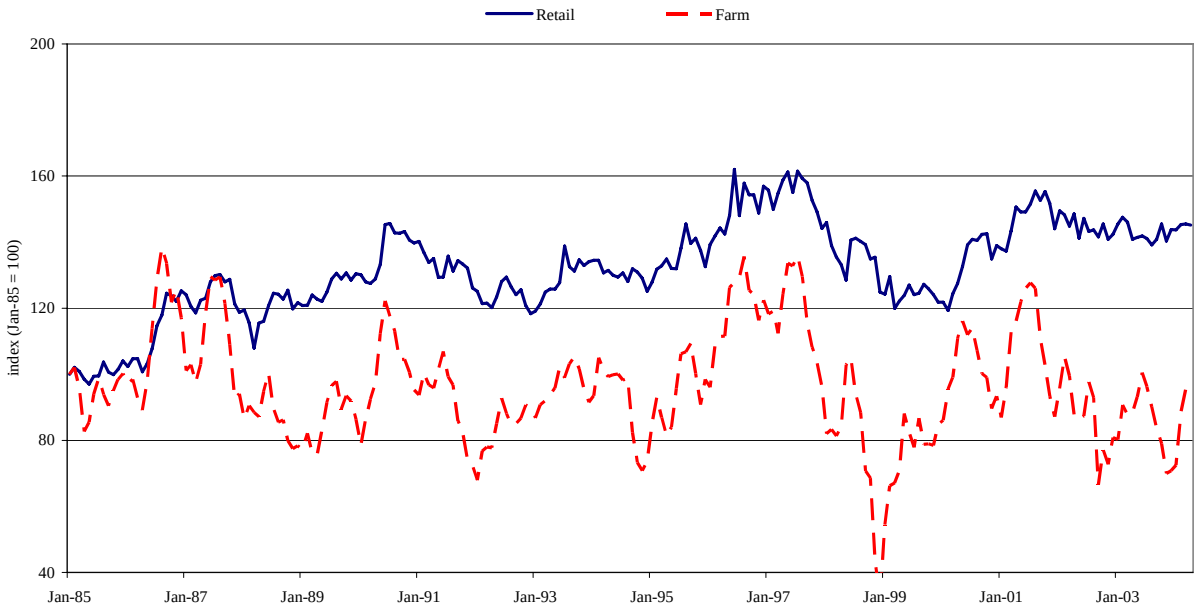

Figure 20. Index of farm and retail pork prices (Jan-85 = 100) in Ontario, January 1985 to April 2004.

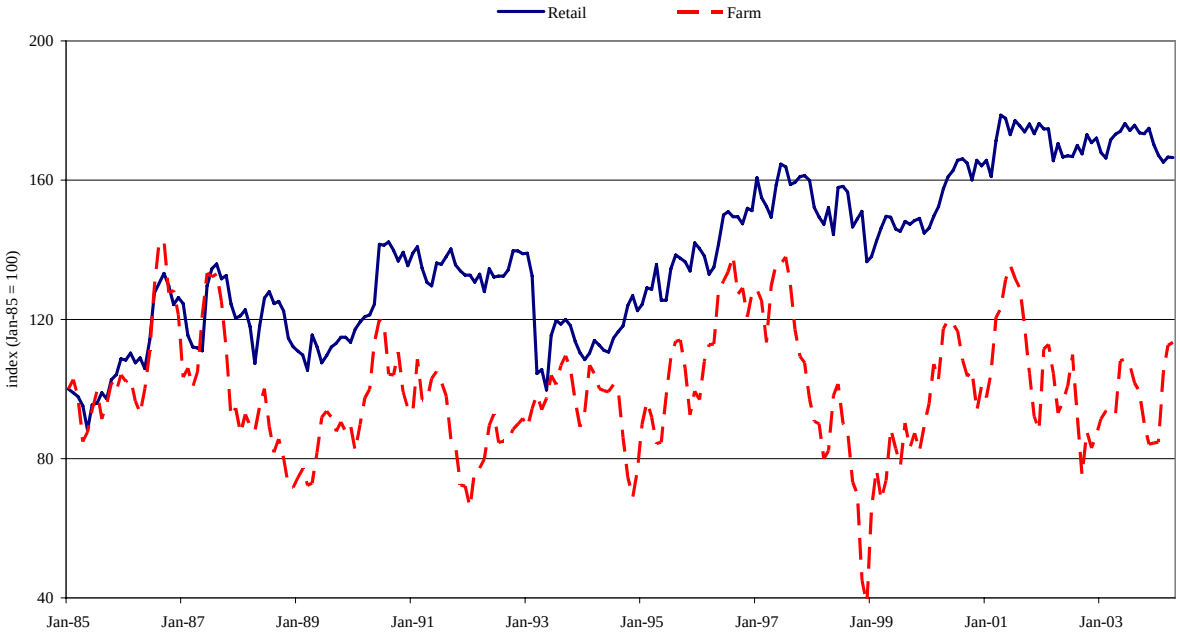

Figure 21. Index of farm and retail pork prices (Jan-85 = 100) in Alberta, January 1985 to April 2004.

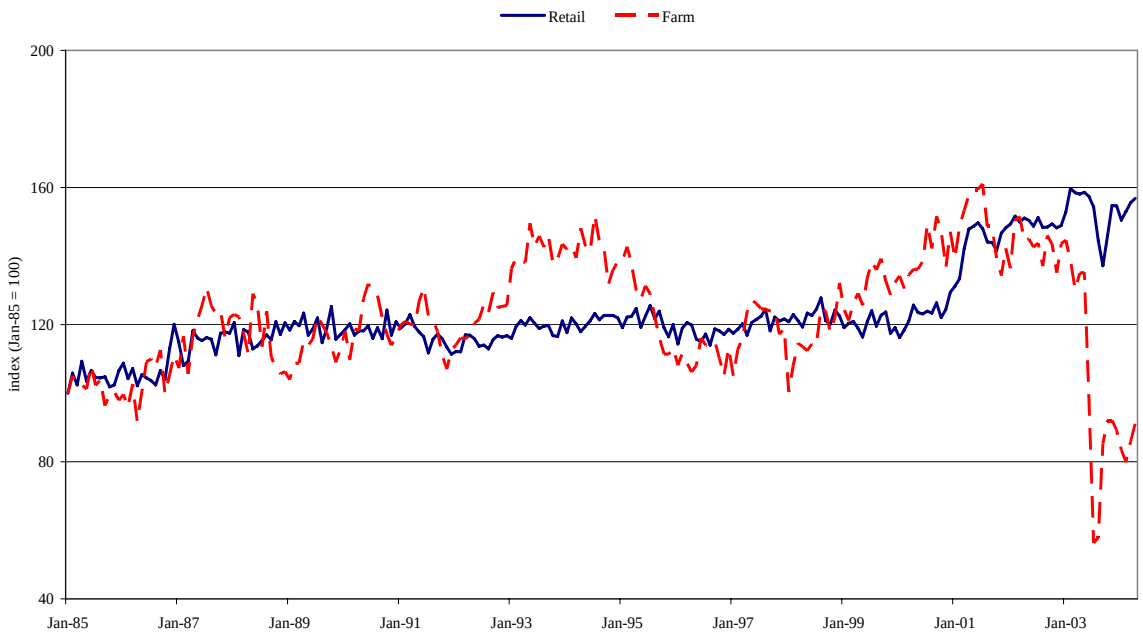

Figure 22. Index of farm and retail beef prices (Jan-85 = 100) in Quebec, January 1985 to April 2004.

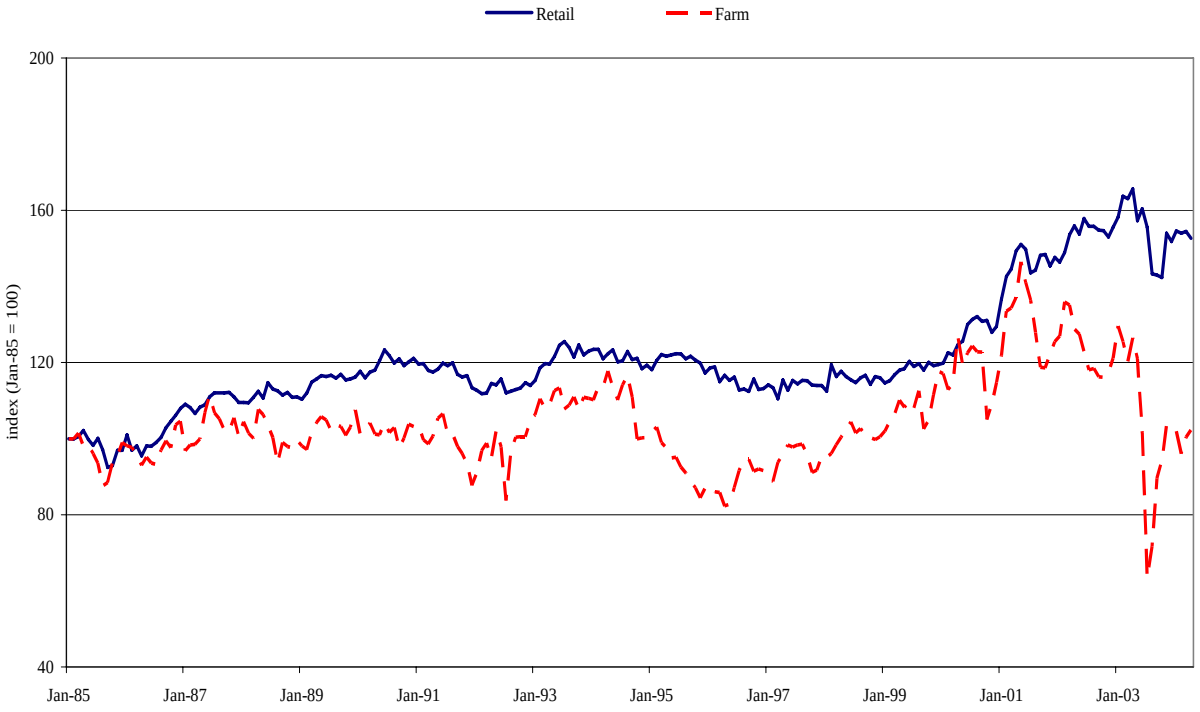

Figure 23. Index of farm and retail beef prices (Jan-85 = 100) in Ontario, January 1985 to April 2004.

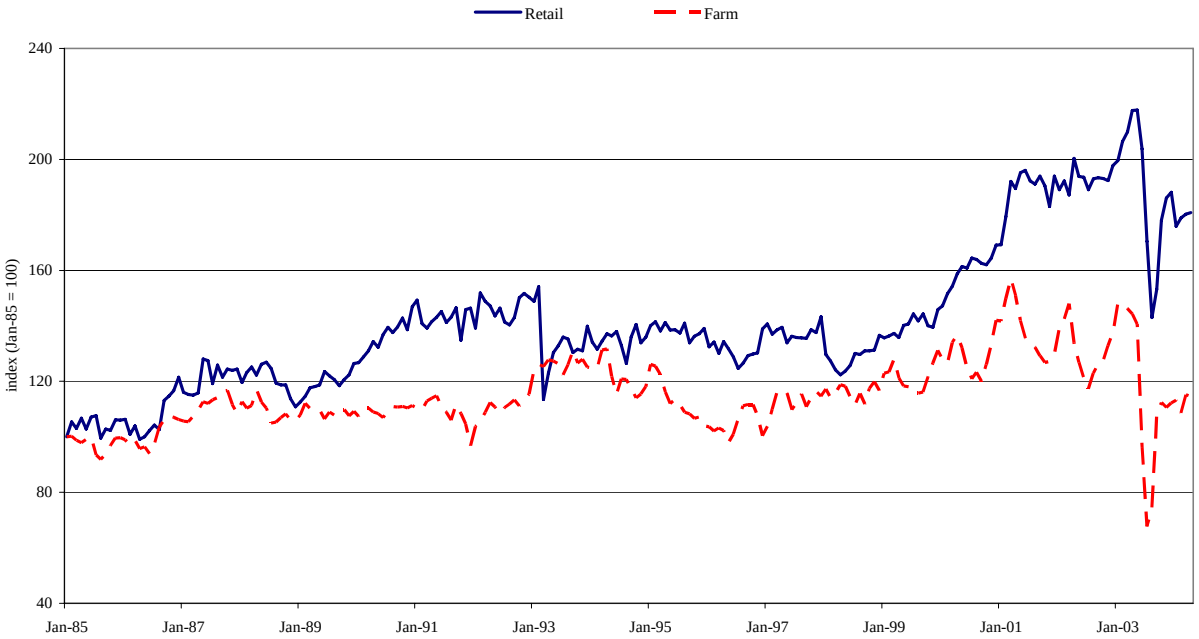

Figure 24. Index of farm and retail beef prices (Jan-85 = 100) in Alberta, January 1985 to April 2004.

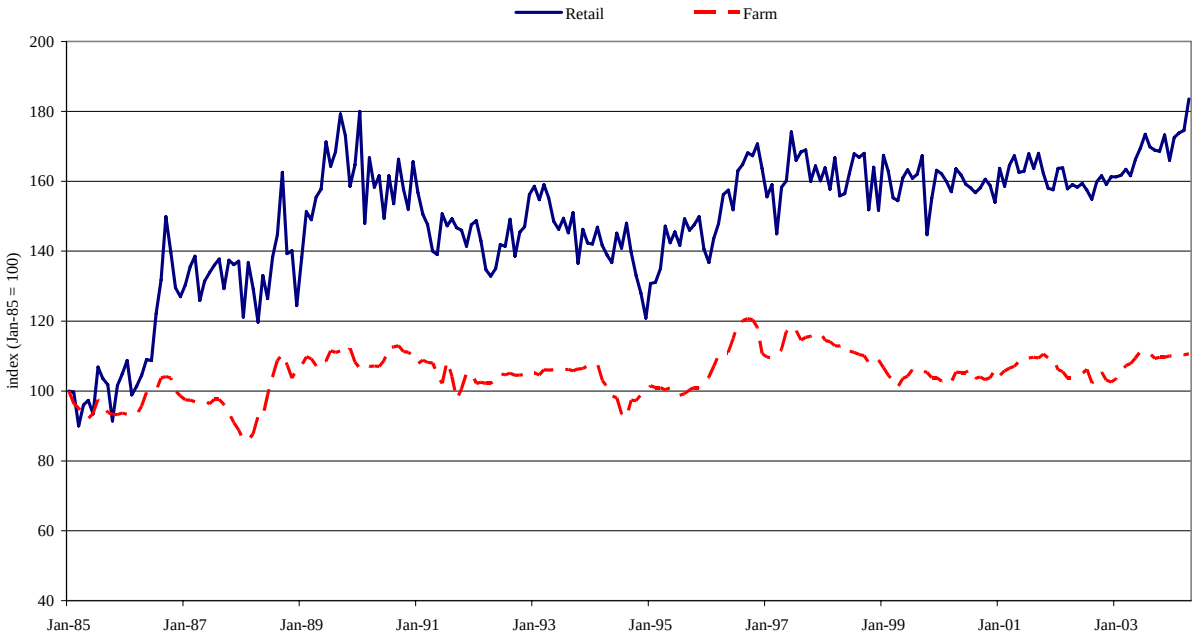

Figure 25. Index of farm and retail chicken prices (Jan-85 = 100) in Quebec, January 1985 to April 2004.

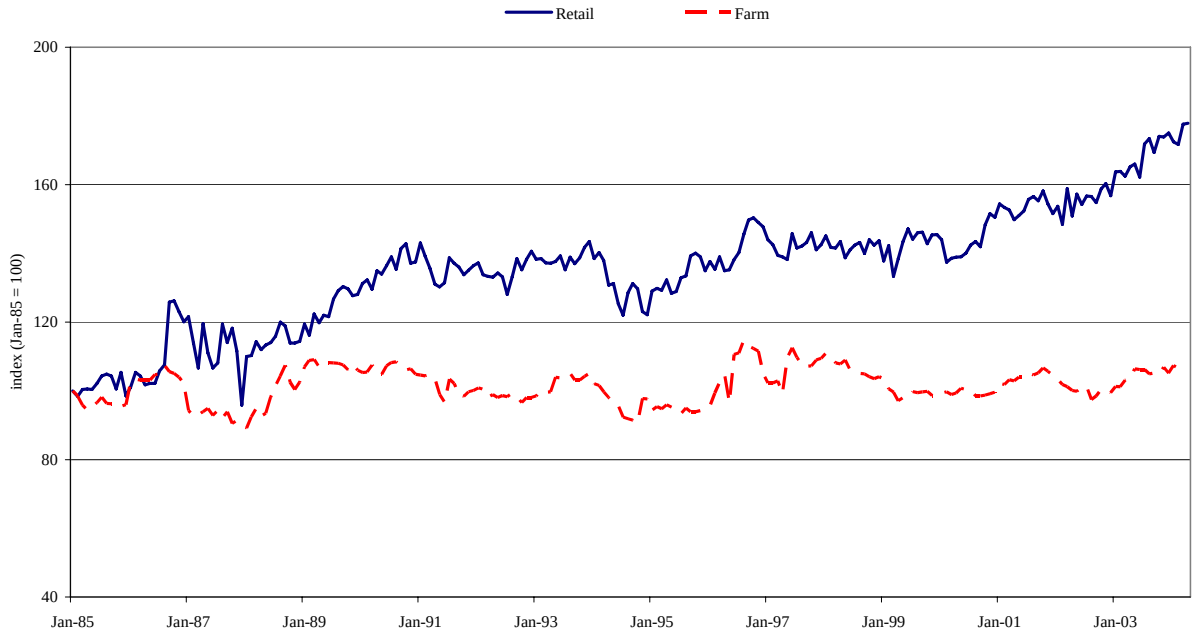

Figure 26. Index of farm and retail chicken prices (Jan-85 = 100) in Ontario, January 1985 to April 2004.

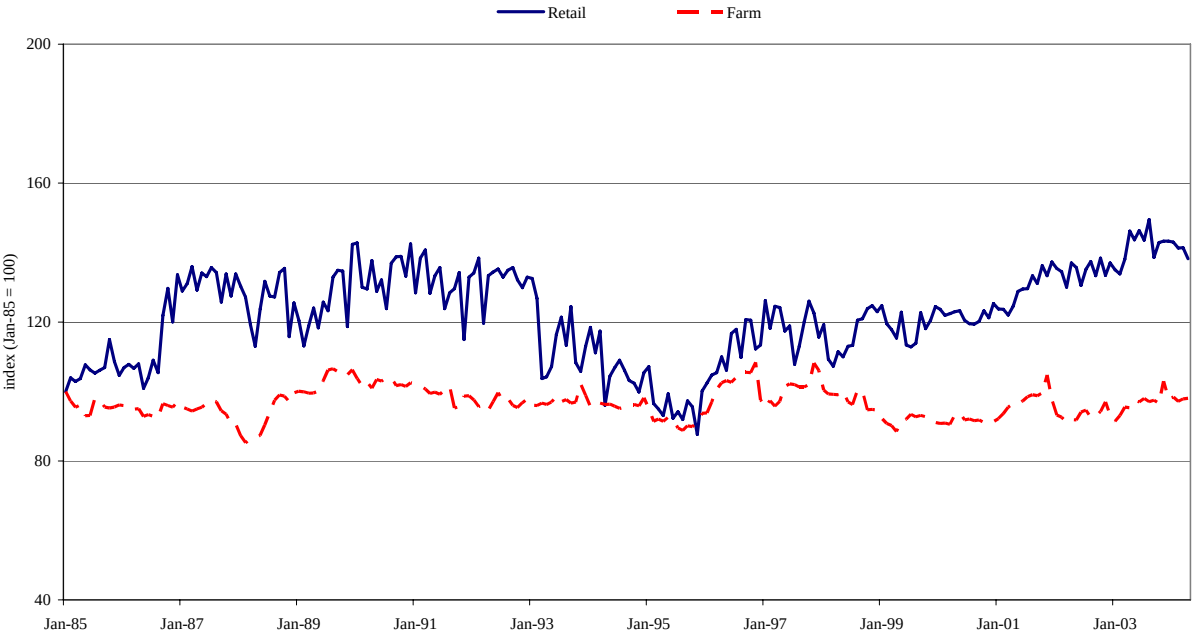

Figure 27. Index of farm and retail chicken prices (Jan-85 = 100) in Alberta, January 1985 to April 2004.

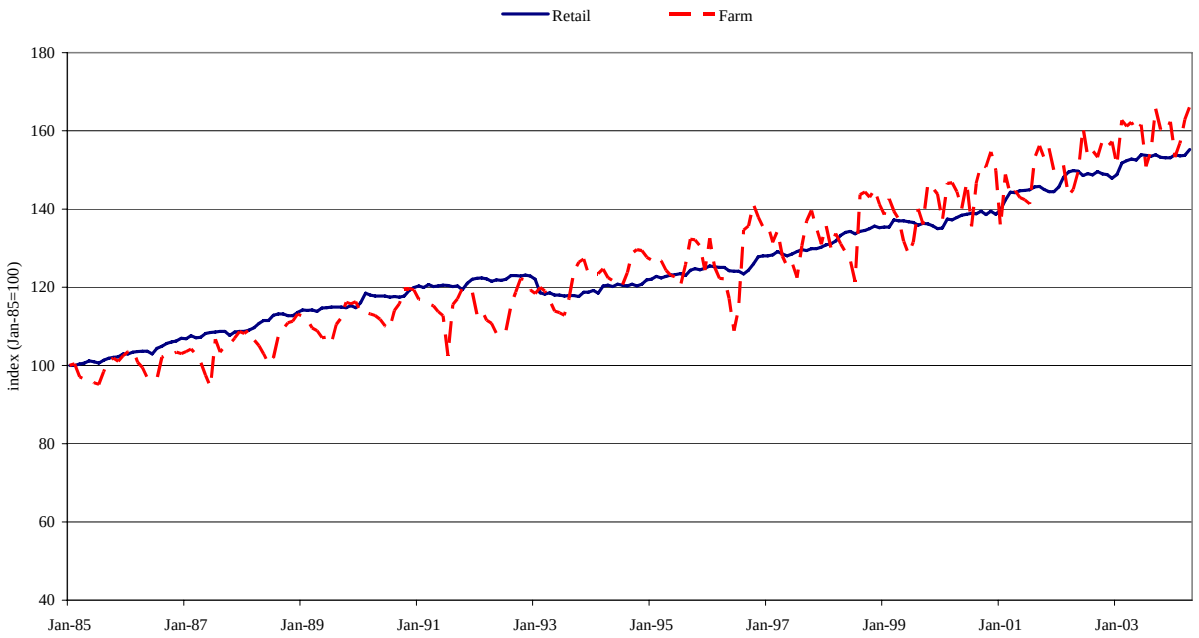

Figure 28. Indices of farm milk prices and retail dairy product prices (Jan-85 = 100) in Quebec, January 1985 to April 2004.

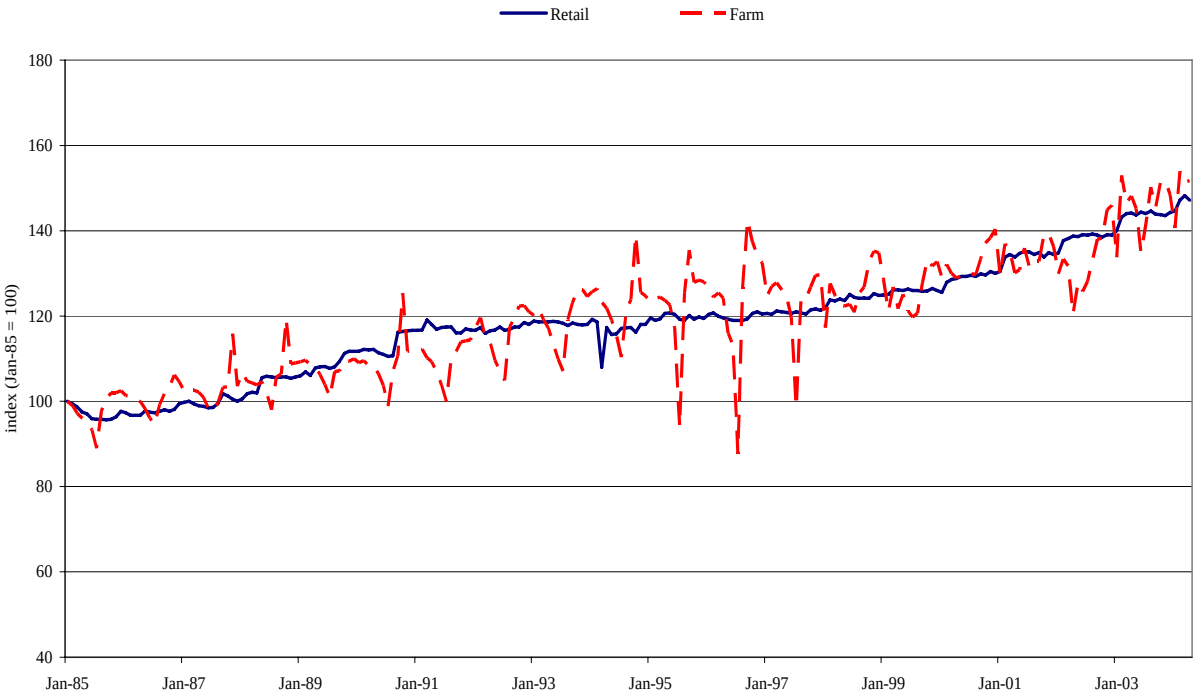

Figure 29. Indices of farm milk prices and retail dairy product prices (Jan-85 = 100) in Ontario, January 1985 to April 2004.

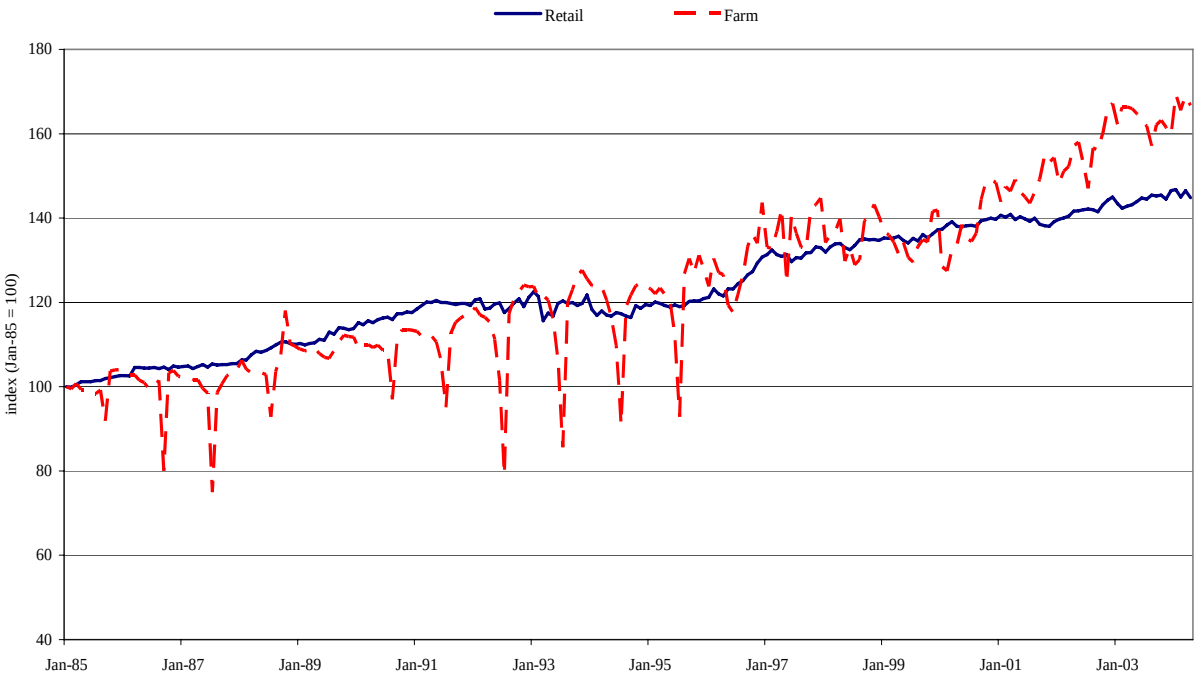

Figure 30. Indices of farm milk prices retail dairy product prices (Jan-85 = 100) in Alberta, January 1985 to April 2004.

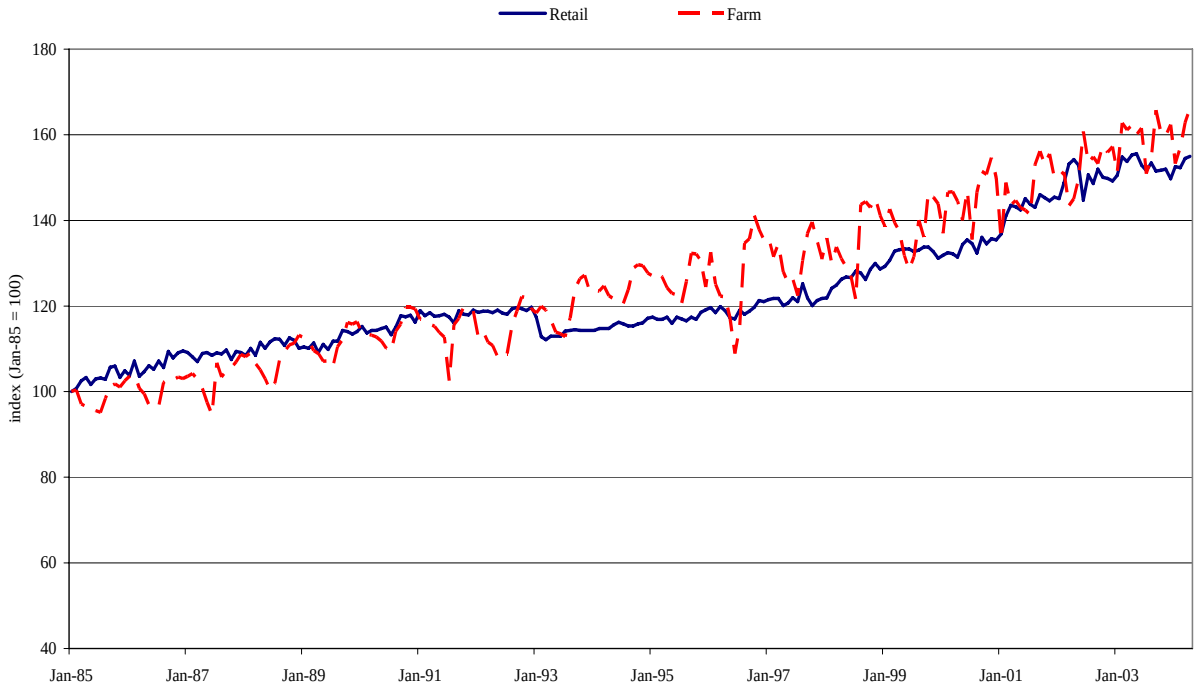

Figure 31. Indices of farm milk prices and retail butter prices (Jan-85 = 100) in Quebec, January 1985 to April 2004.

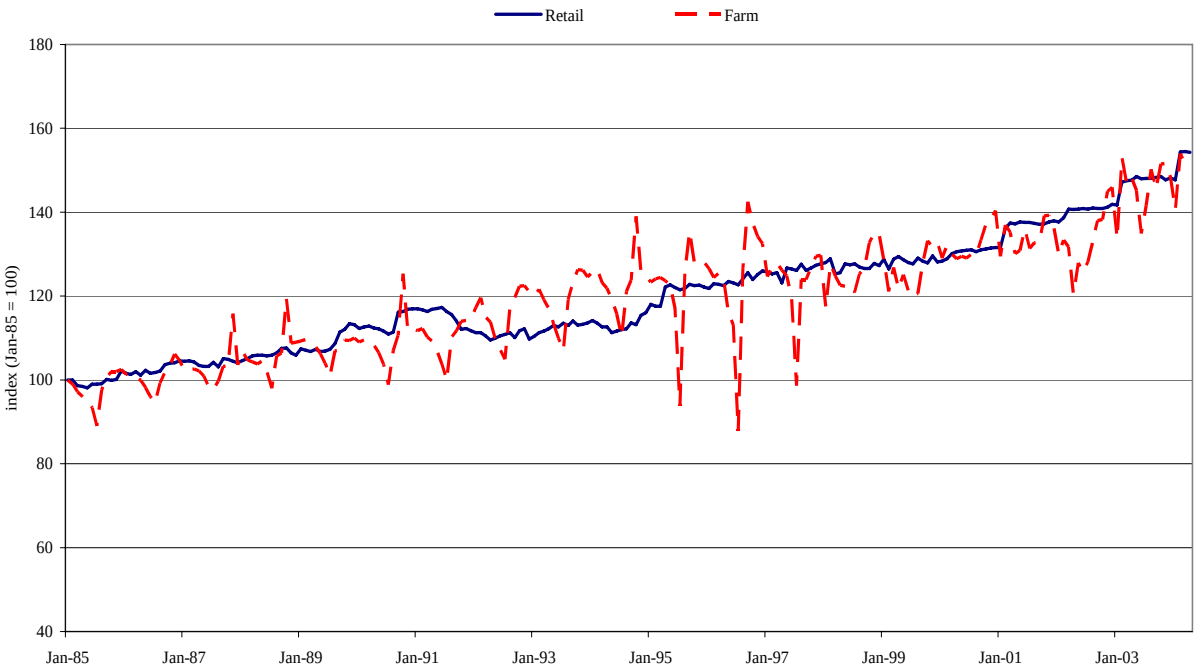

Figure 32. Indices of farm milk prices and retail butter prices (Jan-85 = 100) in Ontario, January 1985 to April 2004.

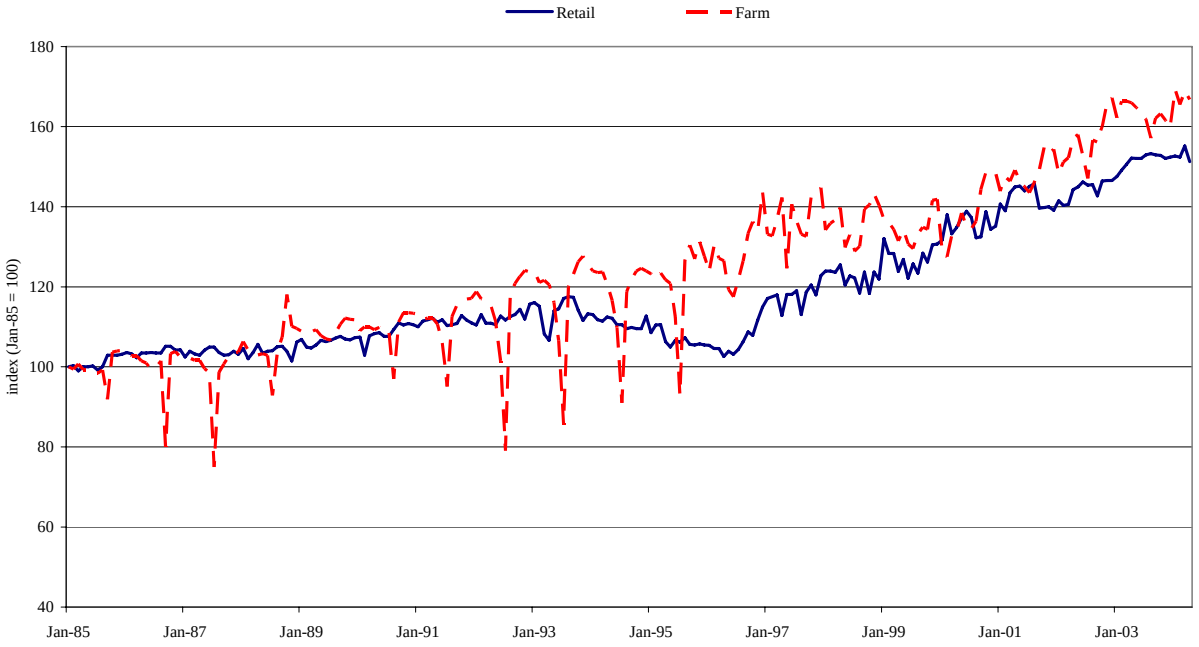

Figure 33. Indices of farm milk prices and retail butter prices (Jan-85 = 100) in Alberta, January 1985 to April 2004.

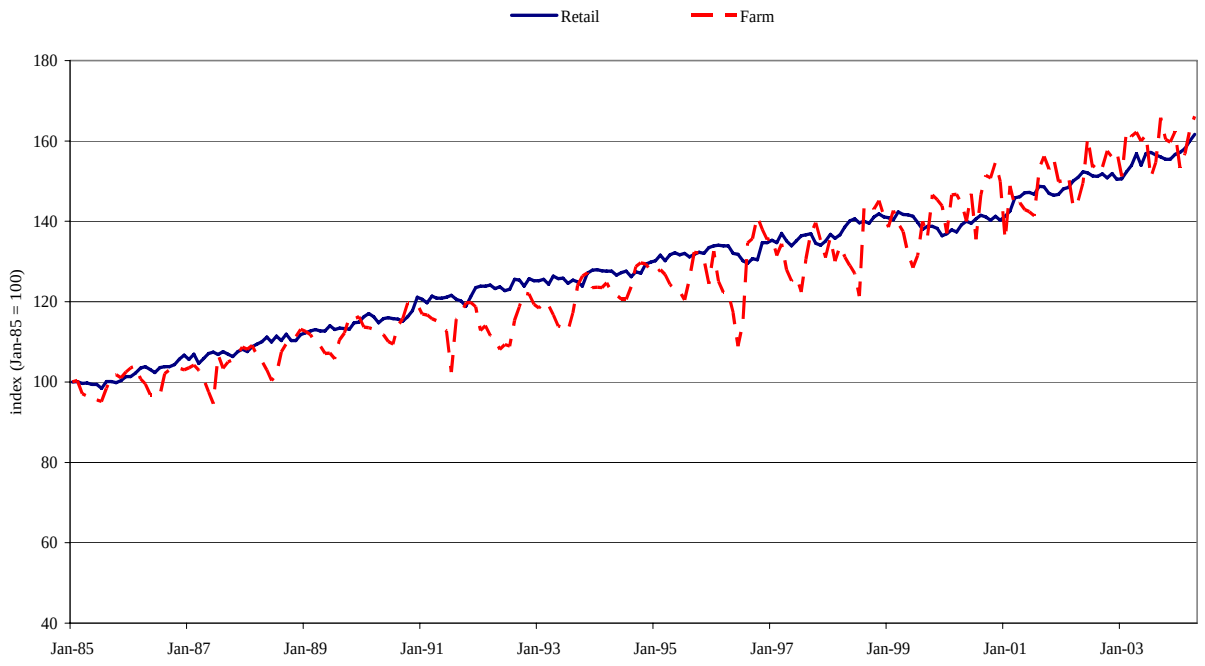

Figure 34. Indices of farm milk prices and retail cheese prices (Jan-85 = 100) in Quebec, January 1985 to April 2004.

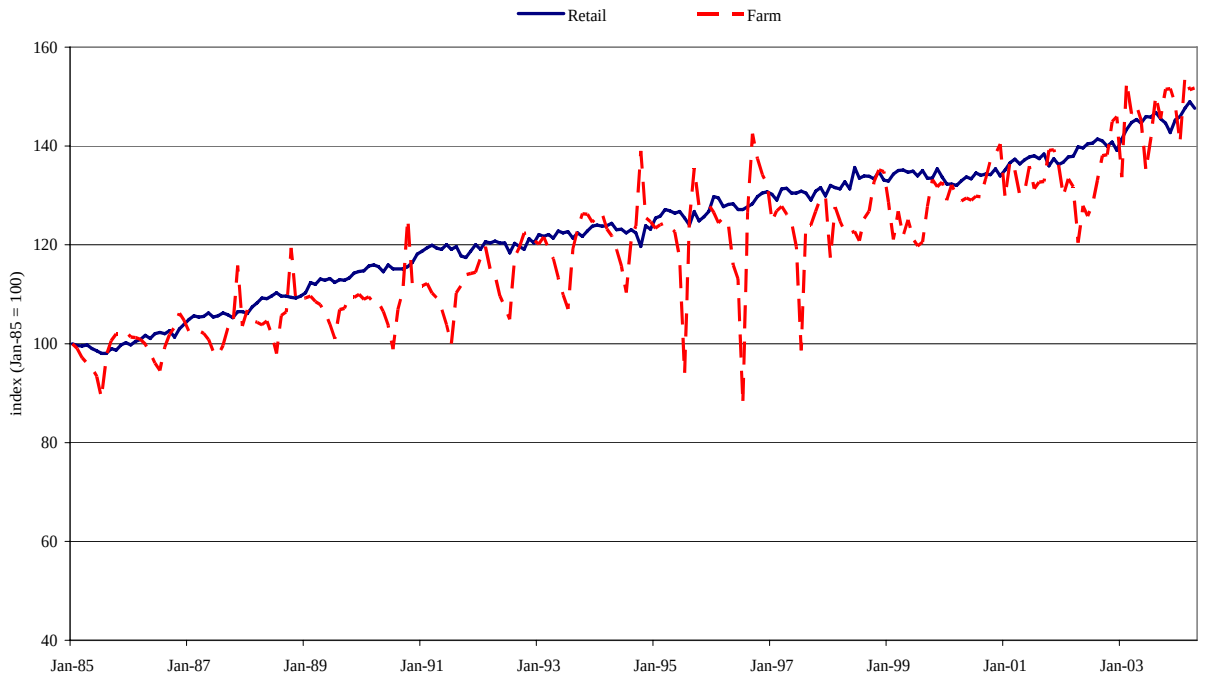

Figure 35. Indices of farm milk prices and retail cheese prices (Jan-85 = 100) in Ontario, January 1985 to April 2004.

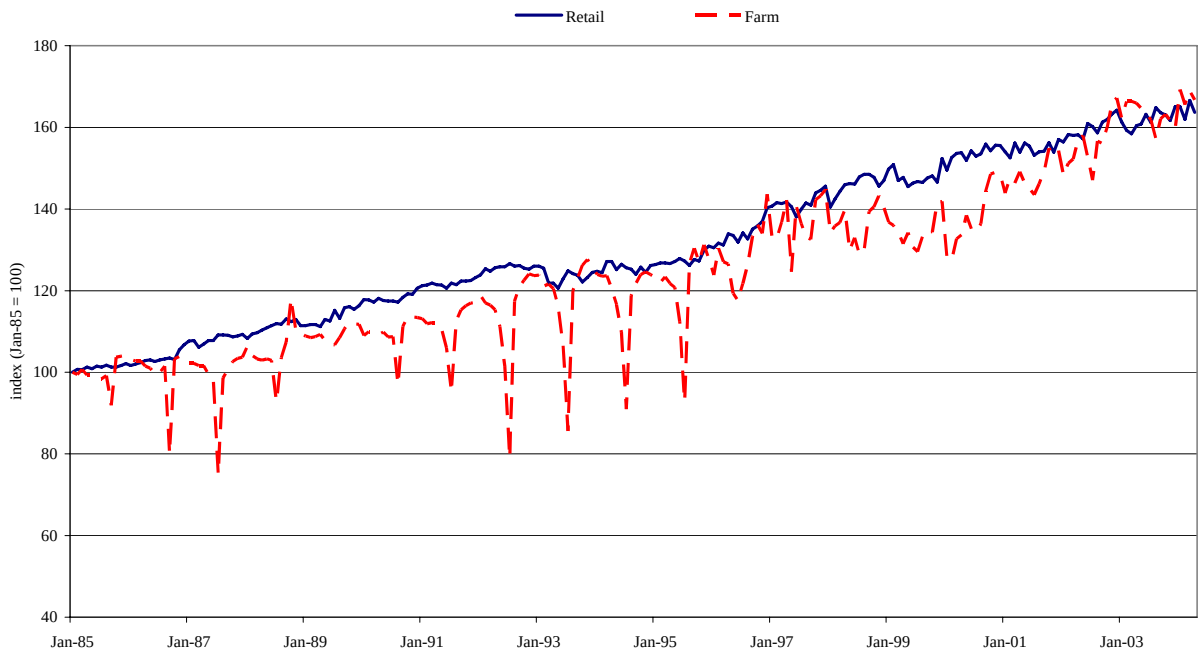

Figure 36. Indices of farm milk prices and retail cheese prices (Jan-85 = 100) in Alberta, January 1985 to April 2004.

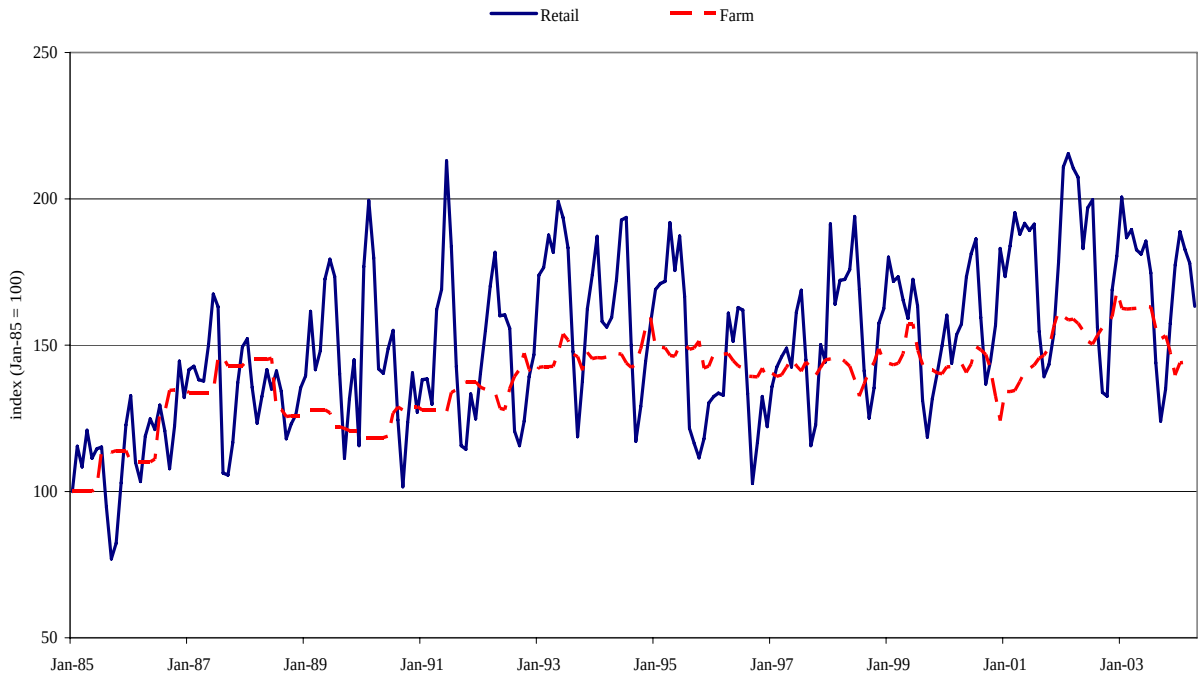

Figure 37. Indices of farm and retail fresh vegetable prices (Jan-85 = 100) in Quebec, January 1985 to April 2004.

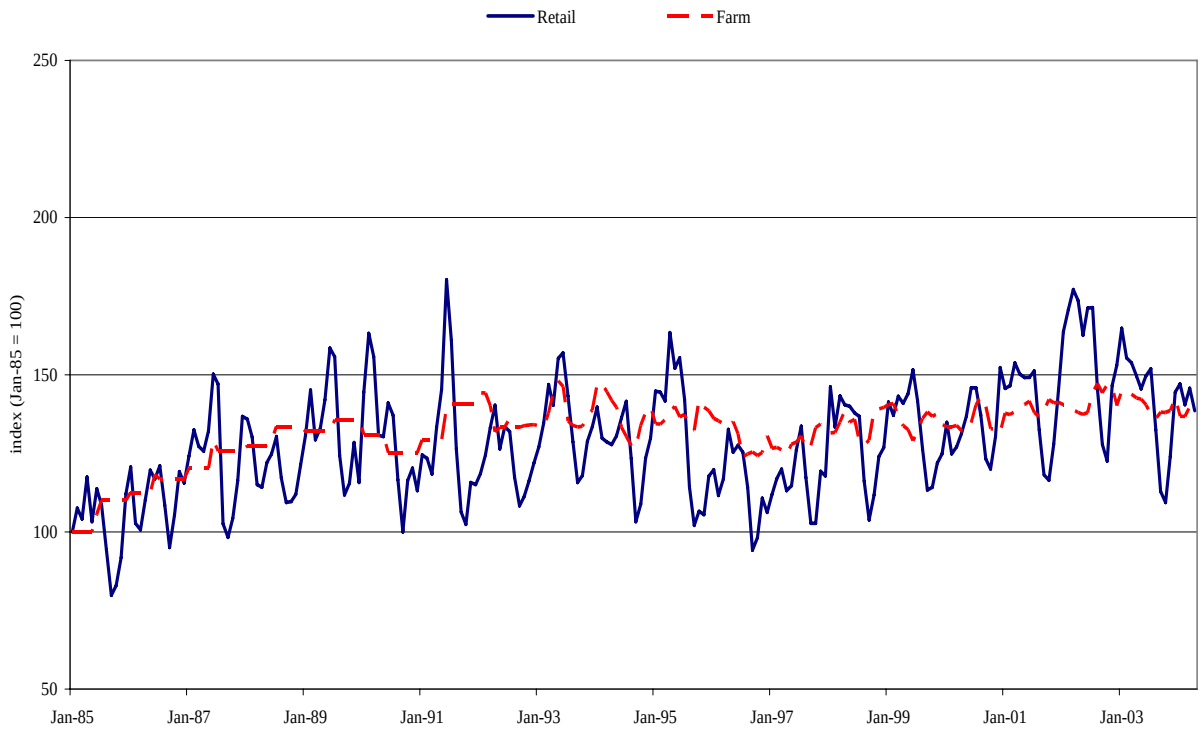

Figure 38. Indices of farm and retail fresh vegetable prices (Jan-85 = 100) in Ontario, January 1985 to April 2004.

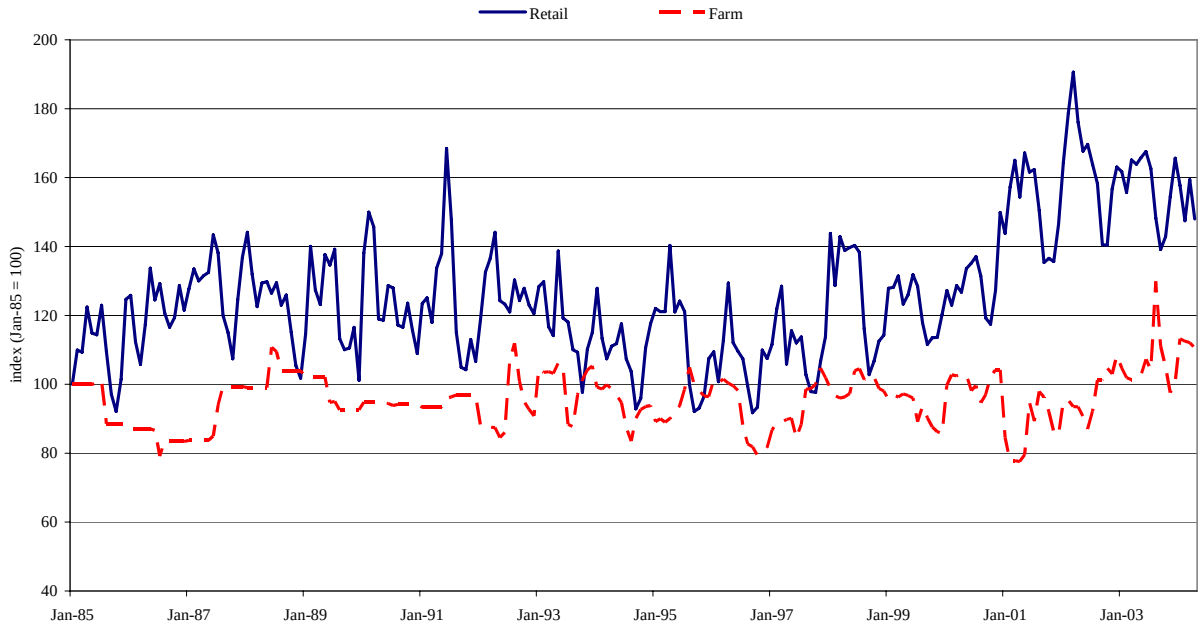

Figure 39. Indices of farm and retail fresh vegetable prices (Jan-85 = 100) in Alberta, January 1985 to April 2004.

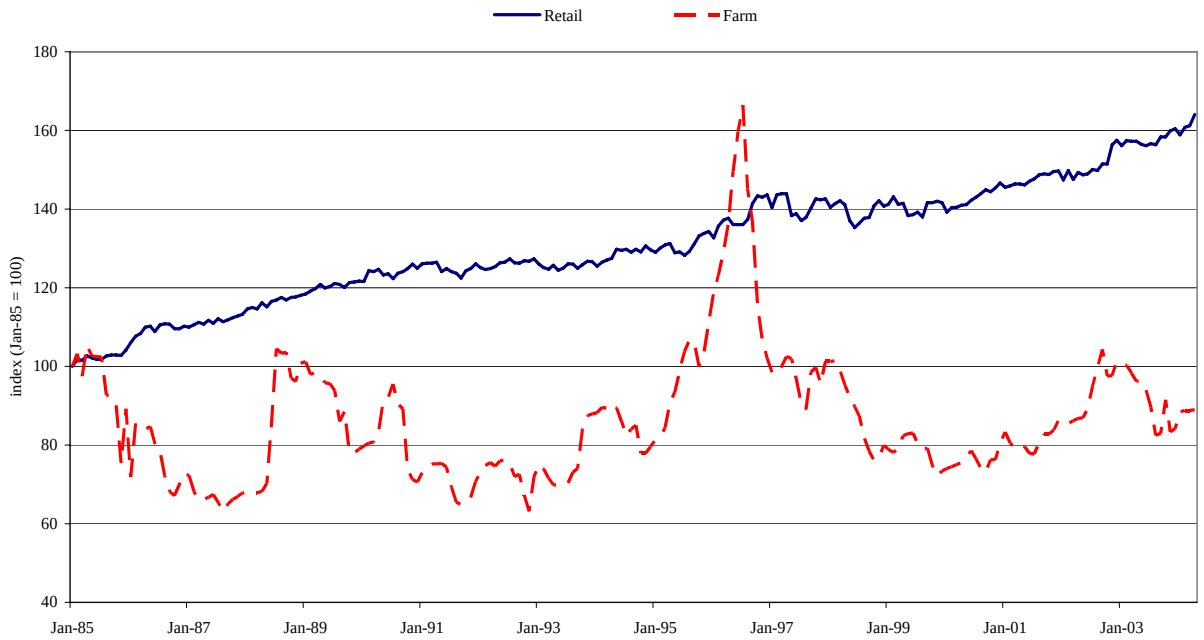

Figure 40. Indices of farm grain prices and retail prices of bakery and cereal products (Jan-85 = 100) in Quebec, January 1985 to April 2004.

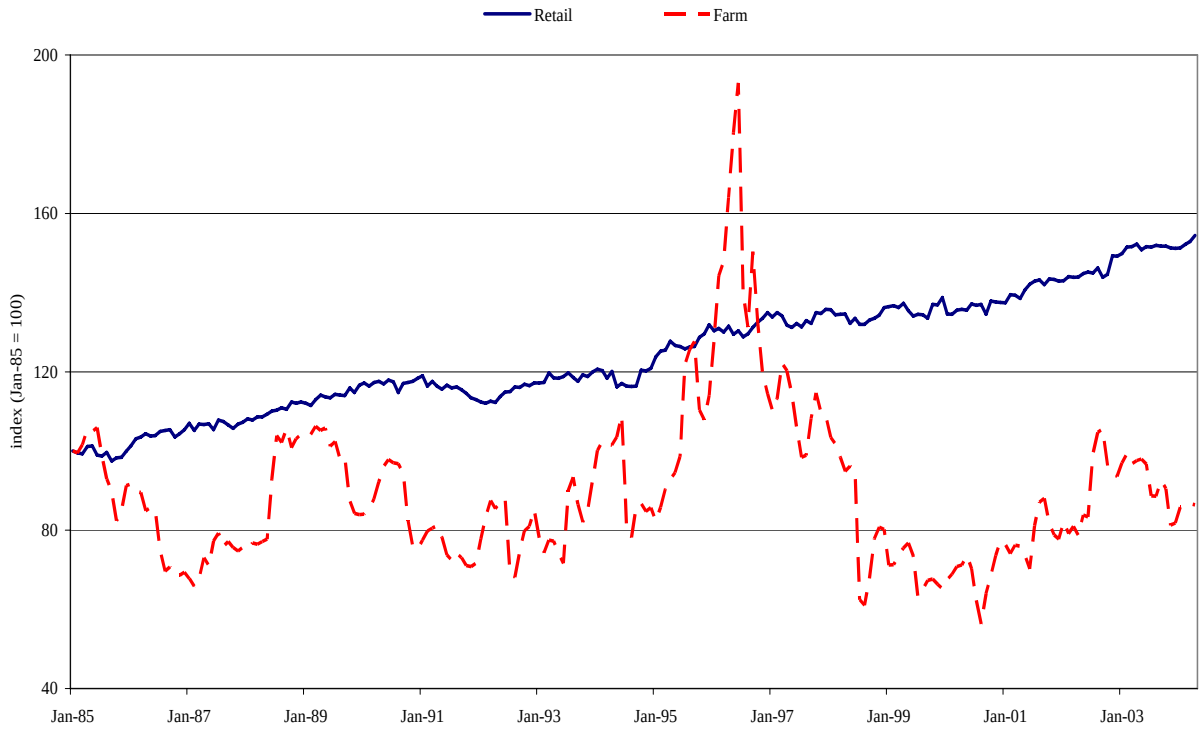

Figure 41. Indices of farm grain prices and retail prices of bakery and cereal products (Jan-85 = 100) in Ontario, January 1985 to April 2004.

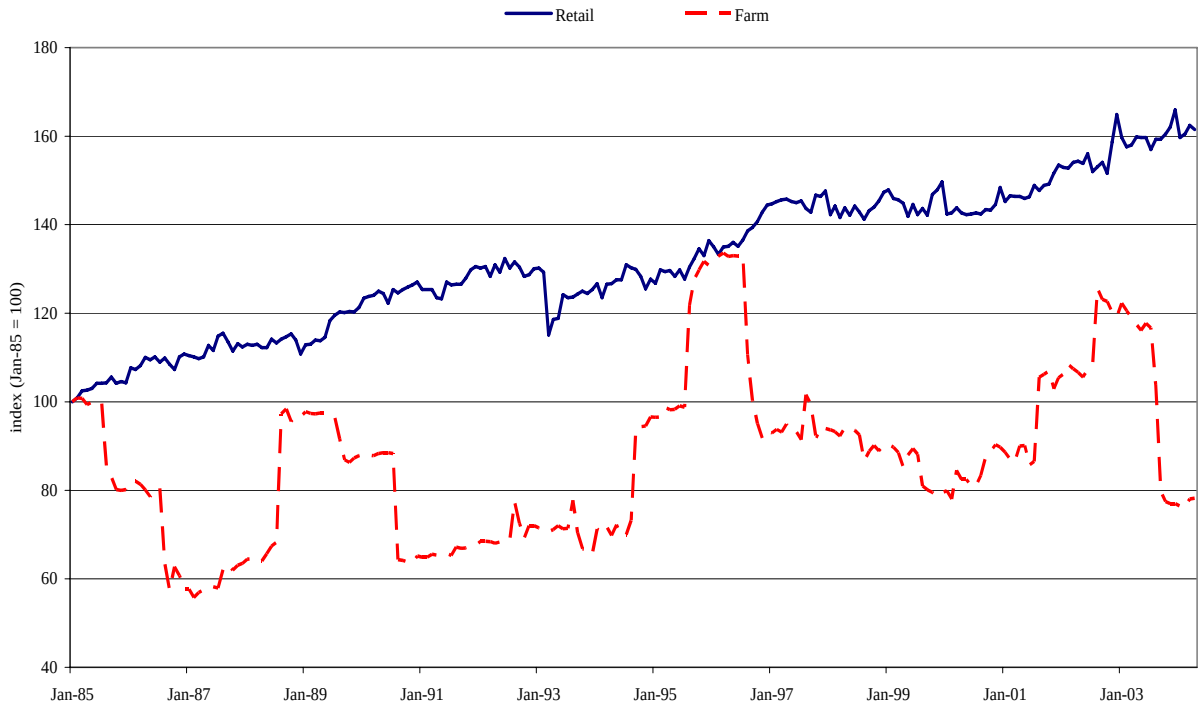

Figure 42. Indices of farm grain prices and retail prices of bakery and cereal products (Jan-85 = 100) in Alberta, January 1985 to April 2004.

DATA SOURCES AND TRANSFORMATIONS

This study relied on multiple data sources. This appendix documents the sources of the data used in the empirical section and it describes the transformations made to the data series.

Chicken

Monthly chicken farm prices were obtained from the Chicken Farmers of Ontario (CFO) from April 1992 to December 2003. Live weight prices were converted into eviscerated equivalent using a conversion factor of 0.736. Wholesale chicken prices for various meat cuts were obtained from Chicken Farmers of Canada. Monthly wholesale prices for: bone-in breasts (0.33), legs with back (0.42), wings (0.11) and necks and other parts (0.12) were used to construct a composite chicken price with the numbers between parentheses used as the weights of each cut. Note that the weights do not sum to one to account for potential wastage of production. Monthly wholesale prices for "whole A" broilers were also collected. The monthly wholesale price of chicken was computed as the weighted average of the composite price and the "whole A" broiler price using weights of 0.82 and 0.18 respectively. Monthly retail prices in Ontario were computed in much the same way as wholesale prices. Retail prices for bone-in breasts, legs with back and wings were obtained from the Poultry marketplace website (www.agr.gc.ca/misb/aisd/poultry/stats_e.htm). The weights used to compute a retail composite price in this case were 0.38, 0.49, and 0.13 respectively because no data were available for neck and other parts at the retail level. Moreover, two retail prices were available for "whole A" broilers: fresh and frozen. A simple arithmetic average was used to compute a single retail price for whole chickens under 2kg. This estimate was combined with the retail composite price to obtained a final retail "blended" price in the same proportions as in the wholesale case.

Pork

Monthly hog prices in the province of Quebec were obtained from the red meat market information website (www.agr.gc.ca/misb/aisd/redmeat/mimain.htm). Live weight prices were converted on a carcass basis using a conversion factor of 0.817 (CDPQ, 2003). Wholesale prices in Montreal for various pork cuts are also available from the same source. Wholesale prices are computed by sampling various distributors in the Montreal area. A carcass equivalent wholesale price is computed by aggregating the wholesale price of four different cuts: shoulder Montreal style (24%), loin trimmed (25%), ham (34%) and belly skinless (17%). Retail prices are computed using the monthly price index for pork meat reported by Statistics Canada (base period: 1992 = 100) and the average unit value of various pork meat purchases reported by Quebec households in the 2001 Food expenditures Survey compiled by Statistic Canada. The meat cuts are loin, shoulder, ham and belly. The same proportions as in the wholesale price are used to obtain a proxy for the aggregate retail price of pork meat in Quebec in 2001. To obtain monthly pork meat retail prices, the monthly price indices in 2001 are averaged out to obtain a 2001 average price index. This index becomes the new base index (2001 = 100) and a new price index series is computed out of the 1992 = 100 series. The 2001 retail price is updated using the newly created price index from January 1988 to December 2003.

Beef

Monthly farm prices in Quebec (A1,2 steers - auction) were obtained from the red meat market information website (www.agr.gc.ca/misb/aisd/redmeat/mimain.htm). Live weight prices were converted on carcass basis using a conversion factor of 0.59. Monthly wholesale prices for selected beef cuts are also available from the same source for the Montreal region. The beef cut prices for steers and heifers *Canada A1-2* used in this study were (with their weights reported

between parentheses): rib (0.13), square cut chuck (0.30), brisket (0.05), short hip (0.27), short loin (0.10), sirloin (0.07), flank (0.05), shank (0.03). Monthly retail prices are computed using the monthly price index for beef meat reported by Statistics Canada (Table 326-0001, base period: 1992 = 100) and the average unit value of beef purchases reported by Quebec households in the 2001 Food expenditures Survey of Statistic Canada. To obtain monthly retail beef prices, the monthly price indices in 2001 are averaged out to obtain a 2001 average price index. This index becomes the new base period (2001 = 100) and a new price index series is computed out of the 1992 = 100 series. The 2001 unit value is used as the retail price proxy to update prices from 1996 to 2004.

Butter

Milk prices at the farm level used in the production of butter were obtained from the Canadian dairy info centre (www.infolait.gc.ca/cdicsmi.htm). The farm price is a weighted average of three components: fat (0.81), proteins (0.01) and other solids (0.02) in Class IVa.[*] The numbers between parenthesis indicate the weights attached to each price in $ per kg. Wholesale prices paid to processors by retailers are also reported in the same statistical source. They are reported as a spread between a minimum and maximum sample prices. We used the average between these two bounds. Retail prices are computed using the monthly price index for butter reported by Statistics Canada (base period: 1992 = 100) and the average unit value of butter purchases reported by Quebec households in the 2001 Food expenditures Survey of Statistic Canada. To obtain monthly butter prices, the monthly price indexes in 2001 are averaged out to obtain a 2001 average price index. This index becomes the new base index (2001 = 100) and a new price

[*] The weights add up to 1 once moisture, the residual valueless component, is factored in.

index series is computed out of the 1992 = 100 series. The 2001 unit value is used as the retail price proxy to update prices from 1985 to 2004.

Cheddar cheese

Milk prices at the farm level used in the production of cheddar cheese were obtained from the Canadian dairy info centre (www.infolait.gc.ca/cdicsmi.htm). The farm price is a weighted average of the prices of three components: fat (0.33), proteins (0.23) and other solids (0.05) in Class IIIb. Wholesale prices paid to processors by retailers were also reported in the same statistical source. The minimum and maximum sampled prices are reported. We used the arithmetic average of these two bounds. Retail prices are computed using the monthly price index for cheese reported by Statistics Canada (Table 326-0001, base period: 1992 = 100) and the average unit value of cheddar purchases reported by Quebec households in the 2001 Food expenditures Survey of Statistic Canada. To obtain monthly cheddar prices, the monthly price indexes in 2001 are averaged out to obtain a 2001 average price index. This index becomes the new base index (2001 = 100) and a new price index series is computed out of the 1992 = 100 series. The 2001 unit value is used as the retail price proxy to update prices from 1985 to 2004.

Farm and consumer price indexes

The monthly farm price indexes were obtained from Statistics Canada Cansim, Table 002-0021. Monthly consumer price indexes were obtained from Statistics Canada Cansim Table 326-0001.