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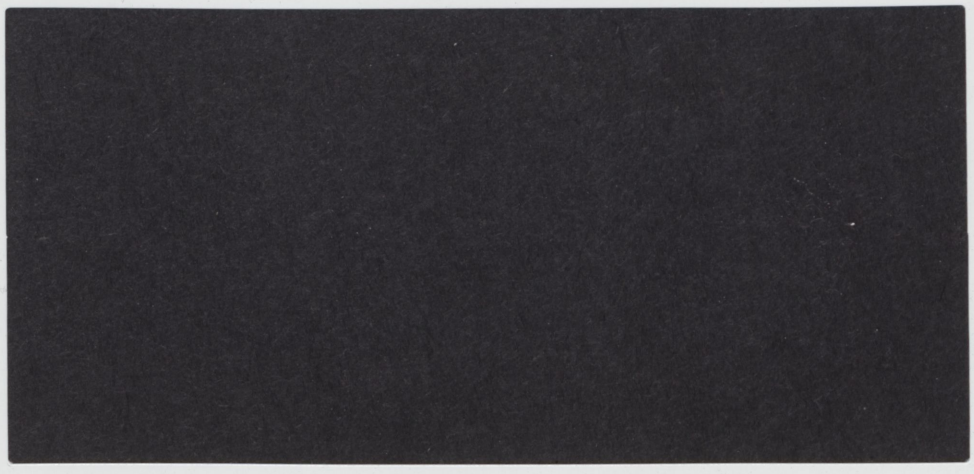

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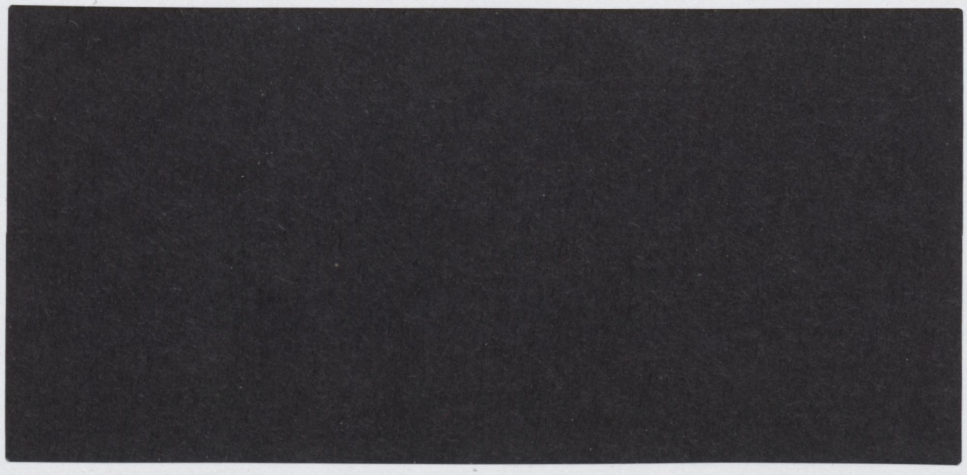

MODELLING FARM-RETAIL PRICE LINKAGE FOR EIGHT AGRICULTURAL COMMODITIES

(Technical Report #1/96)

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EXECUTIVE SUMMARY

In this report we investigate the price linkage between farm and retail prices for eight agricultural commodities in Canada: beef, pork, eggs, chicken, milk, cheese, butter, ice cream. Our purpose is to measure summary statistics, specifically elasticities, that relate the farm commodity to the retail commodity. The theoretical framework for this study is based on standard demand and supply relationships for both the farm and retail sectors, and the equilibrium is solved under general competitive conditions. The empirical model developed allows for non-market clearing conditions (i.e., inventories) and for dynamic adjustments to shocks in the farm and retail sectors.

In Canada, supply restricting marketing boards and North American trade in beef and pork requires us to account for these factors in model specification. For marketing board commodities, farm output is fixed by quotas and the corresponding farm price is set, in general, by cost of production price formula. On the other hand, trade in beef and pork requires us to recognize that farm price for these commodities is set in a North American market and should be considered exogenous in a Canadian model. The empirical models are based on the assumption that causality runs from the farm to the retail sector. This assumption is consistent with published empirical results and seems reasonable for the Canadian case. In addition, the estimated models represent reduced form equations of an underlying structural model for the retail and farm markets.

The data used in estimation represent monthly average price indexes of retail and farm commodity, quantity indexes of farm output, an aggregate measure of retail demand factors and an aggregate price index measuring marketing cost inputs. In general, the data have been collected from CANSIM files of Statistics Canada. The data represent a twelve year period 1983(1)-1994(12) or a total of 144 observations. Cheese is an exception with observations starting in 1985(1) for a total of 120 observations.

One concern in our research is the effect of imperfect competition after the farm gate. Given the concentration of firms at the food retailing and processing sector in Canada it is possible that such firms will use their market power to influence price determination. We argue that the form of the market power is likely to manifest in larger marketing margins than would otherwise be the case but would not restrict or curtail the price response of imperfectly competitive firms to cyclical or other shocks in the retail/farm marketing structure. Consequently, the elasticity estimates generated in our model are likely to be robust over both the competitive and imperfectly competitive market structure.

The focus of our study is in generating appropriate and useful estimates of the price transmission elasticity between the retail price and farm price. In general, the results

obtained are consistent with expectations of increasing elasticity over time and seem to characterize well the relationship between farm and retail prices. It is worth noting that for the supply controlled commodities of milk, butter and ice cream, a one percent change in farm price results in a one percent change to retail prices. This is not true for beef and pork where less than half of the farm price percentage increase is transferred to retail prices.

SOMMAIRE

Dans ce document, nous étudions le rapport entre les prix à la production et ceux de détail de huit produits agricoles de base au Canada, soit le boeuf, le porc, les oeufs, le poulet, le lait, le fromage, le beurre et la crème glacée. Nous voulons ainsi obtenir des statistiques sommaires, en particulier sur l'élasticité, entre le produit à l'exploitation et celui qui est écoulé au détail. Le cadre théorique de cette étude repose sur les rapports habituels entre l'offre et la demande tant dans le secteur de la production que celui de la vente au détail, et l'équilibre est obtenu dans des conditions de concurrence normales. Le modèle empirique mis au point prévoit des conditions de déséquilibre entre l'offre et la demande (p. ex. excédents) et des ajustements dynamiques aux changements qui pourraient survenir dans les deux secteurs.

Au Canada, les offices de commercialisation qui restreignent l'offre, d'une part, et le commerce du boeuf et du porc en Amérique du Nord, d'autre part, nous obligent à tenir compte de ces facteurs dans les spécifications du modèle. Pour les offices de commercialisation, la production agricole est contingentée et le prix à la production correspondant est fixé en général selon une formule de calcul des coûts de production. D'un autre côté, le commerce du boeuf et du porc nous force à reconnaître que le prix à la production de ces produits est établi sur le marché nord-américain et doit être considéré comme un facteur exogène pour un modèle canadien. Les modèles empiriques reposent sur l'hypothèse que la causalité va du secteur de la production à celui de la vente au détail. Cette hypothèse correspond aux résultats empiriques publiés et semble raisonnable dans le cas du Canada. En outre, les modèles prévus représentent des équations de forme réduite d'un modèle structurel sous-jacent pour les deux secteurs.

Les données utilisées pour l'estimation sont les indices des prix à la production et de détail moyens mensuels du produit, des indices quantitatifs de la production agricole, une mesure globale des facteurs liés à la demande au détail et un indice composé des prix tenant compte des coûts des intrants nécessaires à la transformation et à la commercialisation. En général, les données proviennent des fichiers de CANSIM de Statistique Canada. Elles portent sur douze ans, soit de 1983(1) à 1994(12) pour un total de 144 observations. Toutefois, l'étude sur le fromage fait exception, puisque les observations ont commencé en 1985(1), pour un total de 120.

L'une de nos préoccupations dans cette étude est l'incidence d'une concurrence imparfaite en aval de la production. Étant donné leur concentration dans le secteur de la vente au détail et de la transformation des aliments au Canada, il est possible que les entreprises exercent leur pouvoir sur le marché pour influer sur l'établissement des prix. Nous

alléguons que la forme de ce pouvoir commercial ne devrait vraisemblablement se manifester plus souvent qu'autrement que chez les entreprises jouissant de marges commerciales importantes, mais ne limiterait, ni ne réduirait la capacité d'intervention sur les prix des entreprises imparfaitement concurrentielles en cas de fluctuations cycliques ou autres de la structure de commercialisation, de la production au détail. Par conséquent, les estimations de l'élasticité obtenues grâce à notre modèle sont probablement solides pour les structures de commercialisation tant concurrentielles qu'imparfaitement concurrentielles.

Notre étude vise principalement à produire des estimations appropriées et utiles de l'élasticité du report des prix de la production au détail. En général, les résultats obtenus correspondent aux prévisions d'élasticité accrue avec le temps et semblent bien caractériser le rapport entre les prix à la production et ceux de détail. Il est intéressant de noter que, pour les produits du lait, du beurre et de la crème glacée assujettis à la gestion de l'offre, un écart de 1 p. 100 du prix à la production entraîne une variation de 1 p. 100 des prix de détail. Cela n'est pas le cas pour le boeuf et le porc, pour lesquels seulement la moitié de la hausse en pourcentage se répercute sur les prix de détail.

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I. Introduction

The purpose of this report is to investigate the price linkage between farm and retail prices for eight agricultural commodities in Canada: beef, pork, eggs, chicken, milk, cheese, butter, ice cream. The effort is to measure summary statistics, specifically elasticities, that relate the farm commodity to the retail commodity. Although considerable work has been done in measuring the price relationship between the farm and retail sectors, most of this work has been applied to US data (see, Brorsen et al., 1985; Wohlgenant, 1989; Holloway, 1991; Lyon and Thompson, 1993). The theoretical framework for these studies is based on work by Gardner (1975), which defines demand and supply relationships for both the farm and retail sectors, and the equilibrium is solved under general competitive conditions. This model has been extended by Heien (1980) to allow both for non-market clearing conditions (i.e., inventories) and for dynamic adjustments to shocks in the farm and retail sectors. In these models, it is generally assumed that the quantity of farm output is a function of past farm prices and, therefore, exogenous to farm price in the current period. On the other hand, both retail and farm price are endogenous in model specification and determined by current market conditions, as is the retail/farm price ratio. Explanatory variables used in regression models to measure variations in retail and farm price are aggregate values measuring the shift in retail demand, the marketing cost of moving commodity from the farm to retail level and the total quantity of farm output.

This model specification may well capture the essential factors describing farm to retail price linkage in the US market, but in Canada, supply restricting marketing boards and North American trade in beef and pork requires us to modify the standard retail/farm model for Canadian application. For marketing board commodities, farm output is fixed by quotas and the corresponding farm price is set, in general, by cost of production price formula. On the other hand, trade in beef and pork requires us to recognize that farm price for these commodities is set in a North American market and should be considered exogenous in a Canadian model[1].

Our purpose in this paper is to develop a regression model to explain farm to retail price linkages for eight Canadian agricultural commodities. The report is organized as follows. In section II, the methodology used in model specification is outlined. We describe the basic Wohlgenant/Holloway model and present modifications to the model specification to account for Canadian application. Section III provides a general discussion of the market

[1]This differs from the US practice of assuming that farm quantity is the exogenous factor in determining current period farm price.

structure and competitive conditions in the commodity marketing sector in Canada. The data used in empirical application and variable transformations are reported in section IV.

In section V, the results of the estimated regression models are presented. The final section is a conclusion and summary of our findings.

II. Methodology

The standard approach to modelling retail/farm price linkage is based on the theory of derived demand, where consumer demand for the retail commodity generates a derived demand for the agricultural commodity. The retail price of the commodity will reflect the farm price plus the cost of marketing the commodity from the farm to the retail level. The retail/farm price margin is defined as the difference between the retail and farm price. The interest of this study is in determining the impact on the retail price and on the marketing margin resulting from shocks to either the retail or farm sectors. To make such predictions it is necessary to impose structure on the general model.

A simple condition to impose is that there is a fixed relationship between the farm product and the marketing inputs used in processing the product for the retail market. Also, assume that the supply of marketing inputs is perfectly elastic (Wohlgenant and Haidacher, 1989). This relationship is described in figure 1. The farm price (Pf) is set by the intersection of the farm supply function (Sf) and the derived demand for farm product (Df). In this figure, the farm supply function is upward sloping indicating a positive output response to increases in farm price.[2] The supply of marketing inputs (Sw) is horizontal representing the assumption of perfectly elastic supply. Assuming a fixed proportions technology for the retail sector implies that the supply of retail commodity is the sum of farm commodity and the fixed supply of marketing inputs. The equilibrium retail price is represented by (Pr) in figure 1. In this simple model, the derived demand at the farm level is obtained by subtracting the marketing margin from the retail demand function. The prediction being that increases in farm output will have no effect on marketing margin but will decrease retail price. In other words, if the retail market can be approximately described by this simple model then a regression model would find that changes in farm output will have an insignificant effect on marketing margin and a negative effect on retail price.

If the assumption of fixed production technology is maintained but we allow for less than a perfectly elastic supply of marketing inputs, it is possible for changes in farm output to effect changes in the marketing margin. This is represented in figure 2. The upward sloping supply function for marketing inputs (Sw) represents the need to use proportionally larger amounts of marketing inputs to process increased levels of farm output. At the initial equilibrium level represented by farm price (Pf) and retail price (Pr), the marketing margin is the difference (Pr-Pf). A leftward shift in the supply of farm product to Sf1 caused, say, by a decrease in subsidy to farm production, results in an increase in farm price to Pf1 and, under the assumption of fixed proportions, an increase in retail price (Pr1). However, the marketing margin (Pr1-Pf1) resulting after the quantity change has been reduced from its

[2]This is likely representative of the Canadian beef and pork sectors but not representative of other farm commodities regulated by marketing boards.

initial level (Pr-Pf). The prediction from this model is that decreases in farm output cause an increase in both farm and retail price a decrease in marketing margin. Under these

Figure 1.

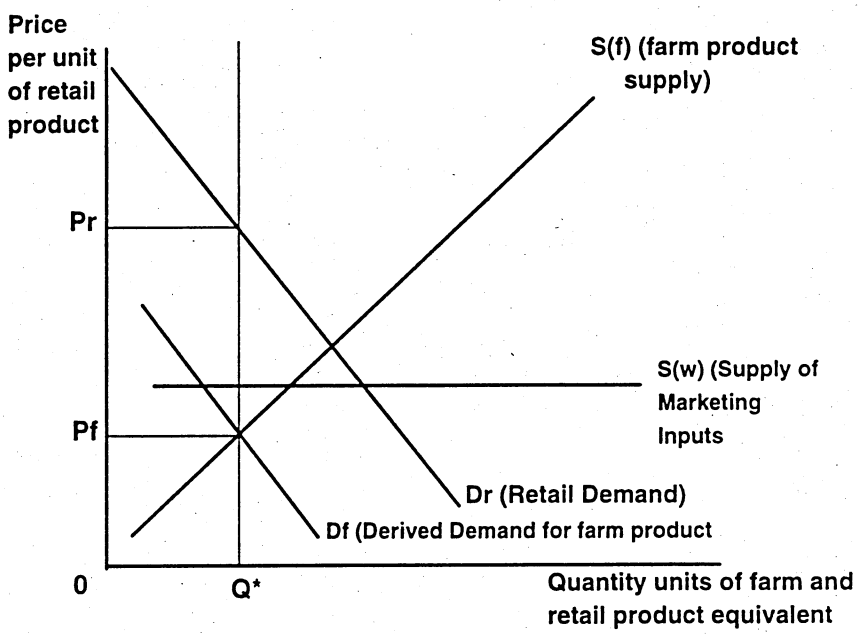
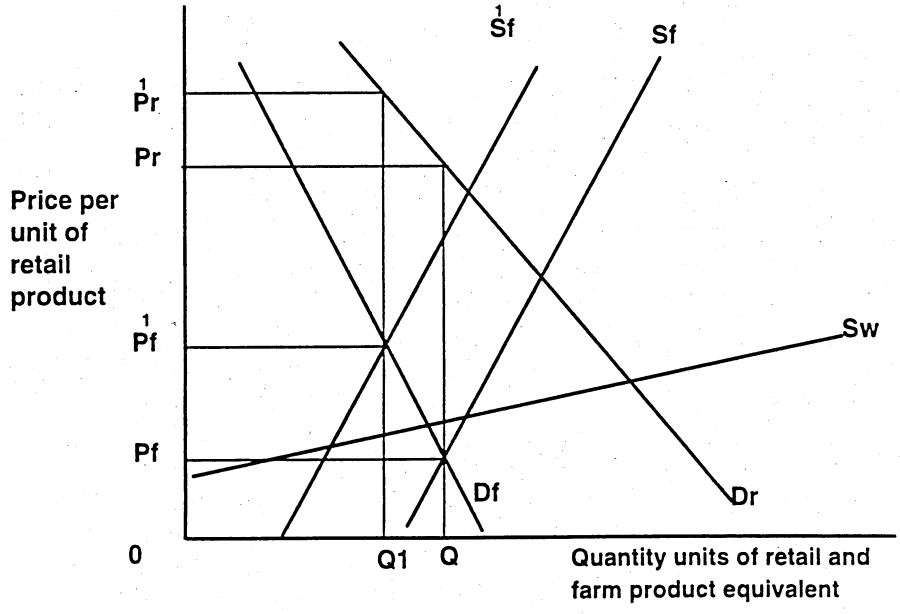


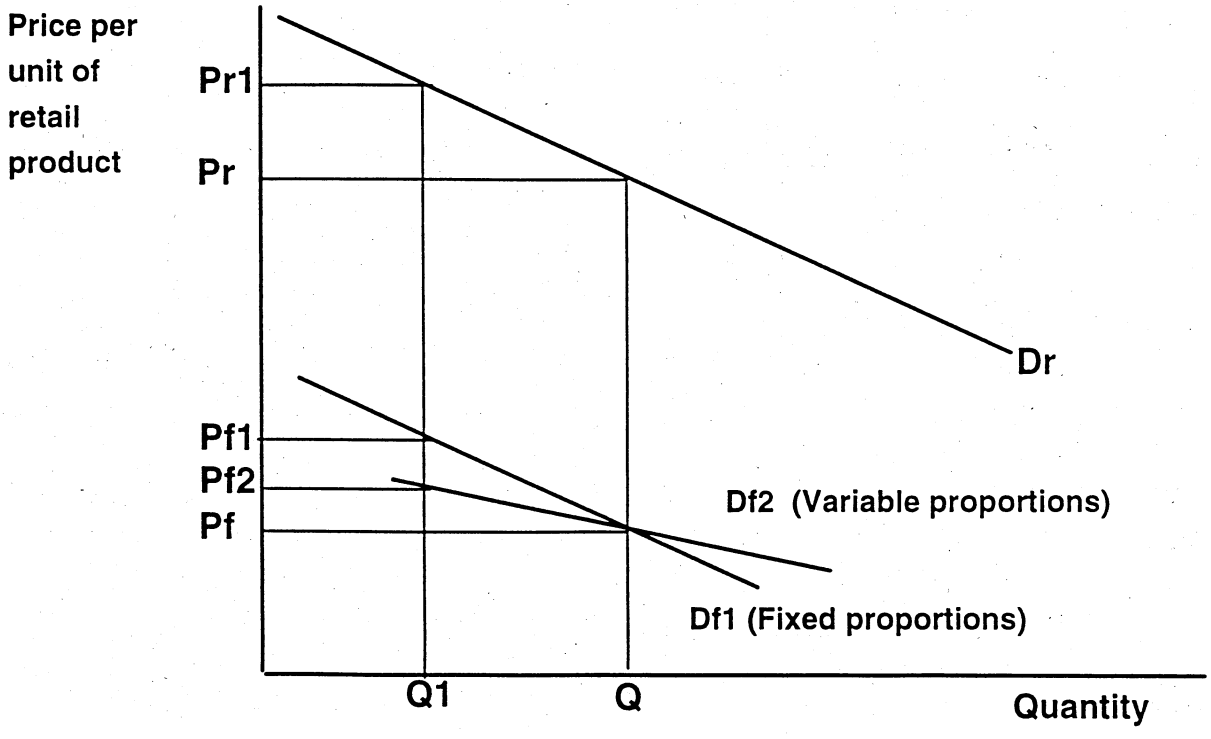
Figure 2.



conditions a regression model would find that changes in farm commodity will have a negative effect on marketing margin[3].

Finally, for this simple model, assume that the supply of marketing inputs is perfectly elastic but allow for substitution possibilities between the farm commodity and marketing inputs. This situation is shown in figure 3 where the initial farm output is set at Q with farm price Pf and retail price Pr. If a shock to the system results in farm output decreasing to Q1, farm price under fixed proportions would increase along the original farm demand curve (Df1) to Pf1. However, if it is possible to substitute some marketing inputs for the now higher priced farm commodity the derived farm demand curve (Df2) is more elastic and farm price increases to only Pf2, which is less than Pf1. Under these conditions a decrease in farm output can be associated with an increase in marketing margin. In a regression model, changes in farm output would be positively related to marketing margin.

Figure 3.



[3]If there are external economies to the marketing sector (i.e., the marketing supply function (Sw) has a negative slope) one would obtain the prediction that farm output is negatively related to marketing margin.

The assumption of variable proportions technology appears to have some merit at both the firm and industry level. Wohlgenant and Haidacher (1989) argue that at the firm level such substitution is not restricted to reducing spoilage and waste in food processing as farm commodity price increases, but also firms can choose alternative production processes, including different modes of transporting commodity, interproduct substitutability and the substitution of quality for quantity. Moreover, even if fixed proportions characterize retail firm production, the existence of firms of different size in the industry makes it possible to observe input substitution at the industry level[4].

From the rather simple descriptive models presented here it is clear that one can obtain a number of predictions as to the relationship among retail price, farm price and the marketing margin. The mixed results reported in the applied literature may well represent the various possibilities. Our modelling effort of the retail/farm price linkage will follow the work of Wohlgenant (1989) and Holloway (1991) from which we modify the model to better fit the Canadian market and the monthly data used in analysis. (Appendix A provides a description and regression results for two alternative models for measuring marketing margins.)

Wohlgenant (1989) and Holloway (1991) specify a competitive equilibrium three equation model to measure variations in marketing margin (Mi), retail price (Pri) and farm price (Pfi). The determining factors for each equation represent a marketing cost index (MCi), which is a weighted price index of the inputs used in moving the farm commodity through the processing stage to the retail market, a retail demand shifter (RDi), which is a weighted index representing the price of substitute commodities, non-food commodities, income and population levels, and a farm output (Qi) variable. The model, which we refer to as the Unrestricted Holloway Model, is written as:

$$(1) \qquad \begin{aligned} M_i &= \beta_{mo} + \beta_{mmc} MC_i + \beta_{mrd} RD_i + \beta_{mq} Q_i + \epsilon_1 \\ Pr_i &= \beta_{pro} + \beta_{prmc} MC_i + \beta_{prrd} RD_i + \beta_{prq} Q_i + \epsilon_2 \\ Pf_i &= \beta_{pfo} + \beta_{pfmc} MC_i + \beta_{pfrd} RD_i + \beta_{pfq} Q_i + \epsilon_3 \end{aligned}$$

where ϵ_i is a random error term.

The disadvantage of the model defined in equation (1) is that the third regression equation is incorrectly specified for the Canadian case of either marketing board supply control commodities or traded commodities such as beef and pork. Under supply control, farm price is set by formula. Beef and pork farm prices are set in the North American market. In a Canadian retail/farm model, farm price should be treated as an exogenous variable.

[4]This is consistent with Diewert (1981) who shows that the level of input substitution is larger at the industry that at the firm level.

The advantage of the model specified in equation (1) is that linear restrictions imposed on the parameters can be used to test a null hypotheses of perfect competition in the different sectors (Holloway, 1991). Specifically, a null hypothesis of Ho: $\beta_{jrd} + \beta_{jq} = 0$, for j = M, Pr and Pf, is a test for perfect competition in each sector. Holloway (1991) argues that this hypothesis is a necessary condition for competitive markets to exist. In addition, the sufficient condition requires Ho: $\beta_{prmc} = 0$. We carry out these tests after estimation of equation (1) and refer to the estimated results as the Restricted Holloway Model.

Because the data set used in estimation is monthly average values, it is possible that this time period is too short to allow for market clearing as required in the equilibrium specification of equation (1). In other words, shocks to the different sectors may require a number of periods for the full effect to be captured by the dependent variables (Kinnucan and Forker, 1987). Arguments for such lagged effects depend on price stickiness in the retail market, perhaps due to the cost of making the price change. We attempt to capture this lagged effect by including in the model specification lagged values of each independent variable in equation (1). Specifically, each independent variable is lagged twice. We refer to the resulting lagged model as the Dynamic Holloway Model.

In the Canadian food market, the farm price as argued above is exogenous for both supply restricted and traded (beef and pork) commodity models. Consequently, it may be possible to improve upon the specification of the Holloway model by replacing the farm output variable with farm price. Making the farm price/output substitution in equation (1) and maintaining a two period lagged structure to capture lagged effects from farm to retail sectors, the Modified Dynamic Holloway Model can be written as:

$$
\begin{aligned}
(2) \qquad M_i = {} & \beta_{mo} + \beta_{mmc} MC_i + \beta_{mmc1} MC_{it-1} + \beta_{mmc2} MC_{it-2} \\
& + \beta_{mrd} RD_i + \beta_{mrd1} RD_{it-1} + \beta_{mrd2} RD_{it-2} \\
& + \beta_{mf} Pf_i + \beta_{mf1} Pf_{it-1} + \beta_{mf2} Pf_{it-2} + \epsilon_1 \\
Pr_i = {} & \beta_{pro} + \beta_{prmc} MC_i + \beta_{prmc1} MC_{it-1} + \beta_{prmc2} MC_{it-2} \\
& + \beta_{prrd} RD_i + \beta_{prrd1} RD_{it-1} + \beta_{prrd2} RD_{it-2} \\
& + \beta_{prf} Pf_i + \beta_{prf1} Pf_{it-1} + \beta_{prf2} Pf_{it-2} + \epsilon_2
\end{aligned}
$$

This model has the advantage of allowing measurement of both the monthly and combined three month effects of changes in the independent variables on marketing margin and retail price.

Finally, we approach the regression exercise by smoothing out month to month variations in the data using a three month moving average model. In this model, each variable is defined as a three month moving average transformation. We attempt to measure a longer run adjustment to changes in the dependent variables resulting from shocks to the different sectors. We do this by including in each regression equation the value of each transformed

variable lagged three times. In other words, the three month moving average variable and its three month lagged value do not overlap observations. This will allow us to define both short-run and intermediate-run elasticity values for marketing margin and retail price. This model, referred to as the Moving Average Model, is written as:

$$(3) \quad SM_i = \beta_{mo} + \beta_{mmc} SMC_i + \beta_{mmc3} SMC_{it-3} + \beta_{mrd} SRD_i + \beta_{mrd3} SRD_{it-3} + \beta_{mf} SPf_i + \beta_{mf3} SPf_{it-3} + \epsilon_1$$

$$SPr_i = \beta_{pro} + \beta_{prmc} SMC_i + \beta_{prmc3} SMC_{it-3} + \beta_{prrd} SRD_i + \beta_{prrd3} SRD_{it-3} + \beta_{prf} SPf_i + \beta_{prf3} SPf_{it-3} + \epsilon_2$$

For all models presented in this section, the implicit assumption is that causality runs from the farm to the retail sector. This assumption is consistent with published empirical results (Heien, 1980) and seems reasonable for the Canadian case. Also worth noting, is that the models presented here represent reduced form equations of an underlying structural model for the retail and farm markets.

III. Modelling Imperfect Competition after the Farm Gate

The assumption of perfect competition seems implausible when applied to the food processing-distribution-retailing (PDR) sector in Canada. This sector, similar to most non-farm industries, is characterized by market structures which appear to be oligopolistic or monopolistically competitive in nature. Moreover, this is not likely to be quantitatively unimportant, given that food and beverage marketing adds somewhat more to GDP than does the farm sector. In Canada, the numbers 3:3:4 are a reasonable approximation of the contributions, in percent, to total GDP of the farm, processing and distribution/retailing sectors respectively (Cooper, 1982).[5]

Table 1 gives some structural information on eight Canadian food processing or manufacturing industries. This table represents all industries included in our study with the exception of eggs, the grading and packing of which is not considered to be a manufacturing activity in Canada.

Table 1. Structural Characteristics of Canadian Food Processing

Column #	1	2	3	4	5
	Number of Plants	4 - Firm Seller Concentration Ratio		Gross Profit Margin on Sales	
		Canada	US	Canada	US
Beef	165	50	44	0.077	0.097
Pork	101	50	39	0.037	0.100
Processed Pork	67	60	26	0.120	0.129
Chicken	101	45	22	0.121	0.166
Milk	160	42	15	0.160	0.188
Butter	40	50	29	-0.022	0.190
Cheese	66	60	40	0.190	0.145
Ice Cream	41	50	22	0.123	0.248

Notes:
Colums 1, 4, 5 for 1986; colums 2, 3 for 1982.
Gross profit margin is (sales-materials-wages) / sales.
4-firm seller concentration ratio is the market share of the four largest firms.
Sources: Statistics Canada, Industry Canada, T. Hazledine estimates.

[5]On top of which is the unmeasured value added to food by further processing in the home.

We see from column 1 that there is a large number of plants engaged in processing meat and dairy products, which might suggest competitive or monopolistically competitive market behaviour. But the next column reveals that the size distribution is heavily skewed, as is typical in manufacturing industries. In most of these activities, the four largest firms, some of which operate multiple plants, account for at least fifty percent of total Canadian sales. We also note that Canadian concentration ratios are always higher than US ratios (column 3) for matching industries -- a well-known result that is generally believed to reflect the much larger size of US markets.

The data reported in Table 1 represent relatively modest numbers in the Processing, Distribution and Retailing (PDR) context. For example, among other food and beverage industries, breweries had a 4-firm concentration ratio of 99%, while sugar industries had a concentration of 95%. Nevertheless, the food PDR numbers are large enough to warrant an examination of the assumption of price-taking behaviour that underlies perfect competition.

When the four largest firms in an industry have approximately one half of their industry's market share, it is possible that these firms play an active role in price-setting. In setting prices, they pay close attention to the likely reactions of other firms. The outcome of such interdependent or oligopolistic behaviour will be determined by the extent to which the major players in an industry can coordinate to take advantage of whatever monopoly rents are available. The standard presumption in oligopoly analysis is that the more concentrated an industry the more likely it is in achieving the joint-profit maximizing price and capturing monopoly rents[6].

The data on profit margins, column 4 and 5 in Table 1, show rather wide variations across the eight industries. Moreover, in 1986, Canadian margins were generally lower than the margins achieved by their less concentrated US counterparts. But, we must keep in mind that many other factors besides concentration may be involved in determining profit margins (such as capital intensity, product differentiation, and protection from import competition), and it remains prudent to investigate the possibility of our price and markup equations being affected by non-perfectly competitive behaviour.

Before exploring the implications of non-perfectly competitive behaviour, we should note the characteristics of the downstream food distribution and retailing sector. Distribution (i.e., transportation, wholesaling, warehousing) is the lesser of the two sectors in the economic sense and is often carried out by the retailers and processors. Retailing, the largest

[6]There are three standard reasons given for this. First, more firms means a more difficult coordination problem to solve, especially since explicit collusion on price is illegal. Second, more firms means that the temptation of each to cheat by secretly undercutting the oligopoly price is higher, since, in relative terms the gains in market share from undercutting are larger the smaller is the firm. Third, more firms means that the chances perceived by each to get away with cheating undetected are larger.

of the sectors is highly concentrated, in the functional sense, with just two major types of activity; grocery stores and restaurants[7].

It is the retail grocery sector that is relevant to our study. Retailing is distinctive in that for most Canadians, it is a non-traded good. Indeed, the relevant market area in which a retailer competes in Canada is provincial or regional. Though aggregate national concentration in food retailing is quite low (i.e., the 4-firm concentration ratio is currently about 42%[8]), each regional market is dominated by two, sometimes three, major chains, which may have little or no presence elsewhere in Canada. In Quebec, Provigo and Metro-Richelieu share 68% of the total market, but are not major players elsewhere. Safeway, which dominates in Alberta and British Columbia, is not in the top five nationally. Thus, with high regional concentration and little or no constraint from imports (except for people living very close to the 49th parallel), it is reasonable to expect food retailing to demonstrate non-perfectly competitive characteristics.

So how should (possibly) imperfectly competitive behaviour in the food PDR sector be dealt with in price and margin models? We will approach this question by asking first how Holloway handles it. The Holloway model is, in detail, a rather formidable mathematical construct, but the essence of the role played by imperfect competition can be demonstrated quite simply using a monopoly model. The key characteristic of profit maximizing imperfect competition, both oligopoly and monopoly, is that price is set to equate marginal revenue to marginal cost, and thus is higher than marginal cost, since demand is not perfectly elastic.

The Holloway model, with farm supply (Q) exogenous, is represented in figure 4. A food PDR monopoly with (again just for simplicity) a fixed coefficient marketing technology produces at constant marginal cost M+Pf (the unit cost of marketing plus the farm price), and, with demand D, sets price to maximize profits. In the Holloway model, it is implicitly assumed that the farm price will adjust to enable marginal cost and marginal revenue to be equated, for a given farm quantity. Thus, with farm supply, say, Q1, we would need farm price Pf1 to be consistent with an equilibrium retail price of Pr1.

[7]Part of this sector is the industry supplying instititions such as hospitals with food and beverage service.

[8]The Globe and Mail's Report on Business Magazine for October 1995 (p.67) gives national market shares for the leading grocery chains to be: Loblaws 15.9%; IGA (etc.) 10.5%; Provigo 10.4%; Metro-Richelieu 5.5%; Sobey's (etc.) 4.5%.

If we increase farm supply to Q2, then the retail price must fall to Pr2[9] which will require a somewhat larger (twice as large, in the linear demand case) decrease in the farm price, to Pf2. Thus, the marketing margin has widened.

Contrast with the perfect competition case, in which farm price is set to make M+Pf=Pr (i.e., zero profits). In this case, changes in supply (or retail demand) will induce equal-sized changes in retail and farm price, and no change in the marketing margin.

This is quite interesting, but there are problems with the setting and detail of Holloway's model. First, with perfectly inelastic farm supply, why would not the PDR firm(s) exploit their monopsony or oligopsony power and drive down the farm price?[10] Holloway's implicit assumption that the PDR sector takes the (equilibrium) farm price as given is implausible if farm supply really is exogenous.

In fact, of course, processors don't drive current period farm price down to zero because if they did there would be no output supplied next period a point that Holloway's model should consider. As well, the details of Holloway's oligopoly formulation are, at the least, idiosyncratic. Cournot-playing firms set price above marginal cost (which is conventional enough), but then free entry is assumed to eliminate any excess of price above average cost. This rather misses the point of monopoly or oligopoly power which is having the ability to prevent competition in both product and input markets such that long-term rents can be earned.

Fortunately, we do not need to attempt to reformulate the Holloway model. As noted above, the exogenous farm output assumption, whatever its plausibility in the large US market, is not appropriate to any of our eight commodities. Either marketing board cost-of-production formulas or free cross-border trade with the US ensures that it is the farm price, not quantity, that should be taken as exogenous for these commodities.

So how should we expect imperfect competition to show up in our Canadian data? One of the endemic problems of oligopoly theory is that it is so 'rich' (this being a euphemism for 'any result is possible') that the outcome depends on the assumptions about how oligopolists behave. But by restricting ourselves to the core prediction of price set above marginal cost we can make some progress. This proposition is summarized by the 'Lerner

[9]This must happen whatever the market behaviour in the PDR sector, simply to satisfy the twin constraints of exogenous demand and exogenous output.

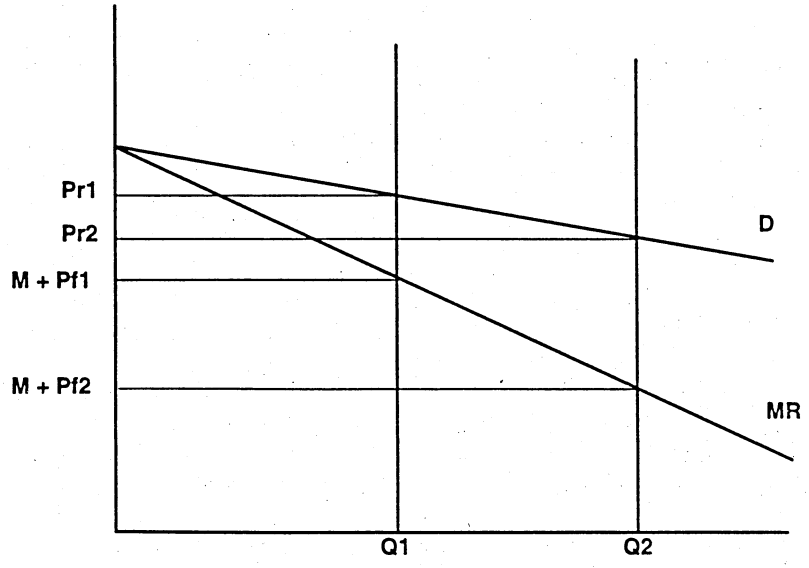
[10]If farm supply is perfectly inelastic, farm price could be driven all the way to zero.

mark-up rule", which relates price to marginal cost for a profit-maximising imperfect competitor by the formula

(4) $PR(1+1/e) = C,$

where PR is retail price, C is marginal cost and e is the price elasticity of demand perceived by the price setter.[11] This is just a first-order-condition, not an estimating model, since

Figure 4.



elasticity could depend on other variables, or if it does not, we simply can write:

(5) $PR = mC,$

where m is the constant proportional markup. In this case, a shift in the retail demand curve will have no effect on price, and a change in costs will have the same effect, regardless of whether m is equal to or exceeds one. This is important because if we have a competitive market m=1 and if we have an imperfectly competitive market m>1. But, in either case, competitive or imperfectly competitive behaviour cannot be distinguished in equation (5).

This is a simple but important insight: an industry could be capturing substantial oligopoly rents but still be indistinguishable in its response to cyclical shocks from a competitive industry just earning normal profits, if elasticity is constant. Nor is this implausible. Most processing and retailing operations have technologies which enable output to be changed even in the short run at fairly constant marginal cost. In addition, such firms may be

[11]Holloway shows a standard version of this for the case of a conjectural variations model, in which the perceived elasticity is the ratio of the conjectured response of other price setters to the elasticity of market demand.

constrained by threat of entry from taking advantage in their markups of cyclical changes in demand or supply conditions.

What if elasticity is not constant? Let us consider this by means of a simple linear monopoly model, such as that underlying figure 4. Choose units such that demand can be written:

$$(6) \qquad PR = a - Q,$$

where a is a constant and assume a constant marginal cost, C. Then, equating marginal revenue to C or:

$$(7) \qquad a - 2Q = C,$$

which solves for profit maximising quantity and price as:

$$(8) \qquad Q^* = (a-C)/2; \quad PR^* = (a+C)/2$$

Now, consider the elasticities of PR* with respect to shifts in demand (epa) and in costs (epc) (i.e, farm price or marketing input price). These elasticities can be written:

$$(9) \qquad epa = a/(a+c); \quad epc = c/(a+c).$$

Both of these elasticities are less than one, and with a > c (equation (8)), price elasticity with respect to the demand shifter is larger than the elasticity with respect to cost.

In contrast, the elasticities for the competitive (PR = C) case are simply:

$$(10) \qquad epa = 0; \; epc = 1.$$

This gives us a way of distinguishing competitive from non-competitive behaviour. Of course, the particular model used here is highly simplified and stylised, but its insights are probably fairly robust: if elasticity increases with price then imperfectly competitive price-setting behaviour should result in larger price responses to demand shifts and small responses to cost changes than would be generated by perfect competition.

There remains yet another caveat. If costs are increasing in output, then even a perfectly competitive industry will show a price response to a demand shift and a less-than-unitary price elasticity with respect to changes in input prices. We would need data on actual costs

(input use) to control for this, and we do not have such data. Consequently, we conclude that the competitive models set out in Section II should be robust over both competitive and imperfectly competitive market conditions and provide reasonable elasticity response measures for the eight food commodities examined in this report.

IV. Data and Variable Transformation

The data used in estimation represent monthly average price indexes of retail and farm commodity, quantity indexes of farm output, an aggregate measure of retail demand factors and an aggregate price index measuring marketing cost inputs. In general, the data have been collected from CANSIM files of Statistics Canada. Eight agricultural commodities are used for analysis; beef, pork, eggs, chicken, milk, butter, cheese and ice cream. The data represent a twelve year period 1983(1)-1994(12) or a total of 144 observations. Cheese is an exception with observations starting in 1985(1) for a total of 120 observations. A complete listing of data sources and definitions appears in Appendix B.

Each price and quantity index is transformed to represent the log differences (e.g. $\ln Z_t - \ln Z_{t-1}$). This transformation is consistent with the work of Wohlgenant (1989) and Holloway (1991), and represents percentage change in the variables allowing the estimated parameters to be interpreted as elasticities.

The retail demand shift variable is an aggregate measure of the influence of other food markets, the non-food market, income effects (Y) and population (Pop) on retail market demand for the commodity in question. The form of the retail demand shifter for the ith commodity used in this study is written as:

$$(11) \qquad \Delta RD_i = \sum_{i \neq j} \eta_{ij} \ \Delta \ln Pr_{jt} + \eta_{iy} \ \Delta \ln Y_t + \ \Delta \ln Pop_t$$

where η_{ij} and η_{iy} are the cross-price and income elasticities respectively, and Pr_{jt} represents the retail price of other food and non-food commodities. Using estimates of cross-price and income elasticities published in previous research (Hassan and Johnson, 1976), we calculate a retail demand shift variable for each of the different food commodities examined.

The marketing cost index is an aggregate price index measuring the price of marketing commodity from the farm to the retail level. The index is a composite of eleven different factor inputs (the weighting for each factor in parentheses): Labour (54.32), Containers and Packaging (10.99), Transportation (5.15), Travel and Promotion (6.88), Fuel and Power (5.10), Rent and Storage (4.74), Maintenance and Repair (3.42), Taxes and Insurance (2.26), Services (3.85), Utilities (1.23) and Office and Other Supplies (2.07) (see, Al-Zand, Barewal and Hewston, 1985). Labour cost indexes are available for both the meat and egg sectors and for the dairy sector. This allows us to generate a separate Marketing Cost Index for the meat and eggs sector and an alternative Marketing Cost Index for the dairy sector. Appendix B lists the data sources for calculating this index.

We represent the data used in estimation graphically in figures 5-16. All data series are in log differences. Figures 5-10 represent prices at the farm, processor and retail level for the eight different food commodities examined. In general, there appears to be substantial month to month variation at all marketing levels. Not surprisingly, supply controlled commodities show less variation in price changes than either beef or pork prices. It is interesting to note the shock to the farm price of eggs (figure 10) for the period 1990 to 1992. This shock does not appear to have been past on to the consumer price! For farm commodities, the log change in output is shown in figures 11-13. Hog output (figure 12) shows substantial but consistent production changes from month to month. Beef (figure 13) on the other hand shows both less variation and consistency in output changes over the period.

Figure 14 represents the month to month variation in the two separate Marketing Cost Indexes for dairy products and for meat and egg products. It is interesting to point out that the indexes show both positive and negative price changes over the period of study. Finally, figures 15 and 16 show variation in retail demand shifters for each food commodity over the twelve year period. The egg and ice cream variables show little month to month variation, whereas, with the exception of the pork variable, the remaining commodities show substantial seasonality.

With our data set and variable transformations defined we are able to proceed with the estimation, testing and reporting of regression results.

Figure 5. Canada Beef Prices (Percent Change)

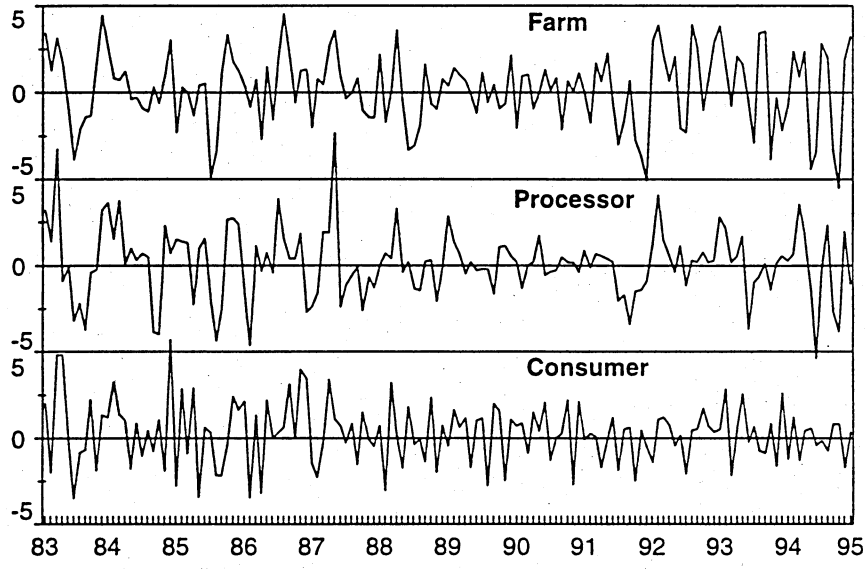


Figure 6. Canada Pork Prices (Percent Change)

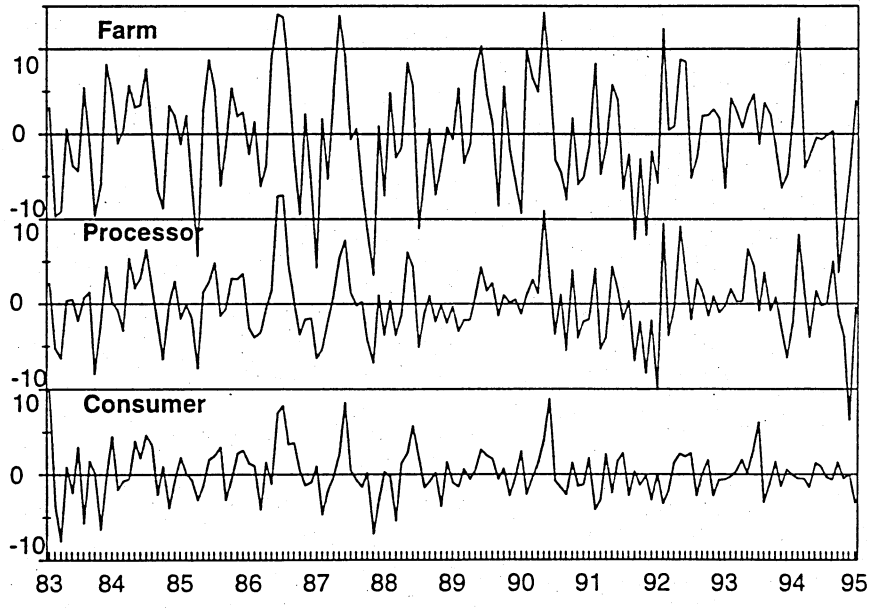


Figure 7. Canada Chicken Prices (Percent Change)

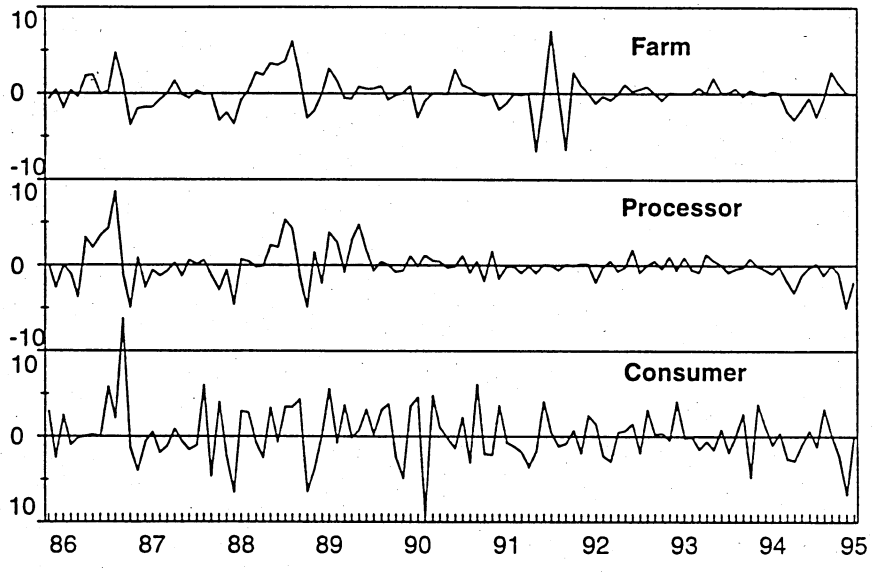


Figure 8. Canada Milk Prices (Percent Change)

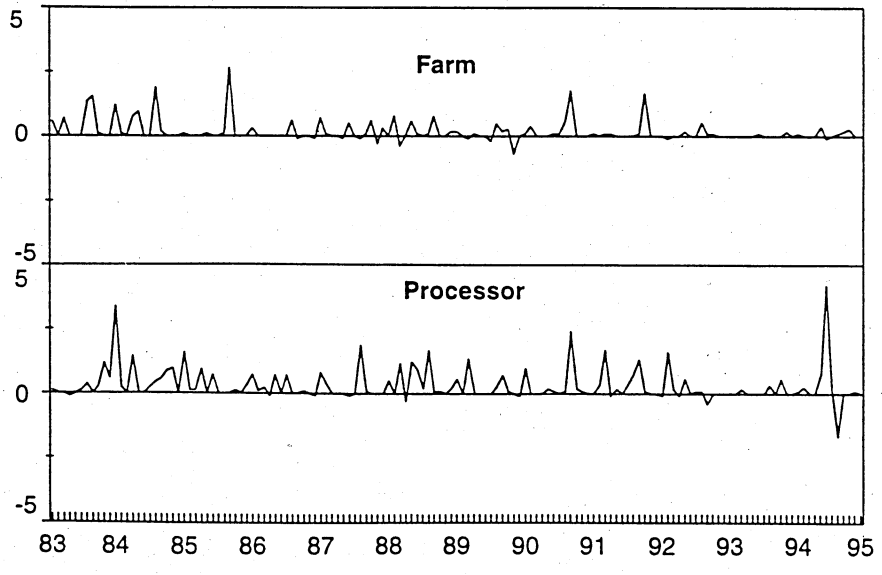


Figure 9. Canada Milk Products Prices (Percent Change)

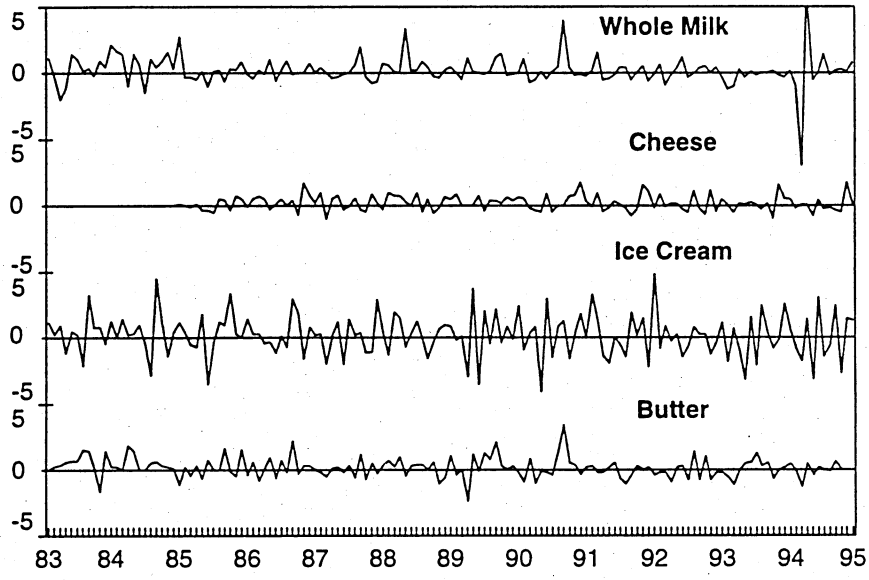


Figure 10. Canada Egg Prices (Percent Change)

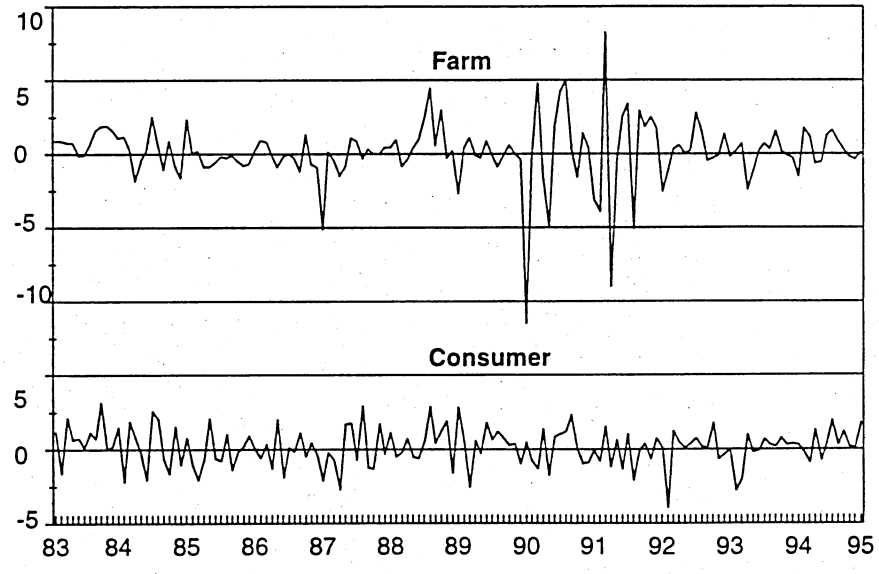


Figure 11. Canada Farm Output (Percent Change)

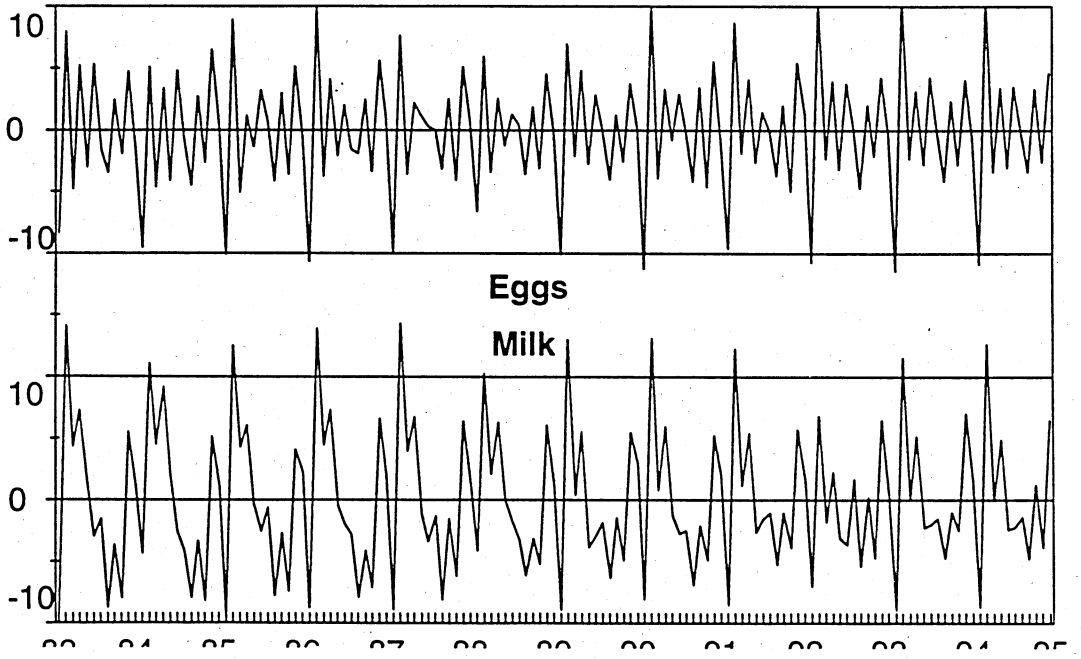


Figure 12. Canada Farm Output (Percent Change)

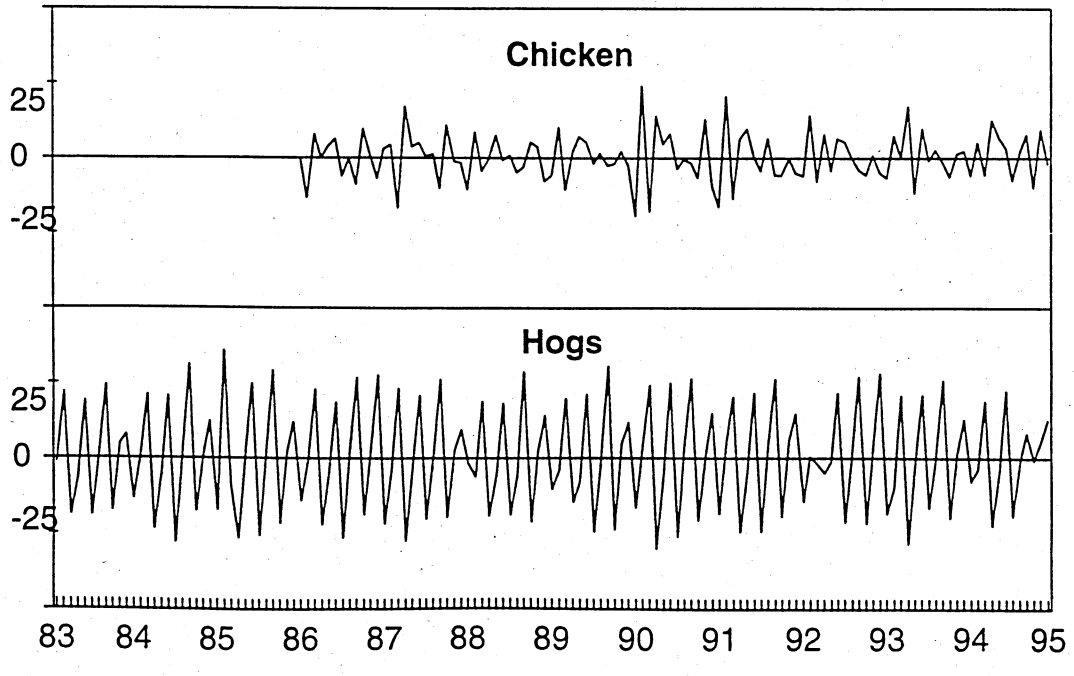


Figure 13. Canada Farm Output (Percent Change)

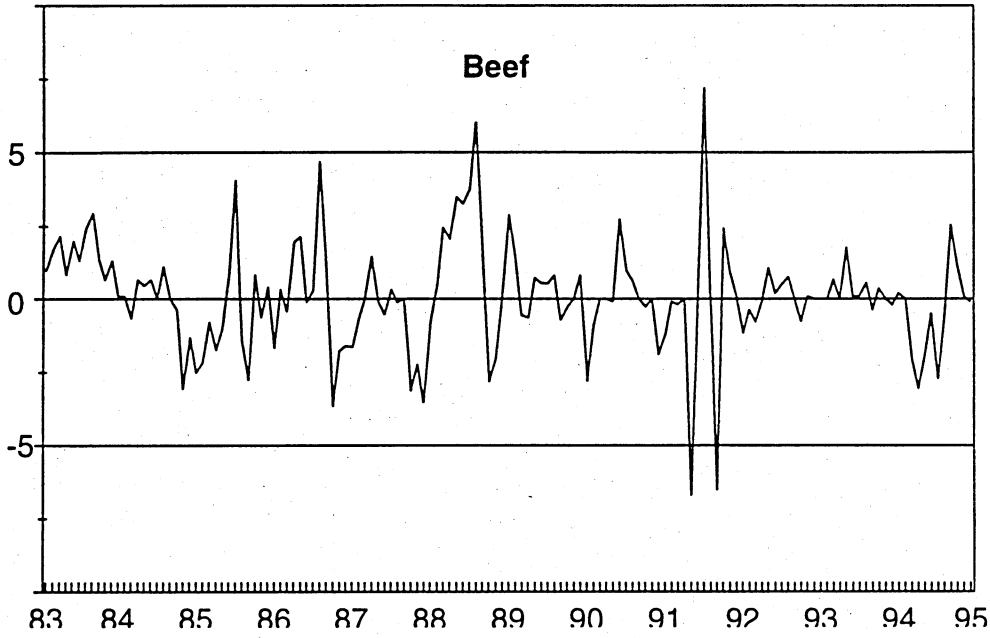


Figure 14. Food Marketing Cost Index (Percent Change)

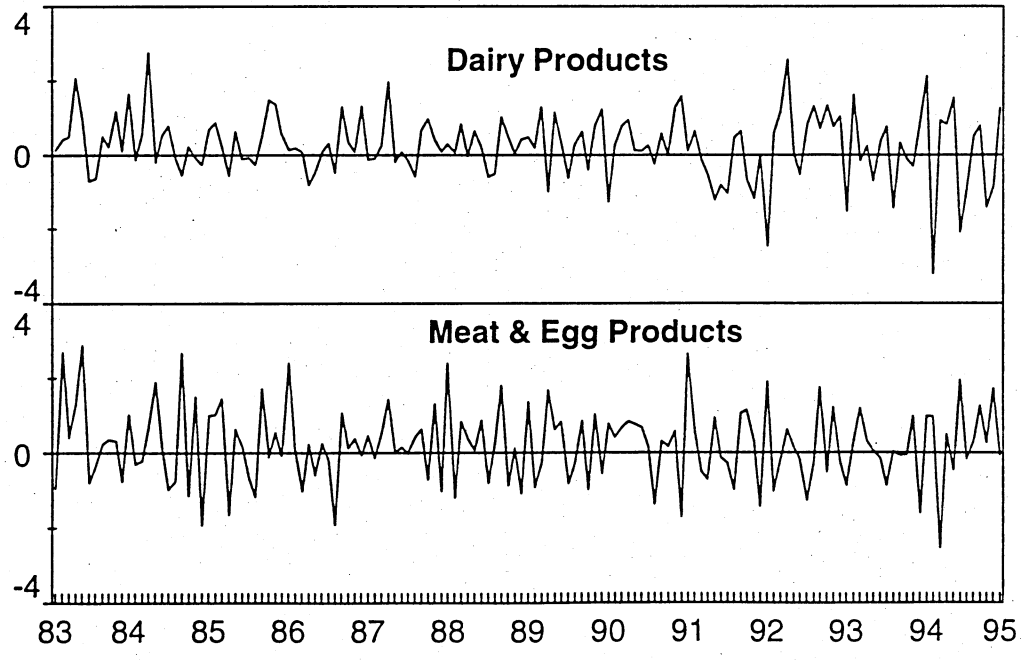


Table 15. Demand Shifters (Percent Change)

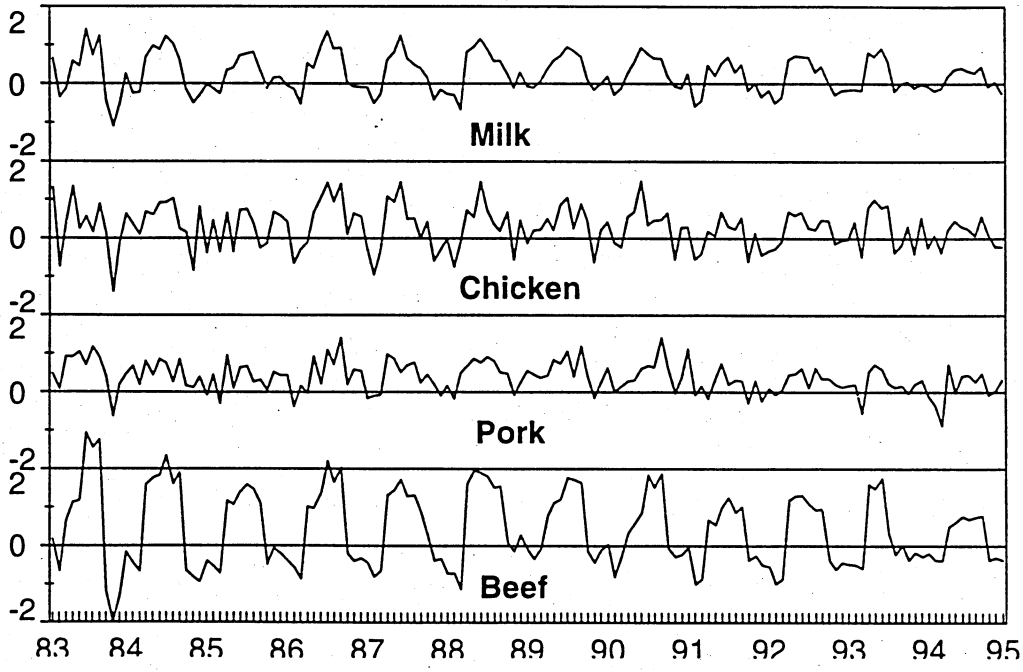
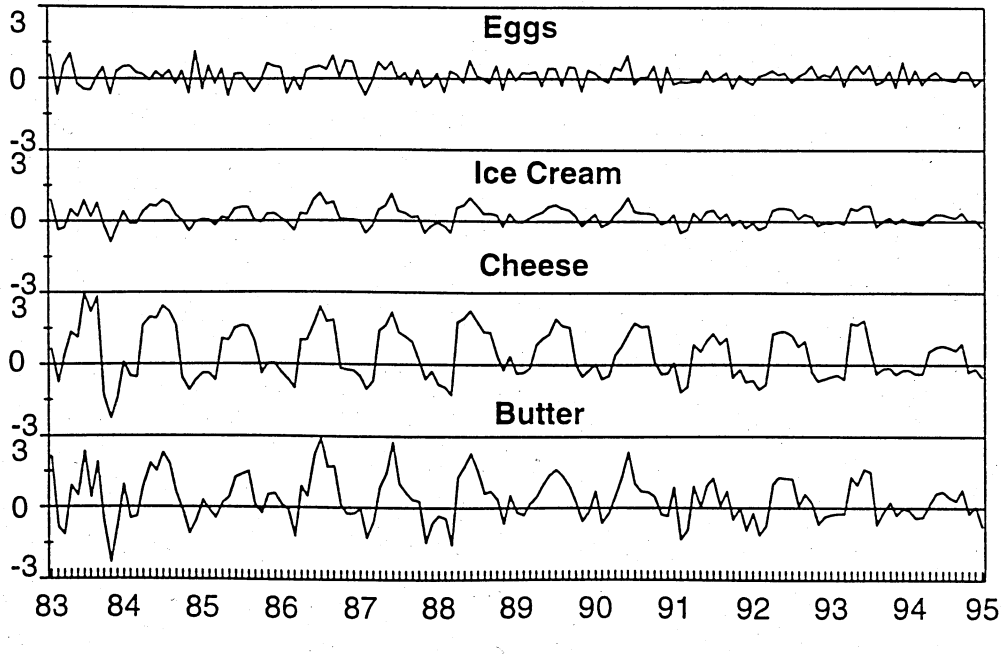


Figure 16. Demand Shifters (Percent Change)



V. Regression and Elasticity Results

Our estimation procedure is to start with the basic Holloway Model and through successive modified regressions, adapt the model for application to Canadian retail farm markets. Ordinary least squares is applied to estimate the parameters in each regression equation.

The estimated parameters of the Unrestricted Holloway Model, equation (1), are reported in Table 2. For each of the eight different commodities three regression equations are estimated to explain variations in marketing margin (Ratio), retail price (Retail) and farm price (Farm). We also report for each equation the R^2, the Durbin-Watson (D-W) statistic and the Q-statistic, which tests the null hypothesis that the estimated residuals are white noise. The Q-statistic is distributed as Chi-square with 12 degrees of freedom. t-statistics are in braces. The estimated intercept term can be interpreted as trend variation in the dependent variable capturing not only trend but also shifts in retail demand not captured by the retail demand shifter.

The most notable point of this table is how poor the results appear to be. Only a few parameters are statistically significant and there is little or no consistency to the sign of the estimated parameters across equations. Moreover, the R^2 statistic shows that very little of the variation in the dependent variable is explained by the regression equations. These results would appear to indicate that direct application of the Holloway model to the Canadian market is not appropriate. This is likely because both the Beef and Pork models suffer from an endogenous right-hand-side variable (farm quantity) and the farm price equation for each commodity is inappropriate. In addition, as the data used in estimation represents differences in monthly observations it is perhaps unreasonable to assume that both farm and retail markets clear within this time period. However, before investigating these possibilities we re-estimate the Holloway model imposing the necessary linear restrictions on the parameters of equation (1) to ensure competitive markets, and list these results in Table 3. We also report both the necessary and sufficient F-test results for testing the null hypotheses that all marketing sectors are characterized by competitive conditions.

Imposing the competitive restrictions for a competitive market appears to improve somewhat the estimation results. The signs of the estimated parameters are more consistent with prior expectations --retail and farm price responding positively to changes in the Retail Demand shift variable and negatively to changes in the Marketing Input Cost index. However, the statistical significance of the estimated parameters and the R^2 statistic improve only marginally. The F-test results are statistically insignificant for both the necessary and sufficient tests of the competitive hypothesis and indicates that we cannot reject the null of competitive markets in all sectors. (The one exception is the farm price equation for milk at the 5% significance level). However, because the equations show such

a generally poor fit to the data (low R^2 and insignificant t-values) the test results for a competitive market are more likely a rejection of the model itself.

In an attempt to improve the parameter estimates and to account for monthly data observations, we introduce a two period lag structure for all independent variables in equation (1) and reestimate the model. The results of this Dynamic Holloway Model are reported in Table 4. Unfortunately, these dynamic results show only marginal improvement compared to the two previous static models. One noteworthy observation from Table 4 is that many of the lagged independent variables are of the correct sign and statistically important. We read this to indicate that a lagged adjustment process is occurring in the different sectors and that the appropriate model specification should account for lagged response. A further improvement in model specification is had by substituting the farm price for the farm output variable in the marketing margin and retail price equations and dropping the farm price equation. The results of the Modified Dynamic Holloway Model, equation (2), are presented in Table 5.

For the estimated equations. the R^2, D-W and Q-statistics are of a reasonable statistical magnitude. In the Beef and Pork equations, retail demand changes in the current period have a negative but insignificant effect on marketing margin and retail price. However, in the first lagged period, we measure a positive and significant response of margin and retail price to the demand shift variable for these two sectors. The second lagged demand shifter is statistically unimportant in both series of equations. The supply restricted commodities seem to offer more mixed results with respect to the retail demand shifter. For chicken, the retail variable shows a positive but insignificant result in all three periods. For the other supply restricted commodities, the retail shifter is statistically unimportant except for a substantial positive response for ice cream noted in the second lagged period.

The estimated farm price coefficients reported in Table 5 are consistent across equations. In the current period, farm price has a negative and significant impact on marketing margin and a positive and significant impact on the retail price. An exception is the ice cream equation which measures a negative relationship for the retail farm price in the current period. The one period lagged farm price is positive and generally significant for both the marketing margin and the retail price. The two period lagged farm price is generally unimportant.

In the current period, the Marketing Input Cost variable tends to be negative reducing both the marketing margin and retail price. The marketing input cost variable responds positively to the one and two period lagged coefficients. However, the statistical relevance of this variable is marginal at best.

The Modified Dynamic Holloway Model is certainly an improvement over the original model. However, we suspect that smoothing month to month variations using the three month Moving Average model is a further refinement to obtain better parameter estimates. The results for this model are reported in Table 6. Before discussing the results, we note that the Marketing Cost Input index has not performed well in previous equations. To provide some additional information on this index, we subtract all factors except the wage component, and use only the wage component as a measure of the Marketing Cost index. The results using this transformation are reported in Table 7.

A survey of Tables 6 and 7 show very similar results (perhaps merely pointing out the importance of the wage component in the combined Marketing Cost index) with only the R^2 value somewhat larger in Table 7. For both tables, the constant (trend) term for beef and cheese shows a general increase in margin and retail price, whereas butter shows a negative trend over the sample period. For all other commodities, the trend estimates show no significant value.

Table 2. Unrestricted Holloway Model

Commodity	Price	Elasticity With Respect to: Constant	Retail Demand	Farm Commodity Supply	Marketing Input Cost	R2	D-W	Q stat
Beef	Ratio	-0.008165	0.48754	-0.039121	-0.17814	0.1773	2.0062	42.61
		(-0.8215)	(1.188)	(-0.9991)	(-0.7116)			
	Retail	0.0015631	-0.17691	-0.004012	-0.18849	0.1551	2.476	22.29
		(0.2082)	(-0.5706)	(-0.1356)	(-0.9966)			
	Farm	0.0097282	-0.66445	0.035109	-0.010346	0.1809	1.5902	24.51
		(1.095)	(-1.812)	(1.003)	(-0.04624)			
Pork	Ratio	0.068526	-0.39812	0.036508	-0.6925	0.3245	1.6798	18.85
		(3.026)	(-0.2779)	(0.4823)	(-1.194)			
	Retail	0.014768	0.042235	-0.022848	-0.4411	0.3412	1.8179	11.79
		(1.421)	(0.06424)	(-0.6576)	(-1.657)			
	Farm	-0.053758	0.44035	-0.059356	0.2514	0.3664	1.3192	34.98
		(-2.337)	(0.3027)	(-0.772)	(0.4268)			
Chicken	Ratio	0.023389	0.58843	-0.019649	0.26941	0.2048	2.5563	21.68
		(1.624)	(0.6776)	(-0.3786)	(0.6159)			
	Retail	0.0077005	1.2195	-0.06482	0.40481	0.2728	2.5374	21.83
		(0.5802)	(1.524)	(-1.355)	(1.004)			
	Farm	-0.021921	0.68747	-0.023775	0.25897	0.2079	1.7574	9
		(-3.015)	(1.568)	(-0.9074)	(1.173)			
Eggs	Ratio	0.024362	0.13062	0.54358	0.10007	0.278	2.2987	12.32
		(3.429)	(0.8323)	(1.12)	(0.4561)			
	Retail	0.0029107	0.2567	0.057518	0.083695	0.1532	2.4339	31.36
		(0.6659)	(0.8596)	(0.5957)	(0.6201)			
	Farm	-0.021451	-0.28687	-0.073105	-0.01638	0.2288	2.1657	16.73
		(-3.087)	(-0.6042)	(-0.4762)	(-0.07632)			
Milk	Ratio	0.0034893	-0.37963	-0.076925	-0.046712	0.0509	2.3713	7.84
		(0.8765)	(-0.9869)	(-1.178)	(-0.3922)			
	Retail	0.0067242	-0.089313	-0.072087	-0.04692	0.0772	2.3566	8.3
		(1.729)	(-0.2376)	(-1.13)	(-0.4032)			
	Farm	0.0032349	0.29032	0.0048372	-0.000208	0.2749	2.2624	15.25
		(2.515)	(2.336)	(0.2292)	(-0.005407)			
Butter	Ratio	-0.003542	0.0052415	0.047649	0.038649	0.0974	2.54114	38.24
		(-1.417)	(0.05013)	(1.168)	(0.5197)			
	Retail	-0.000441	0.087281	0.052823	0.040338	0.2057	2.231	10.82
		(-0.1815)	(0.858)	(1.331)	(0.5574)			
	Farm	0.003101	0.08204	0.0051748	0.0016893	0.2568	2.2259	13.89
		(2.366)	(1.496)	(0.242)	(0.04332)			
Ice Cream	Ratio	0.011845	-0.31742	-0.036943	-0.052595	0.1138	2.9452	47.16
		(2.102)	(-0.5319)	(-0.4025)	(-0.3137)			
	Retail	0.014973	-0.15882	-0.031979	-0.050519	0.1524	2.8906	41.76
		(2.837)	(-0.2841)	(-0.3719)	(-0.3217)			
	Farm	0.0031288	0.1586	0.0049631	0.0020763	0.2513	2.2143	14.22
		(2.373)	(1.136)	(0.2311)	(0.05293)			
Cheese	Ratio	-6.95E-05	0.061806	0.026435	0.0067166	0.4206	2.4858	21.26
		(-0.033)	(0.4748)	(0.6937)	(0.1061)			
	Retail	0.0018162	0.15161	0.036729	-0.008742	0.3866	2.3884	9.91
		(1.036)	(1.387)	(1.148)	(-0.1644)			
	Farm	0.0018857	0.089801	0.010293	-0.015459	0.2243	2.3375	15.28
		(1.449)	(0.3338)	(0.4332)	(-0.3916)			

Unrestricted Holloway Models, t-ratios in braces
Note: Monthly dummy variables not reported

Table 3. Restricted Holloway Model

Commodity	Price	Elasticity With Respect to: Constant	Retail Demand	Farm Commodity Supply	Marketing Input Cost	R2	D-W	Q stat	F-test 1	F-test 2
Beef	Ratio	-0.009464	0.043184	-0.043184	-0.19202	0.1696	1.9783	41.83	1.1833	
		(-0.9585)	(1.107)	(-1.107)	(-0.7675)				(1, 127)	
	Retail	0.0020873	0.0023734	-0.002373	-0.18289	0.1529	2.4846	23.1	0.33745	0.942294
		(0.2807)	(0.0808)	(-0.0808)	(-0.9707)				(1, 127)	(1, 128)
	Farm	0.011552	-0.04081	0.04081	0.0091335	0.1621	1.5751	25.49	2.9179	
		(1.3)	(-1.163)	(1.163)	(0.04057)				(1, 127)	
Pork	Ratio	0.067421	-0.037155	0.037155	-0.70369	0.3242	1.6806	18.88	0.063682	
		(3.046)	(-0.493)	(0.493)	(-1.222)				(1, 127)	
	Retail	0.014827	0.022883	-0.022883	-0.4405	0.3412	1.8164	11.81	0.0008687	2.7766614
		(1.46)	(0.6616)	(-0.6616)	(-1.666)				(1, 127)	(1, 128)
	Farm	-0.052594	0.060038	-0.060038	0.26319	0.3661	1.3144	35.23	0.068517	
		(-2.339)	(0.7842)	(-0.7842)	(0.4498)				(1, 127)	
Chicken	Ratio	0.023682	0.02397	-0.02397	0.2433	0.2011	2.555	22.23	0.42393	
		(1.65)	(0.4671)	(-0.4671)	(0.5603)				(1, 91)	
	Retail	0.0082948	0.073593	-0.073593	0.3518	0.2563	2.4557	19.51	2.0576	0.759402
		(0.6217)	(1.543)	(-1.543)	(0.8714)				(1, 91)	(1, 92)
	Farm	-0.02158	0.028817	-0.028817	0.2285	0.1881	1.6441	10.58	2.2649	
		(-2.949)	(1.101)	(-1.101)	(1.032)				(1, 91)	
Eggs	Ratio	0.025245	-0.066172	0.066172	0.045342	0.2681	2.3031	12.76	1.7424	
		(3.559)	(-0.4424)	(0.4424)	(0.2099)				(1, 127)	
	Retail	0.0033221	-0.02748	0.02748	0.058186	0.1466	2.4398	29.98	1.0001	0.1927274
		(0.7635)	(-0.2995)	(0.2995)	(0.439)				(1, 127)	(1, 128)
	Farm	-0.021923	0.038693	-0.038693	0.012844	0.2256	2.1655	17.57	0.51914	
		(-3.174)	(0.2657)	(-0.2657)	(0.06106)				(1, 127)	
Milk	Ratio	0.003121	0.061955	-0.061955	-0.057049	0.0408	2.3932	8.94	1.3554	
		(0.7854)	(0.9662)	(-0.9662)	(-0.4797)				(1, 127)	
	Retail	0.006594	0.066796	-0.066796	-0.050574	0.0759	2.3698	8.56	0.17746	0.1911972
		(1.706)	(1.071)	(-1.071)	(-0.4373)				(1, 127)	(1, 128)
	Farm	0.003473	0.0048403	-0.00484	0.0064749	0.2439	2.1872	15.21	5.4267	
		(2.663)	(0.02104)	(0.02104)	(0.1659)				(1, 127)	
Butter	Ratio	-0.003298	-0.039925	0.039925	0.041186	0.0959	2.5119	38.48	0.2137	
		(-1.354)	(-1.076)	(1.076)	(0.557)				(1, 127)	
	Retail	0.000205	-0.032364	0.032364	0.047058	0.1958	2.2158	11.13	1.5838	0.4233061
		(0.086)	(0.03629)	(0.8919)	(0.6506)				(1, 127)	(1, 128)
	Farm	0.0035033	0.0075611	-0.007561	0.0058727	0.2445	2.1881	15	2.113	
		(2.723)	(0.3859)	(-0.3859)	(0.1504)				(1, 127)	
Ice Cream	Ratio	0.011266	0.025385	-0.025385	-0.063102	0.1114	2.9414	47.07	0.33755	
		(2.037)	(0.284)	(-0.284)	(-0.3796)				(1, 127)	
	Retail	0.014662	0.025757	-0.025757	-0.056176	0.1517	2.8909	41.8	0.1115	0.1303554
		(2.832)	(0.3079)	(-0.3079)	(-0.361)				(1, 127)	(1, 128)
	Farm	0.003396	0.0003713	-0.000371	0.0069259	0.2436	2.1873	15.28	1.3133	
		(2.614)	(0.01769)	(-0.01769)	(0.1774)				(1, 127)	
Cheese	Ratio	-0.000141	-0.01853	0.01853	0.0089255	0.4183	2.4757	21.57	0.41251	
		(-0.0676)	(-0.5152)	(0.5152)	(0.1416)				(1, 104)	
	Retail	0.0016645	-0.019856	0.019856	-0.004027	0.3709	2.3269	9.67	2.6648	0.0056649
		(0.9435)	(-0.6505)	(0.6505)	(-0.07527)				(1, 104)	(1, 105)
	Farm	0.0018051	-0.001326	0.0013262	-0.012953	0.2141	2.3059	14.94	1.3653	
		(1.386)	(-0.05887)	(0.05887)	(-0.328)				(1, 104)	

Restricted Holloway Models, t-ratios in braces
Note: Monthly dummy variables not reported

Table 4. Dynamic Holloway Model

			Elasticity With Respect to											
Commodity	Price	Constant	Retail Demand	Retail Demand Lag 1	Retail Demand Lag 2	Farm Commodity Supply	Farm Supply Lag 1	Farm Supply Lag 2	Marketing Input Cost	Marketing Cost Lag 1	Marketing Cost Lag 2	R2	D-W	Q stat
Beef	Ratio	-0.011471	-0.22143	1.4052	-0.52394	-0.058232	-0.007293	-0.015849	-0.11245	0.011714	0.29615	0.2237	2.0026	40.28
		(-1.006)	(-0.4362)	(2.464)	(-1.074)	(-1.354)	(-0.1472)	(-0.3262)	(-0.4051)	(0.04376)	(1.14)			
	Retail	0.0066037	-0.63133	0.57065	-0.21363	-0.038622	-0.076625	-0.050876	-0.2065	0.11106	0.15225	0.1951	2.4057	22.21
		(0.7635)	(-1.639)	(1.319)	(-0.5773)	(-1.183)	(-2.038)	(-1.38)	(-0.9805)	(0.5468)	(0.7726)			
	Farm	0.018075	-0.4099	-0.83459	0.31031	0.01961	-0.069332	-0.035027	-0.094058	0.099344	-0.14391	0.224	1.6515	24.78
		(1.772)	(-0.9024)	(-1.635)	(0.711)	(0.5095)	(-1.564)	(-0.8056)	(-0.3786)	(0.4147)	(-0.6192)			
Pork	Ratio	0.075798	-1.0262	0.72029	0.41228	0.0048922	-0.076119	-0.061993	-0.64706	0.56393	0.36405	0.3651	1.7584	22.29
		(2.967)	(-0.6827)	(0.4968)	(0.2767)	(0.05338)	(-0.7678)	(-0.6807)	(-1.039)	(0.9192)	(0.5954)			
	Retail	0.015847	-0.04683	1.0299	-0.44632	-0.052053	-0.049983	-0.079794	-0.39395	-0.27233	-0.19697	0.4291	1.8829	8.69
		(1.466)	(-0.07364)	(1.679)	(-0.708)	(-1.342)	(-1.192)	(-2.071)	(-1.495)	(-1.049)	(-0.7614)			
	Farm	-0.059951	0.97934	0.30957	-0.8586	-0.056945	0.026136	-0.017801	0.2531	-0.83626	-0.56102	0.3821	1.372	34.3
		(-2.272)	(0.6309)	(0.2067)	(-0.558)	(-0.6016)	(0.2553)	(-0.1893)	(0.3936)	(-1.32)	(-0.8885)			
Chicken	Ratio	0.028981	0.1595	0.19309	0.49595	-0.12018	-0.08407	-0.1567	-0.008456	-0.34771	-0.7123	0.3103	2.8966	43.06
		(1.697)	(0.1628)	(0.2063)	(0.5153)	(-1.571)	(-1.012)	(-2.156)	(-0.01792)	(-0.7242)	(-1.485)			
	Retail	-0.002277	0.95531	0.58705	0.42565	-0.17742	-0.1649	-0.1684	0.31556	-0.15033	-0.39965	0.3513	2.7997	30.98
		(-0.1518)	(1.11)	(0.714)	(0.5034)	(-2.64)	(-2.258)	(-2.637)	(0.7613)	(-0.3564)	(-0.9485)			
	Farm	-0.031258	0.79581	0.39396	-0.070291	-0.057241	-0.080827	-0.011701	0.32402	0.19738	0.31265	0.2969	1.8308	8.64
		(-3.811)	(1.691)	(0.8765)	(-0.1521)	(-1.558)	(-2.025)	(-0.3351)	(1.43)	(0.856)	(1.357)			
Eggs	Ratio	0.034395	0.35709	-0.16851	0.11049	0.10195	-0.14361	0.20899	0.16214	-0.25985	0.19469	0.3	2.2648	13.89
		(3.056)	(0.6948)	(-0.3224)	(0.2154)	(0.6108)	(-0.8245)	(1.238)	(0.6763)	(-1.103)	(0.8521)			
	Retail	0.008399	0.0052097	-0.058053	0.37071	0.01791	-0.10791	0.16926	0.18843	-0.13791	0.42541	0.2646	2.3475	21.64
		(1.2880	(0.01749)	(-0.1916)	(1.247)	(0.1851)	(-1.069)	(1.73)	(1.356)	(-1.01)	(3.213)			
	Farm	-0.025996	-0.35188	0.11045	0.26023	-0.084042	0.035696	-0.03973	0.026298	0.12194	0.23072	0.2417	2.1376	15.52
		(-2.336)	(-0.6925)	(0.2137)	(0.5132)	(-0.5093)	(0.2073)	(-0.2381)	(0.1109)	(0.5233)	(1.021)			
Milk	Ratio	-0.008157	-0.33612	0.29006	-0.52543	-0.061941	0.058975	-0.12139	-0.044901	0.15186	-0.18618	0.1219	2.323	9.51
		(-1.0390	(-0.7624)	(0.6479)	(-1.266)	(-0.8276)	(0.8004)	(-1.656)	(-0.3747)	(1.261)	(-1.508)			
	Retail	-0.005027	-0.14814	0.53091	-0.69736	-0.060403	0.060749	-0.11794	-0.04342	0.15194	-0.16005	0.1548	2.3209	10.14
		(-0.6603)	(-0.3464)	(1.222)	(-1.732)	(-0.832)	(0.8499)	(-1.659)	(-0.3735)	(1.301)	(-1.336)			
	Farm	0.0031302	0.18798	0.24085	-0.17193	0.0015385	0.0017739	0.0034555	0.0014801	8.426E-05	0.026137	0.2923	2.2147	17.91
		(1.205)	(1.288)	(1.625)	(-1.251)	(0.06211)	(0.07274)	(0.1424)	(0.03732)	(0.002114)	(0.6395)			
Butter	Ratio	0.0030121	1.677E-05	0.01548	0.078845	0.053138	-0.049749	0.059391	0.035208	0.039755	-0.049057	0.121	2.4688	32.52
		(0.5959)	(0.00014)	(0.1311)	(0.7118)	(1.12)	(-1.057)	(1.282)	(0.4573)	(0.5144)	(-0.6228)			
	Retail	0.0061185	0.048107	0.10076	0.0023586	0.052457	-0.046054	0.067887	0.035724	0.042735	-0.015193	0.2324	2.1817	10.64
		(1.246)	(0.4168)	(0.8785)	(0.02192)	(1.138)	(-1.007)	(1.509)	(0.4776)	(0.5692)	(-0.1985)			
	Farm	0.0031064	0.04809	0.085278	-0.076487	-0.000681	0.0036954	0.0084968	0.0005154	0.0029792	0.033865	0.2778	2.1882	17.15
		(1.175)	(0.7736)	(1.38)	(-1.32)	(-0.02741)	(0.15)	(0.3506)	(0.01279)	(0.07368)	(0.8217)			
Ice Cream	Ratio	0.0068957	-0.4724	-0.16028	1.6719	-0.005534	0.086537	-0.027242	0.0073955	0.094085	-0.074786	0.1741	2.9628	47.4
		(0.6201)	(-0.7059)	(-0.2401)	(2.697)	(-0.05295)	(0.834)	(-0.2674)	(0.04345)	(0.5495)	(-0.4287)			
	Retail	0.0099636	-0.40755	0.022357	1.479	-0.007789	0.090822	-0.017085	0.0087816	0.10016	-0.037187	0.2081	2.9155	42.97
		(0.956)	(-0.6497)	(0.03573)	(2.545)	(-0.07952)	(0.9338)	(-0.1789)	(0.05504)	(0.6241)	(-0.2274)			
	Farm	0.0030679	0.064847	0.18264	-0.19289	-0.002255	0.0042847	0.010157	0.001386	0.0060777	0.037599	0.2705	2.1914	16.83
		(1.157)	(0.4062)	(1.147)	(-1.304)	(-0.09048)	(0.1731)	(0.418)	(0.03414)	(0.1488)	(0.9036)			
Cheese	Ratio	-0.003776	0.19977	-0.26373	0.20276	0.019806	0.045741	-0.037417	0.01382	-0.001669	-0.051678	0.4424	2.5575	22.85
		(-0.8274)	(1.21)	(-1.387)	(1.237)	(0.4463)	(0.9887)	(-0.8464)	(0.2072)	(-0.02476)	(-0.7544)			
	Retail	-0.001239	0.17023	-0.003555	0.086656	0.040167	0.031268	-0.034192	-0.004292	-0.001661	-0.030622	0.4024	2.4206	10.77
		(-0.3218)	(1.222)	(-0.02216)	(0.6269)	(1.073)	(0.8011)	(-0.9168)	(-0.07628)	(-0.02922)	(-0.5298)			
	Farm	0.0025373	-0.02954	0.26017	-0.11611	0.02036	-0.014473	0.0032253	-0.018111	7.709E-06	0.021056	0.2659	2.3554	15.66
		(0.8997)	(-0.2895)	(2.214)	(-1.147)	(0.7425)	(-0.5063)	(0.1181)	(-0.4395)	(0.00019)	(0.4974)			

Note: Monthly dummy variables not reported.

Table 5. Modified Dynamic Holloway Model

		Elasticity With Respect to												
Commodity	Price	Constant	Retail Demand	Retail Demand Lag 1	Retail Demand Lag 2	Farm Price	Farm Price Lag 1	Farm Price Lag 2	Marketing Input Cost	Marketing Cost Lag 1	Marketing Cost Lag 2	R2	D-W	Q stat
Beef	Ratio	-0.011471	-0.44581	0.66185	-0.065051	-0.70299	0.02837	0.28045	-0.14655	0.17242	0.1698	0.6246	2.601	24.27
		(-1.006)	(-1.285)	(1.649)	(-0.1877)	(-9.491)	(0.3733)	(3.759)	(-0.8002)	(0.9681)	(0.9625)			
	Retail	0.0002504	-0.44581	0.66185	-0.065051	0.29701	0.02837	0.28045	-0.14655	0.17242	0.1698	0.324	2.601	24.27
		(0.04201)	(-1.285)	(1.649)	(-0.1877)	(4.01)	(0.3733)	(3.759)	(-0.8002)	(0.9681)	(0.9625)			
Pork	Ratio	0.015827	-0.59956	1.013	-0.47389	-0.94708	0.20241	0.029584	-0.14561	-0.2278	0.020458	0.9191	2.3817	20.82
		(2.05)	(-1.111)	(1.955)	(-0.8927)	(-27.56)	(5.575)	(0.8497)	(-0.6485)	(-1.033)	(0.095)			
	Retail	0.015827	-0.59956	1.013	-0.47389	0.052923	0.20241	0.029584	-0.14561	-0.2278	0.020458	0.5935	2.3817	20.82
		(2.05)	(-1.111)	(1.955)	(-0.8927)	(1.54)	(5.575)	(0.8497)	(-0.6485)	(-1.033)	(0.095)			
Chicken	Ratio	0.010005	1.1967	0.72841	0.3077	-0.96554	0.27137	-0.26428	0.42676	-0.25522	-0.27181	0.4237	2.5472	23.92
		(0.6545)	(1.282)	(0.805)	(0.353)	(-4.688)	(1.29)	(-1.222)	(0.9783)	(-0.575)	(-0.6207)			
	Retail	0.010005	1.1967	0.72841	0.3077	0.034458	0.27137	-0.26428	0.42676	-0.25522	-0.27181	0.2977	2.5472	23.92
		(0.6545)	(1.282)	(0.805)	(0.353)	(0.1673)	(1.29)	(-1.222)	(0.9783)	(-0.575)	(-0.6207)			
Eggs	Ratio	0.002542	0.12784	-0.087003	0.31305	-0.83889	0.030446	0.038275	0.13187	-0.12407	0.34598	0.7715	2.4461	36.73
		(0.5553)	(0.4369)	(-0.2927)	(1.066)	(-15.69)	(0.5735)	(0.7174)	(0.9717)	(-0.9255)	(2.655)			
	Retail	0.002542	0.12784	-0.087003	0.31305	0.16111	0.030446	0.038275	0.13187	-0.12407	0.34598	0.2854	2.4461	36.73
		(0.5553)	(0.4369)	(-0.2927)	(1.066)	(3.014)	(0.5735)	(0.7174)	(0.9717)	(-0.9255)	(2.655)			
Milk	Ratio	0.0030041	-0.31263	0.44905	-0.65669	-0.7479	0.21645	0.13804	-0.055549	0.16563	-0.17083	0.1547	2.3787	9.7
		(0.7337)	(-0.7263)	(1)	(-1.593)	(-2.73)	(0.7914)	(0.5003)	(-0.4687)	(1.407)	(-1.424)			
	Retail	0.0030041	-0.31263	0.44905	-0.65669	0.2521	0.21645	0.13804	-0.055549	0.16563	-0.17083	0.1355	2.3287	9.7
		(0.7337)	(-0.7263)	(1)	(-1.593)	(0.9203)	(0.7914)	(0.5003)	(-0.4687)	(1.407)	(-1.424)			
Butter	Ratio	-0.001345	0.05321	0.033027	-0.005148	-0.56688	0.27186	-0.024204	0.040437	0.033514	-0.021602	0.1977	2.3552	17.65
		(-0.5247)	(0.471)	(0.2904)	(-0.04833)	(-3.368)	(1.626)	(-0.1438)	(0.5454)	(0.4551)	(-0.2892)			
	Retail	-0.001345	0.05321	0.033027	-0.005148	0.43312	0.27186	-0.024204	0.040437	0.033514	-0.021602	0.2576	2.3552	17.65
		(-0.5247)	(0.471)	(0.2904)	(-0.04833)	(2.573)	(1.626)	(-0.1438)	(0.5454)	(0.4551)	(-0.2892)			
Ice Cream	Ratio	0.016118	-0.35182	0.0063388	1.2153	-1.4562	0.94954	0.17516	-0.002109	0.094496	-0.034857	0.3263	2.9251	43.28
		(3.074)	(-0.5838)	(0.01047)	(2.17)	(-4.173)	(2.742)	(0.5009)	(-0.0136)	(0.6124)	(-0.2228)			
	Retail	0.016118	-0.35182	0.0063388	1.2153	-0.45622	0.94954	0.17516	-0.002109	0.094496	-0.034857	0.2646	2.9251	43.28
		(3.074)	(-0.5838)	(0.01047)	(2.17)	(-1.307)	(2.742)	(0.5009)	(-0.0136)	(0.6124)	(-0.2228)			
Cheese	Ratio	0.0023499	0.1569	-0.030152	0.012994	-0.82459	0.28382	-0.041151	-0.014906	-0.007386	-0.032405	0.6144	2.4219	8.98
		(1.207)	(1.195)	(-0.1967)	(0.09573)	(-5.909)	(2.012)	(-0.2999)	(-0.2723)	(-0.1353)	(-0.5873)			
	Retail	0.0023499	0.1569	-0.030152	0.012994	0.17541	0.28382	-0.041151	-0.014906	-0.007386	-0.032405	0.4194	2.4219	8.98
		(1.207)	(1.195)	(-0.1967)	(0.09573)	(1.257)	(2.012)	(-0.2999)	(-0.2723)	(-0.1353)	(-0.5873)			

Note: Monthly dummy variables not listed.

The estimated coefficients in Tables 6 and 7 are much the same as those presented in Table 5 with two noteworthy points. First, in many cases, there is a significant contribution to the model offered by the lagged three month moving average variable, indicating a substantial adjustment process in food marketing. Second, farm price coefficients are robust to changes in model specification and consistent over the three tables reported. The coefficients show a significant negative impact on marketing margin in the current period, with the opposite impact on the retail price. In the lagged period, except for chicken, the results are positive in both margin and retail price equations.

For the retail equation the coefficient on farm price in the current period can be interpreted as the short-run transmission elasticity. When the coefficient for farm price is combined with the coefficient on the lagged farm price variable, it can be interpreted as the more intermediate or long-run elasticity. These elasticity estimates appear to be robust over different models and to provide a reasonable characterization of the farm retail price transmission.

One disturbing result in Table 6 is the negative and significant retail demand shift variable in the estimated cheese and ice cream equations. One explanation for such an odd result is perhaps evident from figures 14 and 15 showing the percent change in the demand shift variable over the twelve year period. All retail demand shifters, except perhaps for eggs, show considerable seasonality. We suspect that the seasonality in the demand shift variable may be the cause of the negative result observed for the cheese and ice cream equations. To investigate this possibility, each retail demand shifter is transformed using a dummy variable regression to measure demand seasonality (i.e., the predicted value of a regression of eleven monthly dummies on the retail demand variable) and the deseasonalized retail demand shifter (i.e., the predicted residuals from the dummy variable regression). Using these transformed variables, we reestimate the Moving Average model and report the results in Table 8.

There are two noteworthy points to this table. First, the estimated farm price coefficient is robust to the retail demand shift variable transformation used and is consistent across equations, similar to the estimates reported in Table 6 and 7. Second, the separation of the retail demand variable into seasonal and deseasonalized components shows that the negative coefficient for the retail demand shifter in the cheese and ice cream equations is a result of the seasonal changes in retail demand. What is more, the seasonally adjusted demand shifter is either positive and significant or zero.

A modified Holloway model with appropriate lags appears to offer a reasonable model for measuring the impact of farm price changes on marketing margin and retail price. In the final section, we will summarize the study and report the final estimates of the short-run and intermediate-run price transmission elasticities.

Table 6. Moving Average(1)

		Elasticity With Respect to									
Commodity	Price	Constant	MCI	MCI Lag	Demand Shifter	Demand Shifter Lag	Farm Price	Farm Price Lag	R2	D-W	Q stat
Beef	Ratio	0.0055718	0.047471	-0.090051	-0.10312	0.044308	-0.69935	0.13507	0.6532	1.6963	41.95
		(2.081)	(0.3187)	(-0.6271)	(-1.356)	(0.6049)	(-14.4)	(2.69)			
	Retail	0.0055718	0.047471	-0.090051	-0.10312	0.044308	0.30065	0.13507	0.2948	1.6963	41.95
		(2.081)	(0.3187)	(-0.6271)	(-1.356)	(0.6049)	(6.193)	(2.69)			
Pork	Ratio	-0.003725	-0.091378	-0.064088	1.7321	-0.63156	-0.78123	0.11049	0.9064	1.1054	67.47
		(-0.5949)	(-0.378)	(-0.2742)	(4.216)	(-1.671)	(-30.63)	(4.384)			
	Retail	-0.003725	-0.091378	-0.064088	1.7321	-0.63156	0.21877	0.11049	0.6053	1.1054	67.47
		(-0.5949)	(-0.378)	(-0.2742)	(4.216)	(-1.671)	(8.578)	(4.384)			
Chicken	Ratio	-0.009033	-0.37061	-0.8638	1.2369	1.2001	-0.48074	-0.23587	0.3128	1.1736	28.98
		(-1.337)	(-1.077)	(-2.431)	(3.024)	(3.073)	(-4.242)	(-1.984)			
	Retail	-0.009033	-0.37061	-0.8638	1.2369	1.2001	0.51926	-0.23587	0.3833	1.1736	28.98
		(-1.337)	(-1.077)	(-2.431)	(3.024)	(3.073)	(4.582)	(-1.984)			
Eggs	Ratio	-0.001781	0.1322	0.3203	0.41552	0.037059	-0.71828	0.086229	0.7004	1.0348	49.08
		(-0.7501)	(1.076)	(2.698)	(1.628)	(0.152)	(-16.73)	(1.989)			
	Retail	-0.001781	0.1322	2.698	0.41552	0.037059	0.28172	0.086229	0.2939	1.0348	49.08
		(-0.7501)	(1.076)	(2.698)	(1.628)	(0.152)	(6.561)	(1.989)			
Milk	Ratio	-8.32E-05	0.0353	-0.002079	0.087702	0.064056	-0.47608	0.43717	0.0786	0.9928	68.11
		(0.002282)	(0.3611)	(-0.02149)	(0.7157)	(0.5245)	(-2.319)	(2.127)			
	Retail	-8.32E-05	0.0353	-0.002079	0.087702	0.064056	0.52392	0.43717	0.1149	0.9928	68.11
		(0.002282)	(0.3611)	(-0.02149)	(0.7157)	(0.5245)	(2.552)	(2.127)			
Butter	Ratio	-0.003744	-0.003705	0.085739	0.15858	0.17052	-0.31925	0.11037	0.1722	0.9978	79.51
		(-2.469)	(-0.05468)	(1.282)	(3.474)	(3.702)	(-2.284)	(0.7954)			
	Retail	-0.003744	-0.003705	0.085739	0.15858	0.17052	0.68075	0.11037	0.3734	0.9978	79.51
		(-2.469)	(-0.05468)	(1.282)	(3.474)	(3.702)	(4.871)	(0.7954)			
Cheese	Ratio	0.0051813	0.017988	0.033182	-0.10427	-0.004939	-0.8876	0.46053	0.5204	1.0203	43.2
		(4.253)	(0.3499)	(0.6452)	(-3.235)	(-0.1483)	(-6.805)	(3.55)			
	Retail	0.0051813	0.017988	0.033182	-0.10427	-0.004939	0.1124	0.46053	0.2474	1.0203	43.2
		(4.253)	(0.3499)	(0.6452)	(-3.235)	(-0.1483)	(0.8617)	(3.55)			
Ice Cream	Ratio	0.0012641	0.07403	-0.081726	-0.58271	0.33086	-0.30122	0.52423	0.1776	1.6089	37.49
		(0.4483)	(0.6461)	(-0.7258)	(-2.944)	(1.662)	(-1.285)	(2.241)			
	Retail	0.0012641	0.07403	-0.081726	-0.58271	0.33086	0.69878	0.52423	0.2143	1.6089	37.49
		(0.4483)	(0.6461)	(-0.7258)	(-2.944)	(1.662)	(2.982)	(2.241)			

MA2

Table 7. Moving Average(2)

Commodity	Price	Elasticity With Respect to: Constant	Wages	Wages Lag	Demand Shifter	Demand Shifter Lag	Farm Price	Farm Price Lag	R2	D-W	Q stat
Beef	Ratio	0.0061858	-0.088814	-0.15306	-0.10054	0.02996	-0.70287	0.13421	0.6542	1.6645	40.93
		(2.514)	(-0.5476)	(-0.958)	(-1.298)	(0.3976)	(-14.54)	(2.669)			
	Retail	0.0061858	-0.088814	-0.15306	-0.10054	0.02996	0.29713	0.13421	0.2968	1.6645	40.93
		(2.514)	(-0.5476)	(-0.958)	(-1.298)	(0.3976)	(6.146)	(2.669)			
Pork	Ratio	-0.003287	-0.11623	0.236	1.6213	-1.769	-0.78167	0.11585	0.9074	1.1009	61.31
		(-0.5281)	(-0.4565)	(0.9549)	(4.016)	(-1.769)	(-30.96)	(4.705)			
	Retail	-0.003287	-0.11623	0.236	1.6213	-0.67159	0.21833	0.11585	0.6094	1.1009	61.31
		(-0.5281)	(-0.4565)	(0.9549)	(4.016)	(-1.769)	(8.648)	(4.705)			
Chicken	Ratio	-0.01216	-0.35947	-0.86854	1.2976	1.1673	-0.47715	-0.23088	0.3101	1.1633	27.87
		(-1.911)	(-0.9984)	(-2.396)	(3.145)	(2.954)	(-4.194)	(-1.938)			
	Retail	-0.01216	-0.35947	-0.86854	1.2976	1.1673	0.52285	-0.23088	0.3809	1.1633	27.87
		(-1.911)	(-0.9984)	(-2.396)	(3.145)	(2.954)	(4.596)	(-1.938)			
Eggs	Ratio	7.82E-06	0.049701	0.25385	0.35708	0.053503	-0.72008	0.083928	0.6927	1.018	47.91
		(0.00351)	(0.3686)	(1.961)	(1.378)	(0.2158)	(-16.5)	(1.871)			
	Retail	7.82E-06	0.049701	0.25385	0.35708	0.053503	0.27992	0.083928	0.2757	1.018	47.91
		(0.00351)	(0.3686)	(1.961)	(1.378)	(0.2158)	(6.413)	(1.871)			
Milk	Ratio	0.0002006	0.012309	-0.05885	0.096178	0.054006	-0.46271	0.46003	0.08	0.9973	66.74
		(0.0904)	(0.1219)	(-0.5595)	(0.7783)	(0.4422)	(-2.276)	(2.278)			
	Retail	0.0002006	0.012309	-0.05885	0.096178	0.054006	0.53729	0.46003	0.1163	0.9973	66.74
		(0.0904)	(0.1219)	(-0.5595)	(0.7783)	(0.4422)	(2.642)	(2.278)			
Butter	Ratio	-0.003547	-0.005358	0.093841	0.15294	0.16903	-0.31036	0.11605	0.1724	1.0064	76.8
		(-2.405)	(-0.0767)	(1.287)	(3.313)	(3.673)	(-2.239)	(0.852)			
	Retail	-0.003547	-0.005358	0.093841	0.15294	0.16903	0.68964	0.11605	0.3736	1.0064	76.8
		(-2.405)	(-0.0767)	(1.287)	(3.313)	(3.673)	(4.976)	(0.852)			
Cheese	Ratio	0.0052641	0.014823	0.039848	-0.10648	-0.004164	-0.88517	0.46637	0.5207	1.024	42.87
		(4.475)	(0.2832)	(0.7275)	(-3.32)	(-0.1262)	(-6.798)	(3.633)			
	Retail	0.0052641	0.014823	0.039848	-0.10648	-0.004164	0.11483	0.46637	0.2479	1.024	42.87
		(4.475)	(0.2832)	(0.7275)	(-3.32)	(-0.1262)	(0.882)	(3.633)			
Ice Cream	Ratio	0.0012744	0.091462	-0.17422	-0.5453	0.3274	-0.29511	0.54246	0.1891	1.6375	38.64
		(0.4661)	(0.7793)	(-1.429)	(-2.746)	(1.656)	(-1.277)	(2.379)			
	Retail	0.0012744	9146.2	-0.17422	-0.5453	0.3274	0.70489	0.54246	0.2253	1.6375	38.64
		(0.4661)	(0.7793)	(-1.429)	(-2.746)	(1.656)	(3.051)	(2.379)			

VI. Conclusion and Summary Of Elasticity Results

The Holloway model is a reduced form representation of the retail/farm price linkage measuring variations in marketing margins, retail price and farm price. The model, as applied to the U.S. market, defines farm output, a retail demand shift variable and a marketing cost index as the explanatory variables in the estimating equations. The theoretical foundations of the model are based on a competitive equilibrium market structure. In this paper, we start our investigation of the retail/farm price linkage for eight Canadian food commodities using the Holloway model but modify the specification to account for marketing board supply controlled commodities and traded commodities such as beef and pork. Our final specification uses an three month moving average model to explain variations in marketing margins and retail food prices. Because we use monthly data, a lagged structure is included in the specification to account for adjustment over time. The estimated model fits the data reasonably well with summary statistics such as R^2, D-W and Q-statistics supporting the model specification. The estimated parameters are consistent across equations and with prior expectations concerning sign and statistical significance.

One concern in our research is the effect of imperfect competition after the farm gate. Given the concentration of firms at the food retailing and processing sector in Canada, it is possible that such firms will use their market power to influence price determination. It is our position that the form of the market power is likely to manifest in larger marketing margins than would otherwise be the case, but would not restrict or curtail the price response of imperfectly competitive firms to cyclical or other shocks in the retail/farm marketing structure. Consequently, it will not be possible to determine the presence of imperfectly competitive behaviour by observing firm response to market changes. On the other hand, the elasticity estimates generated in our model are likely to be robust over both the competitive and imperfectly competitive market structure.

The focus of our study is in generating appropriate and useful estimates of the price transmission elasticity between the retail price and farm price. We summarize these measures in Table 9 for the eight food commodities investigated. We report both short run and intermediate run estimates of the price elasticity. The short run is defined over a three month period where as the intermediate run is defined over a six month period.

The estimates are consistent with expectations that the elasticity becomes more elastic over time. One exception is chicken which is measured to have a smaller elasticity in the intermediate run but is statistically unimportant. We read this result to indicate that for chicken the short run (three month) elasticity captures the bulk of the retail price adjustment. Note, that we do not measure a statistical significant price transmission

elasticity for cheeses in the short run period, but do so in the intermediate run. It is worth noting that for the supply controlled commodities of milk, butter and ice cream a 1% change in farm price results in a 1% change to retail prices. This is not true for beef and pork where less than half of the farm price percentage increase is transferred to retail prices.

Table 8. Moving Average (With Seasonally Adjusted Demand Shifters)

		Elasticity With Respect to											
Commodity	Price	Constant	MIC	MIC Lag	Demand Seasonality	Demand Seasonality Lag	Seas. Adj. Demand Shifter	Seas. Adj. Demand Shifter Lag	Farm Price	Farm Price Lag	R2	D-W	Q stat
Beef	Ratio	0.00610	0.03441	-0.10365	-0.16725	0.08154	0.19588	-0.11709	-0.68549	0.12596	0.668	1.7475	39.92
		(2.175)	(0.2334)	(-0.7258)	(-2.053)	(1.003)	(1.209)	(-0.7319)	(-13.94)	(2.536)			
	Retail	0.00610	0.03441	-0.10365	-0.16725	0.08154	0.19588	-0.11709	0.31451	0.12596	0.325	1.7475	39.92
		(2.175)	(0.2334)	(-0.7258)	(-2.053)	(1.003)	(1.209)	(-0.7319)	(6.394)	(2.536)			
Pork	Ratio	-0.02975	0.02120	-0.19095	3.49350	-0.13950	0.79224	-0.47471	-0.78650	0.07460	0.916	1.1258	57.3
		(-2.923)	(0.08967)	(-0.8158)	(5.644)	(-0.2246)	(1.705)	(-1.047)	(-28.7)	(2.888)			
	Retail	-0.02975	0.02120	-0.19095	3.49350	-0.13950	0.79224	-0.47471	0.21350	0.07460	0.6458	1.1258	57.3
		(-2.923)	(0.08967)	(-0.8158)	(5.644)	(-0.2246)	(1.705)	(-1.047)	(7.791)	(2.888)			
Chicken	Ratio	-0.00777	-0.39783	-0.80591	0.95537	1.32770	1.69240	1.00450	-0.49183	-0.26240	0.3202	1.2145	28.87
		(-0.9663)	(-1.145)	(-2.226)	(1.829)	(2.59)	(2.684)	(1.732)	(-4.252)	(-2.137)			
	Retail	-0.00777	-0.39783	-0.80591	0.95537	1.32770	1.69240	1.00450	0.50817	-0.26240	0.3899	1.2145	28.87
		(-0.9663)	(-1.145)	(-2.226)	(1.829)	(2.59)	(2.684)	(1.732)	(4.393)	(-2.137)			
Eggs	Ratio	-0.03152	0.17214	0.27114	3.89330	4.49780	0.34570	-0.17532	-0.75702	0.10666	0.7378	1.0843	40.17
		(-4.06)	(1.476)	(2.356)	(3.556)	(4.19)	(1.363)	(-0.7269)	(-18.18)	(2.591)			
	Retail	-0.03152	0.17214	0.27114	3.89330	4.49780	0.34570	-0.17532	0.24298	0.10666	0.382	1.0843	40.17
		(-4.06)	(1.476)	(2.356)	(3.556)	(4.19)	(1.363)	(-0.7269)	(5.834)	(2.591)			
Milk	Ratio	-0.00233	0.09032	0.04797	0.20038	0.12874	-0.25669	-0.17535	-0.51334	0.48897	0.0986	0.993	58.11
		(-0.8817)	(0.8748)	(0.4617)	(1.415)	(0.8769)	(-0.9492)	(-0.6552)	(-2.347)	(2.359)			
	Retail	-0.00233	0.09032	0.04797	0.20038	0.12874	-0.25669	-0.17535	0.48666	0.48897	0.1342	0.993	58.11
		(-0.8817)	(0.8748)	(0.4617)	(1.415)	(0.8769)	(-0.9492)	(-0.6552)	(2.225)	(2.359)			
Butter	Ratio	-0.00426	0.00363	0.11273	0.16619	0.20570	0.15435	0.10056	-0.37634	0.11572	0.1773	1.0081	75.8
		(-2.416)	(0.04955)	(1.529)	(2.879)	(3.372)	(1.659)	(1.102)	(-2.433)	(0.8185)			
	Retail	-0.00426	0.00363	0.11273	0.16619	0.20570	0.15435	0.10056	0.62366	0.11572	0.3773	1.0081	75.8
		(-2.416)	(0.04955)	(1.529)	(2.879)	(3.372)	(1.659)	(1.102)	(4.032)	(0.8185)			
Cheese	Ratio	0.00740	-0.05700	0.01330	-0.15300	-0.00658	0.19367	0.04886	-0.92951	0.33214	0.6087	1.1856	52.54
		(6.084)	(-1.151)	(0.2664)	(-4.925)	(-0.2049)	(2.81)	(0.6984)	(-7.574)	(2.738)			
	Retail	0.00740	-0.05700	0.01330	-0.15300	-0.00658	0.19367	0.04886	0.07049	0.33214	0.386	1.1856	52.54
		(6.084)	(-1.151)	(0.2664)	(-4.925)	(-0.2049)	(2.81)	(0.6984)	(0.5744)	(2.738)			
Ice Cream	Ratio	0.00305	-0.01774	-0.02924	-0.90306	0.54176	0.16385	-0.03843	-0.42097	0.44732	0.2175	1.6403	39.13
		(0.9101)	(-0.1442)	(-0.2365)	(-3.614)	(2.043)	(0.4292)	(-0.1011)	(-1.641)	(1.928)			
	Retail	0.00305	-0.01774	-0.02924	-0.90306	0.54176	0.16385	-0.03843	0.25660	0.23210	0.2524	1.6403	39.13
		(0.9101)	(-0.1442)	(-0.2365)	(-3.614)	(2.043)	(0.4292)	(-0.1011)	(2.257)	(1.928)			

Table 9. Price Transmission Elasticity: Retail Price with Respect to Farm Price

Commodity	Short Run Elasticity (1)	Intermediate Run Elasticity (2)
Beef	0.31451	0.44047
	(6.394)	(6.01)
Pork	0.21350	0.2881
	(7.791)	(7.085)
Chicken	0.50817	0.24576
	(4.393)	(1.48)
Eggs	0.24298	0.34964
	(5.834)	(5.965)
Milk	0.48666	0.97564
	(2.225)	(3.232)
Butter	0.62366	0.73937
	(4.032)	(3.492)
Cheese	0.07049	0.40263
	(0.5744)	(2.918)
Ice Cream	0.25660	1.0264
	(2.257)	(2.102)

1 Three month adjustment period.
2 Six month adjustment period.

Table 10. Price Transmission Elasticity: Retail Price with Respect to Processor Price

Commodity	Short Run Elasticity (1)	Intermediate Run Elasticity (2)
Beef	0.38650	0.5444
	(6.6)	(5.57)
Pork	0.42500	0.5658
	(8.3)	(7.7)
Chicken	0.86300	0.891
	(8.18)	(5.6)
Milk	1.06900	1.3
	(10.6)	(8.46)
Butter	0.73700	0.921
	(7.23)	(6.16)
Cheese	0.00000	0.312
	(0)	(3.412)
Ice Cream	0.22600	0.4167
	(2.001)	(2.505)

1 Three month adjustment period
2 Six month adjustment period

Finally, in Table 10, we report the price transmission elasticity for retail price with respect to processor price. These estimates are generated from the three month moving average model by substituting processor price for farm price. The elasticities show consistently a more elastic response in the intermediate run than in the short run. What is more, the retail/processor elasticity estimates in Table 10 are in general more elastic, except for cheese, than corresponding retail/farm estimates reported in Table 9.

APPENDIX A

Lyon and Thompson (1993) present a simple mark-up model to explain variations in marketing margin. In this model, marketing margin is specified as a linear function of retail price and marketing input costs and can be written as:

$$(A1) \quad M_i = \beta_{mo} + \beta_{mpr} P_{ri} + \beta_{mmc} MC_i + \epsilon$$

where all variables are as defined in the main text. The advantage of this model is that it allows for a combination of absolute and percentage markups to influence the marketing margin. This model will also allow for measurement of the elasticity in marketing margin caused by changes in retail price. For measuring variations in marketing margin using monthly data, Lyon and Thompson (1993) argue that the Rational Expectations Model of Wohlgenant (1985) may be superior in capturing the effect of retail price lagging farm price. They suggest that a four period lag should be adequate for food commodities. The final form of this model can be written as:

$$A2) \quad M_i = \beta_{mo} + \beta_{mf} P_{fi} + \beta_{mf1} Pf_{it-1} + \beta_{mf2} Pf_{it-2} + \beta_{mf3} Pf_{it-3} + \beta_{mf4} Pf_{it-4} + \beta_{mmc} Mc_i + \epsilon.$$

This model has the advantage of measuring the lagged impact of farm price on retail price and providing an estimate of the elasticity of marketing margin with respect to farm price at each lagged point.

The Mark-up Model (equation A1) regression results are reported in Table 1A. The R2, D-W and Q-statistics all show reasonable values. The retail price variable is of the correct sign and statistically significant for all commodities.

The dairy sectors show an elasticity of marketing margin with respect to retail price close to one, indicating that current changes in retail price are fully reflected in increased margins. In other words, for these supply restricted commodities the farm price does not adjust quickly to account for changes in price at the retail level. On the other hand, beef, pork and eggs show substantially less change in margins as retail price changes. In this case, farm price adjusts within the current period to capture some of the increase in retail price. The Marketing Input Cost variable is negative in all cases except for eggs and cheese. However, in no case are the results of statistical importance. The simple Mark-up Model appears to show a good statistical fit to the data for the commodities examined and provides reasonable and consistent estimates of the margin elasticity with respect to retail price. A summary of the elasticities of the marketing margin with respect to retail price is shown in Table 2A.

Improving on the mark-up specification, we estimate the Rational Expectations Model (equation A2) where the margin is a function of current and lagged values of farm price and the Marketing Input Cost variable. The results for this estimation are reported in Table 3A. This table tells an interesting story with respect to changes in marketing margin caused by shocks to farm price. Increases in the farm price in the current period causes an unambiguous decrease in margins. These results are statistically significant in all cases. In the second period (i.e., farm price lagged one period), there is a general positive adjustment, except for beef, of margins to the increase in farm price. The margin on beef requires yet another lagged period (i.e., farm price lagged two periods) before a positive response is measured to changes in the farm price. In all cases, the farm price lagged three and four periods is statistically unimportant. The Marketing Input Cost variable is generally negative but, again, statistically unimportant.

To complete this section, we reestimate the three month moving average model (Table 8) reported in the text, redefining the marketing margin to be the log difference between retail and processing prices (Table 4A) and again as the log difference between processing prices and farm prices (Table 5A). Of particular interest in both tables is the estimated coefficients for the farm price and farm price lagged variables. These columns provide some information on the effect of changes in farm price impacting on the processing margin and price. Of particular note in Table 5A, a 1% change in the farm price of the marketing board commodities, specifically milk, butter and ice cream, is completely passed through to the processing sector with six months resulting in a 1% change in retail price. This is not true for commodities such as beef and pork where only about 50% of the farm price change is past on to the processing level after six months.

Table 1A. Mark Up Model

Commodity	Elasticity With Respect to: Constant	Retail Price	Marketing Input Cost	R2	D-W	Q stat
Beef	-0.0046052	0.66881	-0.13866	0.3723	1.5967	40.25
	(-0.6664)	(6.554)	(-0.6571)			
Pork	0.053968	0.41751	-0.47508	0.3478	1.5138	24.04
	(2.875)	(2.21)	(-0.8361)			
Chicken	0.013718	0.84971	-0.093346	0.7106	1.6558	20.22
	(1.64)	(12.75)	(-0.3575)			
Eggs	0.023317	0.57069	0.0088593	0.3567	2.2083	15.18
	(3.499)	(4.226)	(0.04375)			
Milk	-0.0032338	0.97134	-0.0082214	0.8974	2.1974	14.94
	(-2.568)	(32.82)	(-0.2166)			
Butter	-0.0033063	0.87886	-0.0018326	0.7601	2.325	23.27
	(-2.707)	(18.94)	(-0.04818)			
Ice Cream	-0.0039477	1.0392	-0.0048756	0.9522	2.105	11.24
	(-3.092)	(47.45)	(-0.1266)			
Cheese	-0.0016705	0.012571	0.012571	0.744	2.337	17.65
	(-1.365)	(12.9)	(0.3248)			

Note: Monthly dummy variables not reported

Table 2A. Elasticity of the Marketing Margin with Respect to Retail Price

	Elasticity With Respect to					
Commodity	Constant	Retail Price	Marketing Input Cost	R2	D-W	Q stat
Beef	-0.00461	0.66881	-0.13866	0.3723	1.5967	40.25
	(-0.6664)	(6.554)	(-0.6571)			
Pork	0.053968	0.41751	-0.47508	0.3478	1.5138	24.04
	(2.875)	(2.21)	(-0.8361)			
Chicken	0.013718	0.84971	-0.09335	0.7106	1.6558	20.22
	(1.64)	(12.75)	(-0.3575)			
Eggs	0.023317	0.57069	0.008859	0.3567	2.2083	15.18
	(3.499)	(4.226)	(0.04375)			
Milk	-0.00323	0.97134	-0.00822	0.8974	2.1974	14.94
	(-2.568)	(32.82)	(-0.2116)			
Butter	-0.00331	0.87886	-0.00183	0.7601	2.325	23.27
	(-2.707)	(18.94)	(-0.04818)			
Ice Cream	-0.00395	1.0392	-0.00488	0.9522	2.105	11.24
	(-3.092)	(47.45)	(-0.1266)			
Cheese	-0.00167	0.92184	0.012571	0.7744	2.337	17.65
	(-1.365)	(12.9)	(0.3248)			

Table 3A. Rational Expectations Model

	Elasticity With Respect to									
Commodity	Constant	Farm Price	Farm Price Lag 1	Farm Price Lag 2	Farm Price Lag 3	Farm Price Lag 4	Marketing Input Cost	R2	D-W	Q stat
Beef	0.00050986	-0.73555	-0.009283	0.25081	0.0057066	-0.027225	-0.23123	0.6402	2.7247	27.67
	(0.092)	(-10.42)	(-0.1255)	(3.332)	(0.07731)	(-0.3786)	(-1.317)			
Pork	0.01926	-0.94636	0.19385	0.028791	0.032805	-0.006692	-0.15443	0.9219	2.4189	23.04
	(2.767)	(-28.26)	(5.415)	(0.7877)	(0.9222)	(0.9222)	(-0.724)			
Chicken	0.019717	-0.75075	0.21666	-0.12669	0.076431	0.062343	0.41281	0.3371	2.4975	22.37
	(1.392)	(-4.042)	(1.098)	(-0.6234)	(0.3883)	(0.3346)	(0.9606)			
Eggs	0.0052012	-0.84984	0.040058	0.046853	0.019699	0.065513	0.10785	0.7592	2.4606	34.93
	(1.175)	(-15.12)	(0.7283)	(0.8553)	(0.357)	(1.173)	(0.7925)			
Milk	0.0035468	-0.69196	0.23872	0.12862	0.21426	0.025544	-0.025468	0.1067	2.4464	11.58
	(0.8021)	(-2.575)	(0.8944)	(0.4792)	(0.8076)	(0.09545)	(-0.2151)			
Butter	-0.0012179	-0.54381	0.28837	-0.023217	0.18552	-0.084253	0.044772	0.1998	2.3516	18.09
	(-0.4458)	(-3.275)	(1.749)	(-0.14)	(1.132)	(-0.5096)	(0.6121)			
Ice Cream	0.016838	-1.5424	1.0546	0.23149	-0.001951	-0.28636	-0.020803	0.3044	2.9014	40.2
	(2.903)	(-4.376)	(3.013)	(0.6577)	(-0.00561)	(-0.8159)	(-0.134)			
Cheese	0.00079396	-0.81171	0.29412	-0.025022	0.10333	0.10829	-0.007752	0.6105	2.3979	10.24
	(0.3756)	(-5.995)	(2.144)	(-0.1825)	(0.7532)	(0.7881)	(-0.1418)			

Note: Monthly dummy variables not reported

Table 4A. Consumer/Processing Moving Average (1) (With Seasonally Adjusted Demand Shifters)

		Elasticity With Respect to											
Commodity	Price	Constant	MCI	MCI Lag	Demand Seasonality	Demand Seasonality Lag	Seas. Adj. Demand Shifter	Seas. Adj. Demand Shifter Lag	Farm Price	Farm Price Lag	R2	D-W	Q stat
Beef	Ratio	-0.00758	0.37484	0.22662	0.03074	0.63556	-0.51536	0.55414	-0.32865	0.28515	0.4622	1.8805	46.68
		(-2.131)	(2.005)	(1.251)	(0.2976)	(6.165)	(-2.508)	(2.732)	(-5.269)	(4.528)			
	Retail	0.00610	0.03441	-0.10365	-0.16725	0.08154	0.19588	-0.11709	0.31451	0.12596	0.325	1.7475	39.92
		(2.175)	(0.2334)	(-0.7258)	(-2.053)	(1.003)	(1.209)	(-0.7319)	(6.394)	(2.536)			
Pork	Ratio	0.00320	0.64597	0.48991	0.06001	-0.76214	1.08870	-0.55093	-0.21066	0.06988	0.3967	1.1229	51.3
		(0.2629)	(2.287)	(1.752)	(0.08115)	(-1.027)	(1.961)	(-1.017)	(-6.435)	(2.265)			
	Retail	-0.02975	0.02120	-0.19095	3.49350	-0.13950	0.79224	-0.47471	0.21350	0.07460	0.6458	1.1258	57.3
		(-2.923)	(0.08967)	(-0.8158)	(5.644)	(-0.2246)	(1.705)	(-1.047)	(7.791)	(2.888)			
Chicken	Ratio	-0.01255	-0.46356	-0.24422	0.39133	2.32430	1.39820	0.72986	-0.08256	-0.40380	0.3446	1.67	28.18
		(-1.997)	(-1.707)	(-0.863)	(0.9585)	(5.8)	(2.836)	(1.61)	(-0.9131)	(-4.207)			
	Retail	-0.00777	-0.39783	-0.80591	0.95537	1.32770	1.69240	1.00450	0.50817	-0.26240	0.3899	1.2145	28.87
		(-0.9663)	(-1.145)	(-2.226)	(1.829)	(2.59)	(2.684)	(1.732)	(4.393)	(-2.137)			
Milk	Ratio	-36.00200	0.09032	0.04797	0.20038	0.12874	-0.25669	-0.17535	0.48666	0.48897	0.1342	0.993	58.11
		(-13620)	(0.8748)	(0.4617)	(1.415)	(0.8769)	(-0.9492)	(-0.6552)	(2.225)	(2.359)			
	Retail	-0.00233	0.09032	0.04797	0.20038	0.12874	-0.25669	-0.17535	0.48666	0.48897	0.1342	0.993	58.11
		(-0.8817)	(0.8748)	(0.4617)	(1.415)	(0.8769)	(-0.9492)	(-0.6552)	(2.225)	(2.359)			
Butter	Ratio	-0.01309	0.07020	0.29960	0.14870	0.42525	0.38491	-0.05936	0.03841	-0.31019	0.3339	0.9604	76.99
		(-5.765)	(0.7432)	(3.153)	(1.999)	(5.409)	(3.211)	(-0.5046)	(0.1926)	(-1.702)			
	Retail	-0.00426	0.00363	0.11273	0.16619	0.20570	0.15435	0.10056	0.62366	0.11572	0.3773	1.0081	75.8
		(-2.416)	(0.04955)	(1.529)	(2.879)	(3.372)	(1.659)	(1.102)	(4.032)	(0.8185)			
Cheese	Ratio	-0.00098	0.09450	0.14761	-0.19744	0.09511	0.21729	-0.17774	-0.35341	0.14940	0.2948	1.1484	55.55
		(-0.4718)	(1.113)	(1.725)	(-1.482)	(-3.708)	(1.839)	(1.728)	(-1.68)	(0.7187)			
	Retail	0.00740	-0.05700	0.01330	-0.15300	-0.00658	0.19367	0.04886	0.07049	0.33214	0.386	1.1856	52.54
		(6.084)	(-1.151)	(0.2664)	(-4.925)	(-0.2049)	(2.81)	(0.6984)	(0.5744)	(2.738)			
Ice Cream	Ratio	-0.00699	0.05325	0.15943	-0.92342	1.10200	0.67723	-0.41753	0.01690	0.02041	0.2435	1.4441	48.99
		(-1.943)	(0.4033)	(1.202)	(-3.444)	(3.872)	(1.653)	(-1.024)	(0.06137)	(0.08196)			
	Retail	0.00305	-0.01774	-0.02924	-0.90306	0.54176	0.16385	-0.03843	0.57903	0.44732	0.2524	1.6403	39.13
		(0.9101)	(-0.1442)	(-0.2365)	(-3.614)	(2.043)	(0.4292)	(-0.1011)	(2.257)	(1.928)			

Table 5A. Processor/Farm Moving Average (1) (With Seasonally Adjusted Demand Shifters)

		Elasticity With Respect to											
Commodity	Price	Constant	MCI	MCI Lag	Demand Seasonality	Demand Seasonality Lag	Seas. Adj. Demand Shifter	Seas. Adj. Demand Shifter Lag	Farm Price	Farm Price Lag	R2	D-W	Q stat
Beef	Ratio	0.01368	-0.34042	-0.33027	-0.19799	-0.55402	0.71125	-0.67123	-0.35684	-0.15920	0.4665	1.3015	81.32
		(4.462)	(-2.112)	(-2.116)	(-2.224)	(-6.234)	(4.015)	(-3.838)	(-6.637)	(-2.933)			
	Processing	0.01368	-0.34042	-0.33027	-0.19799	-0.55402	0.71125	-0.67123	0.64316	-0.15920	0.6934	1.3015	81.32
		(4.462)	(-2.112)	(-2.116)	(-2.224)	(-6.234)	(4.015)	(-3.838)	(11.96)	(-2.933)			
Pork	Ratio	-0.03294	-0.62476	-0.68086	3.43350	0.62264	-0.29650	0.07622	-0.57583	0.00472	0.8626	0.7866	85.8
		(-3.302)	(-2.695)	(-2.968)	(5.659)	(1.023)	(-0.651)	(0.1715)	(-21.44)	(0.1863)			
	Processing	-0.03294	-0.62476	-0.68086	3.43350	0.62264	-0.29650	0.07622	0.42417	0.00472	0.8141	0.7866	85.8
		(-3.302)	(-2.695)	(-2.968)	(5.659)	(1.023)	(-0.651)	(0.1715)	(15.79)	(0.1863)			
Chicken	Ratio	0.00478	0.06574	-0.56169	0.56404	-0.99658	0.29420	0.27462	-0.40927	0.14140	0.3827	0.7951	34.34
		(0.9282)	(0.2954)	(-2.422)	(1.686)	(-3.035)	(0.7283)	(0.7392)	(-5.524)	(1.798)			
	Processing	0.00478	0.06574	-0.56169	0.56404	-0.99658	0.29420	0.27462	0.59073	0.14140	0.5592	0.7951	34.34
		(0.9282)	(0.2954)	(-2.422)	(1.686)	(-3.035)	(0.7283)	(0.7392)	(7.973)	(1.798)			
Milk	Ratio	0.00930	-0.07829	-0.15735	-0.00278	-0.35955	-0.45929	0.24676	-0.42797	0.40698	0.3694	0.8962	75
		(5.516)	(-1.189)	(-2.374)	(-0.03074)	(-3.84)	(-2.663)	(1.446)	(-3.068)	(3.078)			
	Processing	0.00930	-0.07829	-0.15735	-0.00278	-0.35955	-0.45929	0.24676	0.57203	0.40698	0.2265	0.8962	75
		(5.516)	(-1.189)	(-2.374)	(-0.03074)	(-3.84)	(-2.663)	(1.446)	(4.101)	(3.078)			
Butter	Ratio	0.00883	-0.06657	-0.18686	0.01748	-0.21954	-0.23056	0.15992	-0.41475	0.42590	0.3775	0.9072	75.12
		(5.541)	(-1.004)	(-2.801)	(0.3347)	(-3.977)	(-2.739)	(1.936)	(-2.963)	(3.329)			
	Processing	0.00883	-0.06657	-0.18686	0.01748	-0.21954	-0.23056	0.15992	0.58525	0.42590	0.2365	0.9072	75.12
		(5.541)	(-1.004)	(-2.801)	(0.3347)	(-3.977)	(-2.739)	(1.936)	(4.181)	(3.329)			
Cheese	Ratio	0.00839	-0.15150	-0.13431	0.04445	-0.10169	-0.02361	0.22660	-0.57610	0.18274	0.319	0.9482	76.1
		(5.051)	(-2.242)	(-1.971)	(1.048)	(-2.32)	(-0.2511)	(2.374)	(-3.44)	(1.104)			
	Processing	0.00839	-0.15150	-0.13431	0.04445	-0.10169	-0.02361	0.22660	0.42390	0.18274	0.1763	0.9482	76.1
		(5.051)	(-2.242)	(-1.971)	(1.048)	(-2.32)	(-0.2511)	(2.374)	2.53100	(1.104)			
Ice Cream	Ratio	0.01005	-0.07099	-0.18867	0.02036	-0.56025	-0.51338	0.37910	-0.43787	0.42691	0.3653	0.9034	76.09
		(5.432)	(-1.046)	(-2.768)	(0.1478)	(-3.832)	(-2.439)	(1.809)	(-3.096)	(3.337)			
	Processing	0.01005	-0.07099	-0.18867	0.02036	-0.56025	-0.51338	0.37910	0.56213	0.42691	0.2215	0.9034	76.09
		(5.432)	(-1.046)	(-2.768)	(0.1478)	(-3.832)	(-2.439)	(1.809)	(3.974)	(3.337)			

APPENDIX B

Data sources:

Statistics Canada catalogues:

13-001 National Economic and Financial Accounts
23-001 The Dairy Review
23-603 Livestock Statistics
62-001 The Consumer Price Index
62-010 Consumer Prices & Price Indexes
62-011 Intermediate Price Indexes
72-002 Employment Earnings & Hours
91-002 Quarterly Demographic Statistics

Agriculture Canada:

Weights for Farm Marketing Cost Index (by Fax)
Livestock Market Review (Dressed Weights for cattle and hogs)
Consumer Demand for Major Foods in Canada, Zuhair A. Hassan & S.R. Johnson
Economics Branch Publication No. 76/2 April 1976 (Elasticities)

Canadian Chicken Marketing Agency

(Chicken Harvest)

The following CANSIM series were used in this study:

Consumer Prices in the form of Consumer Price Indexes:

P700005	Fresh / Frozen Beef
P700006	Fresh / Frozen Pork
P700009	Fresh / Frozen Chicken
P700021	Fresh Milk
P700022	Butter
P700023	Cheese
P700024	Ice Cream & Related Products
P700026	Eggs

Farm prices in the form of farm Price Indexes:

These prices represent the price paid to farmers at the farm gate.

D202808	Cattle & Calves
D202809	Hogs
D202811	Eggs

Raw Material Price Indexes

These prices are marketing board prices for milk, and stockyard prices for chicken. These series were used as suitable farm price indexes could not be found for these products:

D694356	Chickens
D694358	Milk (Whole)

Additional series included:

CANSIM #		
D691002	Intermediate Price Index	Fresh / Frozen Beef & Veal
D691015	Intermediate Price Index	Fresh / Frozen Chicken
D693180	Intermediate Price Index	Fresh / Frozen Domestic pork
D691046	Intermediate Price Index	Milk (processed)
P700000	Consumer Price Index, All Items	
D1	Population, persons	
D10111	Disposable income	
D2971	Federally Inspected Cattle Slaughter (Head)	
D2972	Federally Inspected Calves Slaughter (Head)	
D2974	Federally Inspected Hogs Slaughter (Head)	
N/A	Cattle warm weights (Ag. Canada, Livestock Market Review)	
N/A	Calves warm weights (Ag. Canada, Livestock Market Review)	
N/A	Hogs warm weights (Ag. Canada, Livestock Market Review)	
N/A	Chicken Harvest (Canadian Chicken Marketing Agency)	
L57731	Average Weekly Earnings, Poultry, meat and egg production.	
L57734	Average Weekly Earnings, Dairy industry.	
D691645	Intermediate Price Index, Boxes, bags and other paper containers.	
P700174	CPI, Transportation.	
E13225	Diesel fuel price.	
P700079	CPI, Rent.	
P700081	CPI, Maintenance, repair and other expenses.	
P700085	CPI, Property taxes.	

B14006	Bank Rate, Last Wednesday of the month.
P700089	CPI, Water, fuel, and electric service.
D693070	Intermediate Price Index, Office & stationary supplies.
N/A	Income and Cross-Price Elasticities

Consumer Demand for Major Foods in Canada

Methodology:

Two Food Marketing Cost Indexes were generated from the above data using a weighting scheme supplied by Agriculture Canada. Data was log-differenced to obtain percentage change figures. Percentage change was then weighted according to the following table.

Input	Weight	CANSIM Series
Labour	54.32	L57731 and L57734
Containers and Packaging	10.99	D691645
Transportation	5.15	P700174
Fuel and Power	5.10	E13225
Rent and Storage	4.74	P700079
Maintenance and Repair	3.42	P700081
Taxes	2.26	P700085
Services (short term interest)	3.85	B1406
Utilities	1.23	P700089
Office and other supplies	2.07	D693070

Using two series for labour allowed a Food Marketing Cost Index to be generated for the meat and egg as well as the milk industries.

Demand shifters were generated using the formula:

$$\Delta RD_i = \sum_{i \neq j} \eta_{ij} \, \Delta \ln Pr_{jt} + \eta_{iy} \, \Delta \ln Y_t + \Delta \ln Pop_t$$

with elasticities (η_{ij} and η_{iy}) supplied by Agriculture Canada (Consumer Demand for Major Foods in Canada) and using the CANSIM series; D1 (Population) and D10111 (Disposable Income). The price series used are as described above. Note, an all-other products category is added to the demand shifters using CANSIM series P700000 (CPI, All items).

Farm quantity measures used were generated as follows:

Milk:

Farm production of milk delivered as milk, fluid and cream (Kl of milk equivalent) were added together to generate a variable, all milk produced. This series was log-differenced to obtain a measure of percent change in milk production.

Beef:

Cattle and Calves (Head) were multiplied by their respective average warm weights and the resulting series were added together to obtain a Kg measure of Beef production. This series was log-differenced to obtain a measure of percent change in Beef production.

Pork:

Hogs (Head) was multiplied by the average warm weight to obtain a Kg measure of Pork Production. This series was log-differenced to obtain a measure of percent change in Pork production.

Eggs and Chicken:

These series were reported in units of dozen eggs and Kg of Chicken (Eviscerated weight). These series were log-differenced to obtain a measure of percent change in Egg and Chicken production.

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