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The Transmission of Price Trends from Consumers to Producers and Tests of Market Power

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This study examines the competitiveness of four Canadian agricultural industries (eggs, milk, chicken and turkey) using a general equilibrium farm to retail pricing model developed by Wohlgenant (1989). The model generates retail and farm pricing equations that are estimated using maximum likelihood developed by Johansen (1992). The results indicate that in all cases, long-run constant returns is rejected, indicating market power within the Canadian retail to farm marketing sector. The model also finds more cointegrating vectors than predicted by theory, also inconsistent with competitive markets. Results are based on commercial disappearance as a proxy for consumer demand and therefore confounding between uncompetitive markets and quality differences may be indicated. Less ambiguous results would be obtained if consumer expenditures rather than commercial disappearance data were available. Still, results are rather emphatic in rejection of competitive markets in food markets in Canada. More competitive markets are indicated in the United States using similar methods.

Keywords: Market power, food processing, cointegration

JEL Classification: D41, L66, Q13

Background

The recent rise of the Canadian dollar to parity with its US counterpart has focused attention on the lack of purchasing power parity between the two countries. The reluctance of Canadian retailers to lower prices to Canadian consumers has once again given rise to questions concerning the competitiveness of the Canadian retailing system.

Within agriculture, there has been a long history of complaints that the farm to retail sector does not operate in an efficient and competitive manner. This is often discussed within the context of the transmission of price information from consumers to producers. One function of an efficiently functioning agricultural industry is how fast and how effectively changes in consumer demand and trends in consumer demand are transmitted through the marketing chain. How well this is accomplished depends on the costs of operating the marketing chain and the market power that exists within the marketing chain.

This study will determine the overall competitiveness of the food price transmitting system in Canada. The study will use a model developed by Wohlgenant (1989) for the food industry in the US. Advantages of using this setup include that no a priori restrictions of fixed proportions or product homogeneity are used in the development of the market clearing relationships under the assumption of perfect competition. A test of market power in this framework is shown by Reed and Clark (2000) to be a test for cointegration assuming that variables used in the analysis are characterized by unit root non-stationarity. The lack of a cointegrating relationship among the variables would suggest the existence of market power. Too many cointegrating relationships implies further refinement of theory is needed, perhaps related to the variables included within the analysis or the need for additional model development.

Further tests of market power not related to cointegration are parametric tests of long run constant returns to scale, symmetry and tests of oligopsony market power. The rest of this study will describe the model and present some results for four Canadian food industries: eggs, chicken, milk and turkey.

A Long-run Model of Retail and Farm Prices

This section describes a model of competitive long run equilibrium developed by Wohlgenant (1989) and Wohlgenant and Haidacher (1989). From the standpoint of integrated non-stationary time series theory, this model is an attractive one because, at least at the present time, the economic theory only describes long-run relationships. From an economic policy standpoint, the model is also important because it describes long-run relationships among food and farm prices. Therefore, estimates derived from this model can be used to gain insights into such issues as to how farm gate prices change given changes in retail prices.

One measure of the effectiveness of an agricultural policy is the impact such a policy will eventually have on consumer-level food and farm-level prices. For example, questions of market power by an industrialized food sector have direct implications for policy. Presumably, economic policies will influence food and farm prices differently in competitive markets than in imperfectly competitive markets. Even in competitive markets, however, the transmission of exogenous shifts to consumer and farm level prices differ across industries, and estimates of this transmission may reveal why different industries might respond differently to policy changes. Furthermore, estimating food and farm price relationships within the rigor of a well-posed economic model provides analysts with the opportunity to uncover key structural parameters from time series data.

The economic model used to demonstrate our selected techniques was developed by Wohlgenant (1989), and Wohlgenant and Haidacher (1989). The model is a flexible representation of a competitive food market in which retail and farm prices are determined by the interaction of supply and demand in all input and output markets. While consistent with economic theory, the price relationships of the model are not constrained by the highly restrictive fixed-proportions production assumption, or by the restriction that an industry consists of identical (and marginal) firms. In particular, even if firms within the same industry produce output in different fixed proportions, the model describes an aggregate industry that varies input proportions as relative input prices change. In competitive market equilibrium, the industry would satisfy consumer preferences for a variety of individual food items.

While the long-run competitive model allows for the entry and exit of firms, it differs from the more restrictive textbook case of identical firms by accounting for long-run rents earned by fixed assets of some firms within an industry. Such assets include locational advantage or entrepreneurial capacity (Panzar and Willig, 1970). The long-run static nature of the model makes it an attractive one to use to illustrate our chosen set of cointegration techniques.

Although it is beyond the scope of this paper to derive the model's quasi-reduced form equations, the derivation is straightforward, and the restrictions implied by theory are easy to impose. The retail and farm price equations are based on profit maximization of food marketing firms (i.e., retail, wholesale, and manufacturing firms) in a competitive market, market-clearing in the farm and retail markets, perfectly elastic non-farm input supply, and an unspecified farm supply function. Furthermore, the quasi-reduced-form equations account for shifts in consumer demand with a single variable constructed from a complete system of consumer demand equations.

If Pr represents the retail price, Pf represents the farm price, F represents the farm supply, W represents a vector of non-farm input prices, and Z represents a single demand shifter (i.e., a linear combination of demand shifters in a consumer demand system), an industry's quasi-reduced form equations are

$$\begin{aligned} P_r &= A_{rf} F + A_{rw} W + A_{rz} Z \\ P_f &= A_{ff} F + A_{fw} W + A_{fz} Z \end{aligned} \qquad (1)$$

All variables in equation (1) are expressed in logarithms, so the Aij coefficients of the model are price flexibility coefficients.

The first equation of (1) relates the retail price (Pr) of an industry to the appropriate farm supply (F) of the industry, a vector of non-farm input prices (W), and a single shift in consumer demand (Z). The second equation relates the same set of variables to the industry's farm price (Pf). It has been shown elsewhere (Wohlgenant and Haidacher, 1989) that the coefficients of (1), combined with an estimated consumer demand system, exactly identify the structural parameters underlying the supply and demand functions for retail output and farm inputs. Furthermore, the pair of equations given by (1) can be used to test three important restrictions. Tests of the first two restrictions amount to tests of market power, while a test of the third restriction amounts to a test of the transmission of farm price changes to consumers. The remaining portion of this section outlines the hypotheses to be tested.

Test of Oligopsony Power

The specification of (1) is based on the notion that the food industry is perfectly competitive in acquiring farm commodities in national markets. Rejecting an alternative model that accounts for oligopsony power would support (1), and imply that decisions by a few individual food manufacturing firms influence farm prices. Rejecting this alternative would support the view that 'captive' supplies are a competitive market's response to changing market conditions.

If an industry is competitive in acquiring farm commodities, the marginal value product of the farm commodity equals the farm price.   The test for oligopsony is based on the notion that if some food manufacturing firms influence farm prices by restricting purchases of farm inputs, a 'gap' between the market-determined farm price and the marginal value product for the farm commodity emerges at the market level. Theory indicates this gap consists of functions of variables that shift the farm supply schedule, such as stock variables and prices of inputs used in farm production. A test for the existence of oligopsony power amounts to determining whether such variables add explanatory power to the competitive model described by (1).

The null hypothesis of the oligopsony test is that the industry is competitive in acquiring farm commodities, and the equations of (1) apply. To capture the notion that the marginal value product of the farm commodity equals the farm price in competitive markets, it is necessary to combine the equations of (1). Using the two equations to eliminate F, the model reduces to

$$P_r = B_f P_f + B_w W + B_z Z \qquad (2)$$

where the Bk coefficients are functions of the Aij coefficients of (1). Implicit in (2) is the notion that the marginal value product of the farm commodity equals the farm price.

From a competitive industry's viewpoint, shifts in the farm supply are completely captured by the farm price.

Under the alternative hypothesis of oligopsony power, variables that shift farm supply enter equation (2). Consider a vector C that contains stocks of farm commodities and prices of inputs used in farm production. If the food industry exerts oligopsony power, the alternative model is

$$P_r = B_f\, P_f + B_w W + B_z Z + B_c C \qquad (3)$$

Implicit in (3) is the notion that the marginal revenue product equals the farm price. If the industry exerts oligopsony power, shifts in the farm supply schedule are important because they partially define an industry's marginal revenue product.

The procedure used to test for oligopsony power requires specifying (3) and testing whether Bc = 0. If the variables of (3) are stationary, a test of Bc = 0 can be performed using a standard F test. However, if the variables of (3) are integrated, the usual F test will not be reliable, and the test for the presence of oligopsony power can be reduced to testing whether equations (2) or (3) are cointegrated relationships.

From the point of view of the cointegration methods presented below, finding a (single) cointegrating relationship within the estimation of the Johansen (1992) maximum likelihood procedure without including the vector of C stocks would amount to a test of oligopsony power. The reason is that, if the variables Pr , Pf , W and Z combine to create a cointegrating relationship, the addition of the other variables in the C vector are not important in defining the cointegrating vector in the long run. Hence Bc = 0 in equation (3).

Test of Symmetry

Prices determined in perfectly competitive input and output markets equate industry supply and demand of inputs and output. Faced with market-clearing prices, price-taking firms in perfectly competitive markets maximize profits. Since the equations in (1) are derived by equating supply and demand in input and output markets, a test of perfect competition in the model reduces to a test of whether firms maximize profits. The symmetry test is a test of profit maximization.

The test derives from the inherent symmetry of an industry's profit function. The condition of interest here is that the response of food supply to a change in the farm price equals (the negative of) the response of an industry's demand for the farm product to a change in the retail price of food (e.g., Silberberg, Chapter 6). If Sf denotes the cost share of the farm ingredient used in food production, Wohlgenant and Haidacher (1989, p. 17-19) show that if the elasticity form of this condition holds, the restriction

$$A_{rf} = - S_f \, A_{fz} \qquad (4)$$

on (1) also holds. It is important to note that the market power restriction may fail to hold if the industry exerts either oligopsony or oligopoly power, or if a profit function cannot adequately represent an industry of nonidentical firms. This implies that failure to reject market power restrictions cannot be interpreted as solely due to market power, but could also be due to other confounding factors such as functional form bias. Therefore, failure to reject these restrictions is a necessary, but not sufficient, reason to conclude market power exists in the industry.

Symmetry requires testing cross equation restrictions. Only single equation restrictions can be tested using the statistical package (STATA) used to estimate the cointegrating relationships. Hence it is not presented below.

Test of Constant Returns of the Farm Input

In a traditional analysis of farm and retail food prices, food is assumed to be produced in fixed- factor proportions. Fixing factor proportions imposes many restrictions on a competitive economic model, but among the most noted is the restriction that each percentage increase in farm price translates into a percentage increase in consumer prices equal to the cost share of the farm input. It turns out, however, that this same relationship holds under variable factor proportions if markets are competitive, and if the farm input provides constant returns in food production.

Wohlgenant and Haidacher (1989) show that if constant returns with respect to the farm input holds, the restrictions

$$A_{rz} = - A_{rf}$$

$$A_{fz} = - A_{ff} \quad (5)$$

on (1) also hold. The restricted quasi-reduced form under constant returns is therefore

$$P_r = A_{rf} F + A_{rw} W - A_{rf} Z$$

$$P_f = - A_{fz} F + A_{fw} W + A_{fz} Z$$

Now suppose farm supply expands exogenously. The above restricted model implies, that for each percentage increase in farm supply, retail food prices fall by Arf (<0) and farm prices fall by Afz. Hence, when farm supply changes exogenously (reducing farm prices exogenously), consumer food prices change by the ratio of -Arz/Afz . But by symmetry (equation (4)), this ratio is Sf, or the cost share of the farm input. Failure to reject the constant-returns restrictions provides a more general explanation of a relationship implied directly by fixed proportions models in perfectly competitive markets.

Data

Data were collected for four supply managed industries: eggs, milk, chicken and turkey. Monthly data on retail and farm prices were collected from regular CANSIM data sources. All data run from January, 1997 through February 2005 for 98 observations. Other variables included in the analysis include interest rates as a proxy for the cost of capital and exchange rates as a proxy for the export sector. A farm wage rate was included as a proxy for farm labour costs. Data were converted to per capita data using aggregate Canadian population data.

Quantity variables were commercial disappearance data and prices unit values. Therefore, quantity variables used to estimate the model did not include quality differences and these quality differences could have been transferred to prices (e.g. Reed, Levedahl and Clark (2003) and Nelson (1991)). Furthermore, since the measure of commercial disappearance is not unique, them neither is the measure of demand or unit values. Therefore, results are not invariant to the choice of quantity in the estimation. In this sense, conclusions drawn from these data may confound important quality differences resulting from competitive markets with those of imperfect markets. Hence important quality differences may not be adequately represented within the analysis and are a weakness of this model.

A much better proxy for consumer demand is derived from consumer expenditure data (e.g. Reed, Levedahl, and Clark (2003)). However, lack of adequate time series availability in Canada precludes the use of such data.

Results and Discussion

Development of the Z variables included within the analysis requires the estimation of a demand system. The demand system was estimated but the results are not presented, and available upon request.

All variables are first tested for unit root non-stationarity and none of these variables rejected a single unit root. These results are also not presented, and available upon request.

Since unit root non-stationarity cannot be rejected, we proceed to estimating the testing for cointegrating vectors and testing for constant returns to scale. We do this using Johansen's (1992) maximum likelihood method. The results are summarized in Table 1.

Table 1: Results of estimating the farm and retail price equations

Industry	number of cointegrating relationships	Constant returns to scale
Eggs: Retail Price	1	reject
Farm Price	1	reject
Chicken: Retail Price	2	reject
Farm Price	2	reject
Milk: Retail Price	2	reject
Farm Price	3	reject
Turkey: Retail Price	3	reject
Farm Price	3	reject

Source: From estimates of retail and farm price equations

The test of long run constant returns is rejected in all cases, indicating market power. In all cases, there is evidence of at least one cointegrating vector, consistent with no market power. However, in only one industry (eggs) is a single cointegrating vector indicated (as required by theory). In all others, more than one cointegrating vector is evident and this result is not consistent with the competitive theory that establishes precisely one cointegrating vector.

An adequate explanation for additional cointegrating vectors is required. One explanation for an additional cointegrating vector is Canadian monetary policy, that establishes a relationship between exchange rates and interest rates (two variables used in this study). However, assuming this explanation is justified, this could explain the existence of two cointegrating vectors (in chicken and milk retail prices) but not the existence of three in milk farm price and turkey (or for that matter the lone cointegrating vector in eggs retail and farm price equations). Another explanation of too many cointegrating vectors is the existence of market power since all deviations from the competitive norm are given this interpretation in this study. This explanation is also consistent with rejection of long run constant returns to scale in all cases.

Conclusion

The results indicate that the competitive model developed by Wohlgenant finds very little support in Canadian agriculture. Only in one of the four industries studied (Chicken) was the number of cointegrating vectors predicted by theory found. In all cases, long run constant returns was also rejected, also indicating market power. Our results indicate that the model is rejected because too many rather than too few cointegrating vectors were found. One explanation of this result could be a high degree of market power in Canadian agriculture. Given this explanation, we find a high degree of market power at the retail level of the market, implying that the countervail of supply management may be needed for Canadian food producers. These results are in contrast to Reed and Cark (2000) for the US, where more evidence in favour of competitive markets is found.

The strong rejection of the competitive model ought to be tempered by two problems with this study. The first is that data used to test the model were commercial disappearance data. Commercial disappearance data may lead to confounding of differences in quality for evidence of market power. Data that does not have these drawbacks includes food expenditure data, but these data are not available for sufficiently long time series to be including within this study.

The second is that algorithms of sufficient generality to test all the empirical implications of the competitive model were also unavailable. Namely, tests of symmetry required cross equation restrictions that could not be tested using the available software. Furthermore, since the algorithm could only test restrictions a single equation, each equation was estimated separately from the others. The theory indicates that the equations were generated from a general equilibrium framework. A better approach would be to estimate all the variables simultaneously and test cross equation restrictions within a multivariate framework. This approach awaits the development of more powerful estimation algorithms for cointegrating vectors.

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