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An Investigation of the Marketing of Butterfat by the Canadian Dairy Industry

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This study examines the Canadian Dairy Commission's marketing of butterfat. Previous studies have concentrated on the evaluation of butterfat by using total kilograms of milk. Measuring milk as kilograms is based the assumption of fixed proportions between kilograms of milk and kilograms of butterfat. However, measuring dairy using kilograms may not be a good proxy for the underlying butterfat. In this study we argue that dairy fat maybe an inferior factor of production, whereas kilograms is a normal factor of production. This means that following kilograms within the marketing system may not track butterfat. In fact, butterfat may respond in an opposite direction to kilograms when prices and incomes change. Assuming that butterfat is an inferior factor may explain some of the marketing practices of the provincial marketing boards that on the surface seems to be neither in the interest of consumers or dairy farmers. If the objective of the supply management is to make dairy producers better off, then basing dairy quota on kilograms of butterfat seems logical since the demand for butterfat has been rising over time. In addition, controlling supply at the retail level using minimum milk price supports also benefits producers, although it may not be in the best interest of consumers due to higher dairy prices and increased butterfat consumption.

Keywords: Inferior factors, dairy fat, health policy

JEL Codes: I18, Q18

Introduction

The dairy industry functions under a national supply management system (NSMS) based on planned domestic production, administered pricing, and import controls. Federal interest in dairy supply management lies mainly in the marketing of industrial milk (butter, cheese, yogurt and ice cream) by determining the supply of milk through Market Sharing Quota (MSQ), setting the target price producers receive for raw milk, and establishing support prices for butter and skim milk powder. Provincial legislation governs the marketing of fluid milk (table milk and fresh cream) by determining provincial milk demand and setting the production level and price for fluid milk. Producer quotas include a portion of the provincial share of the MSQ and a predetermined production of domestic fluid milk, giving each producer the right to produce a certain quantity of milk per day measured in daily kilograms of butterfat. In addition, the producer price of raw milk is established as a component price based on the price of butterfat, protein, and other solids. Government intervention in the dairy industry also occurs through the establishment of minimum retail prices for fluid milk creating market power at the retail level. It is recognized that retail price policy is a provincial decision which is implemented in a number of Canadian provinces.

The structure of the NSMS is such milk production quotas and the largest element of the component milk price is based on kilograms of butterfat. As a result, milk and other dairy products are marketed based on butterfat. Therefore, to measure consumer demand for dairy, the dairy demand elasticity should be estimated based on kilograms of butterfat not milk. Previous studies have been based on dairy demand elasticities (Safyurtlu, Johnson and Hasson, 1986; Al-Zand and Andriananjay, 1988; Moschini and

Moro, 1993; Goddard and Tielu, 1995; Kinnucan, H.W. and E.T. Belleza, 1995; Veeman and Peng, 1995; Meilke, K., R. Sarker and D. Le Roy, 1996; Gray and Malla, 1998) that have been calculated using an underlying assumption of fixed proportions between kilograms of milk and kilograms of butterfat. If butterfat is a normal input, then such as assumption would be suffice.

However, it is plausible that butterfat is an inferior input. In fact, Clark and Levedahl (2006) and Clark, Prochazka and Levedahl (2006) argue there is no empirical basis for using kilograms of milk as a proxy for kilograms of butterfat in estimating the consumer demand elasticity for dairy. The butterfat content of dairy is a characteristic of the composite commodity and not the composite commodity itself. If butterfat is an inferior characteristic of dairy products, then using dairy demand elasticity based on kilograms of milk would be a fundamental error in model specification leading to erroneous conclusions.

In addition, the impact of the NSMS for the Canadian dairy industry would differ depending on whether butterfat is an inferior or normal input. If the objective of the supply management is to make dairy producers better off, then it does not seem logical to base dairy quota on kilograms of butterfat. However, if butterfat is an inferior input, then restricting supply using production quotas that are based on butterfat would result in an increase in the amount of butterfat demanded as output declines. An examination of what has been happening in the dairy industry should shed light on whether butterfat is considered an inferior characteristic or not.

Furthermore, the dairy industry established market power at the retail level by using minimum milk price supports. Mandating a minimum retail price for milk prohibits

the sale of milk below a set price. If the intent of the NSMS is make producers better off, it does not seem rational to create market power at the retail level. Raising the price of milk for consumers creates profits for retailers, but seems, at least on the surface of it, to make dairy producers worse off. It also seems to violate the objective of the NSMS too as it seems to make profits for retailers as opposed to producers. However, if butterfat is an inferior input, then the value of quota should increase over time, making producers better off due to the monopoly power at the retail level.

The relationship between the structure of the NSMS and the market for butterfat is not well understood. Since the NSMS not only markets the dairy products, but the butterfat content as well, it is important to understand the role butterfat plays in the dairy industry. This study attempts to provide a better understanding of the butterfat market in the Canadian dairy industry. The objectives of this study are twofold: (1) to construct an economic model to understand the marketing of butterfat in the Canadian dairy industry, and (2) to determine whether butterfat seems to be an inferior characteristic of the dairy composite commodity. Graphical analysis is used to illustrate the underlying structure of the NSMS, the credibility of using an underlying assumption of fixed proportions between total dairy milk and butterfat, and examine the effect of monopoly power at the retail level. Regression analysis is used to determine whether there is a significant relationship between total dairy milk and butterfat. In addition, a unit root test and cointegration tests are used to determine whether the time series are non-stationary and whether cointegration exists between them.

Supply Management in the Canadian Dairy Industry

The *Canadian Dairy Commission Act* is the legal framework under which raw milk is produced and marketed in Canada. In the early 1970s, a national supply management system (NSMS) for the Canadian dairy industry was established to address the unstable markets, uncertain supplies and highly variable producer and processor revenues that were common in the 1950s and 1960s. The goal of NSMS was to balance milk production from all farms with domestic consumption of dairy products by planning domestic production, administering pricing, and controlling dairy product imports.

Federal interest in dairy supply management lies mainly in the marketing of industrial milk (butter, cheese, yogurt and ice cream). The Canadian Milk Supply Management Committee (CMSMC) determines the supply of milk by setting the Market Sharing Quota (MSQ), which is based on forecasted demand for industrial milk. This production quota is the right to produce a certain quantity of milk measured in kilograms of butterfat, with each province assigned its portion of the MSQ based on population growth and its historical market share. The Canadian Dairy Commission (CDC) sets the target price producers receive for raw milk based on producer costs of production. The CDC also establishes support prices for butter and skim milk powder by purchasing these products at predetermined prices to ensure the target price for industrial milk. By altering these support prices, the CDC influences the revenue received by dairy producers, the margin received by processors, and the retail price for dairy products. In addition, industrial milk is made available for use in various dairy products or products containing dairy ingredients at competitive prices which differs from the target price depending on its end use.

The marketing of fluid milk (table milk and fresh cream) is governed by provincial milk marketing boards by setting the production level and price for fluid milk based on provincial demand. The provincial milk marketing boards allocate producer quotas, which are also based on daily kilograms of butterfat, by dividing its share of the MSQ and the predetermined production of domestic fluid milk among individual producers. In addition, provincial milk marketing boards are responsible for selling fluid milk to fluid milk dairies on behalf of producers. Provincial milk marketing boards use the Canadian Dairy Commission's support prices as a guide in determining the processor price for the portion of the milk that is used in the production of industrial dairy products (butter, skim milk powder, cheese, yogurt, ice cream and other processed foods).

Provincial government intervention in the dairy industry also occurs at the retail level, at least in certain provinces such as Quebec and Nova Scotia. The price of fluid milk is controlled at retail level through the establishment of minimum retail prices. Originally, fluid milk prices were adjusted according to the support prices established by the CDC. However, they are now based on a formula that accounts for the consumer price index, cash costs of producing milk, and personal disposable income. Such minimum price supports create market power for fluid milk at the retail level.

The NSMS in Canada is accompanied by import controls to restrict foreign supply of dairy products. To ensure imports are at a predictable level, there is an import ban of dairy product sales, quota restrictions allowing only a limited level of dairy imports, and import tariffs. That is, only a predetermined level of dairy products are allowed to be imported tariff-free, and imports above that level is subject to high tariffs. In addition,

the CDC monitors export sales of dairy products by provincial milk marketing boards and purchases many dairy products imported into Canada.

Analytical Framework and Methods

As a result of the national supply management system (NSMS), there are two milk streams in Canada, the fluid milk market (table milk and fresh cream) and the industrial milk market (butter, cheese, yogurt and ice cream). Currently, approximately 60% of the milk shipped by producers enters the industrial milk market for further processing and the remaining 40% is destined for the fluid milk market. The NSMS impacts three interlinked markets: (1) raw milk at the farm level, (2) processed milk at the wholesale level, and (3) fluid milk and dairy products at the retail level.

At the farm level, dairy producers produce raw milk destined for both the industrial and fluid milk markets. Their production decisions are based on expected milk prices and the level of production quota they hold. The raw milk is sold to provincial milk marketing boards destined for either the industrial milk or fluid milk processing streams. The actual price producers receive for the raw milk is set by government authorities as a component price based on the price of butterfat, protein, and other solids. At the wholesale level, processors purchase raw milk to produce fluid milk and manufactured dairy products. Processors pay government-mandated high prices for both fluid and industrial milk. The prices wholesalers receive are also the result of government intervention as they are based on a pricing system that guarantees a certain level of processing margin. At the retail level, retailers purchase milk and dairy products

from processors at these distorted prices. In addition, the price for fluid milk is regulated using minimum price supports creating a monopoly power at the retail level.

The NSMS has been referred to as a government-supervised cartel for milk production. Using qualitative analysis, the underlying economic structure of the NSMS is examined. In general, the structure of the NSMS acts the same as that of a monopoly such that the restricted supply results in higher milk prices. At the farm level, S refers to the supply of milk produced by dairy farmers and D refers to the demand for milk by processors. As can be seen in Figure 1, by cutting back the supply of milk at the farm level the quantity supplied drops from Q_1 to Q_2. Restricting supply using production quotas increases the producer price for milk, resulting in a price increase from P_1 to P_2. Using monopolistic pricing, producers are made better off through higher profits than would occur at the competitive equilibrium. Processors are made worse off as they pay more for the raw milk than they would otherwise in a competitive market.

Figure 1 can also be used to show the monopoly power at the retail level resulting from the minimum price policy imposed by government regulation for fluid milk. Here, S refers to the supply of fluid milk from processors and D refers to the demand for fluid milk by retailers. The minimum retail price is set at P_2, whereby retailers are prohibited to sell fluid milk products below this regulated price. By cutting back the supply at the retail level and marketing a higher price, the quantity demanded drops from Q_1 to Q_2. Such monopolistic pricing makes retailers better off. In addition, the higher dairy prices at the retail level cause consumers to consume less than the market equilibrium level of dairy, making consumers worse off than they would otherwise be without government

intervention. If the objective of the NSMS is to make producers better off, then why is it designed at the retail level to make profits for retailers?

Figure 1: Dairy Milk Monopoly Pricing at the Farm and Retail Levels

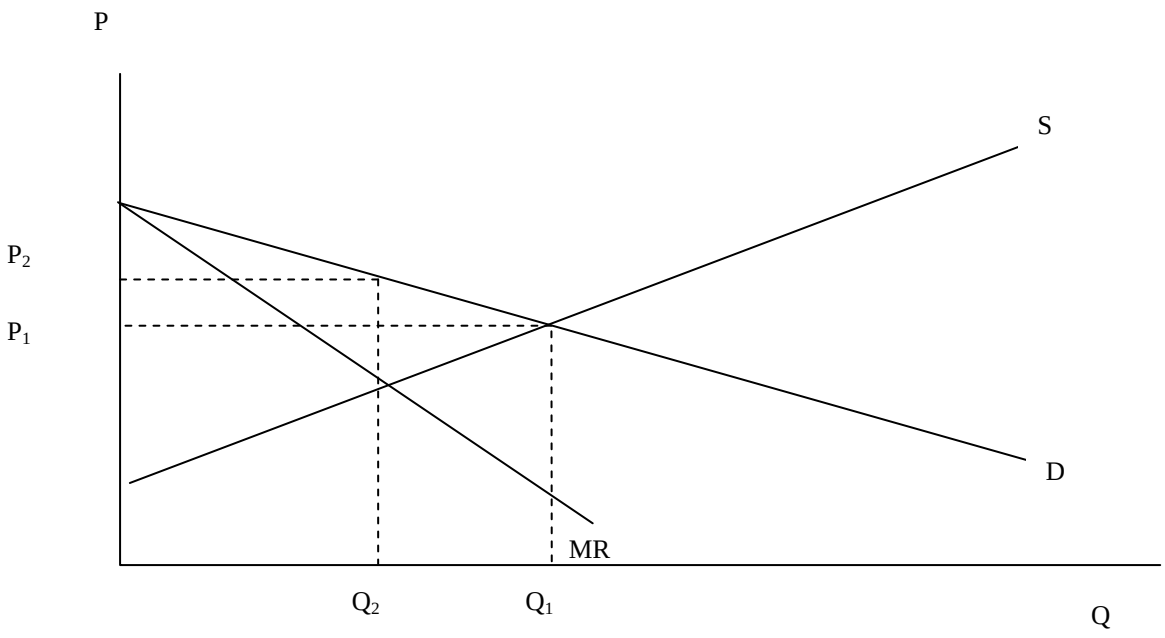
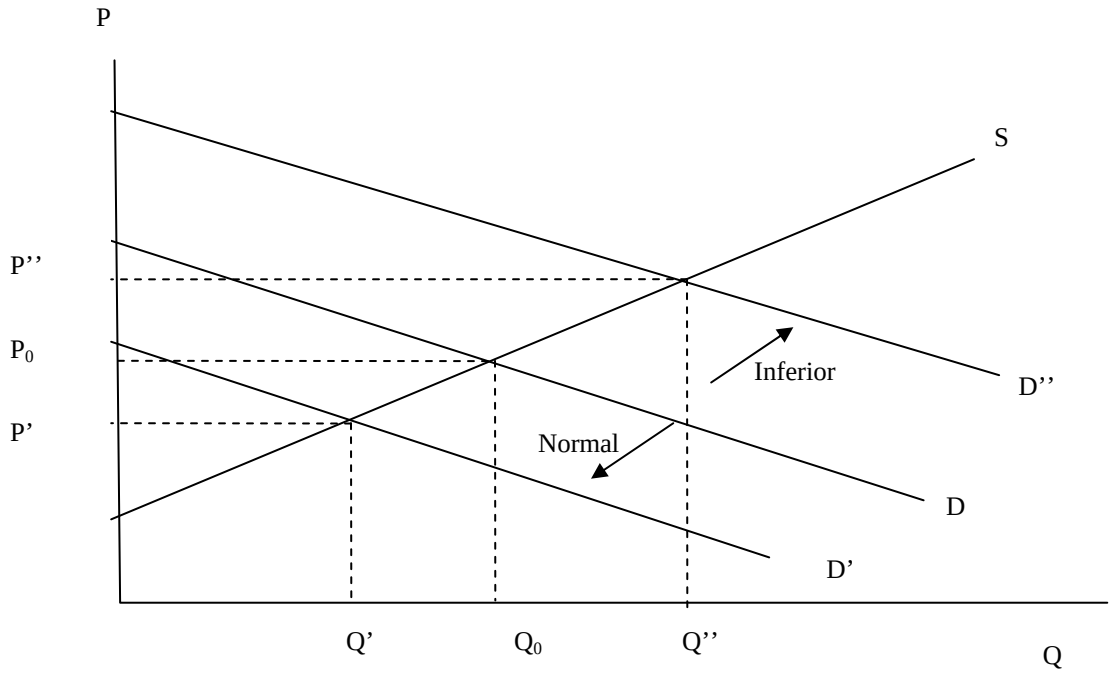


Figure 2 shows how the demand of butterfat (kg) at the processing level would shift if the supply of dairy products (kg) from processors is reduced. Firstly, if butterfat is considered a normal factor of production, which is most often the case for factors, then the demand for butterfat would shift to the left to D'. That is, the normal input is demanded less because of declining output. If butterfat is a normal input, then the supply of butterfat and the price of butterfat would be expected to fall from Q_0 to Q' and P_0 to P', respectively. Since the price falls to producers and rises to consumers, the result of this policy would seem to only benefit retails and not consumers or producers. Since the production quota is based on butterfat, then dairy producers would end up with lower and

lower revenue over time due to the monopoly power at the retail level. Furthermore, the value of quota would also fall over time as the demand of butterfat shifts downward. Hence, adopting an underlying assumption that butterfat is a normal input seems contrary to the interests of dairy producers.

Figure 2: Derived Dairy Butter at the Processing Level



On the contrary, if butterfat is assumed to be an inferior input in the processing of dairy products, then the demand for butterfat would rise as output falls at the retail level. In this case, the demand of butterfat would shift to the right to D'' and the price of butterfat would rise from P_0 to P'' (Figure 2). The quantity demanded of butterfat would increase from the equilibrium to Q''. Thus, dairy producers would receive a higher price for butterfat. Hence, if butterfat is an inferior input, restricting supply at the retail level would increase the price of butterfat to dairy producers.

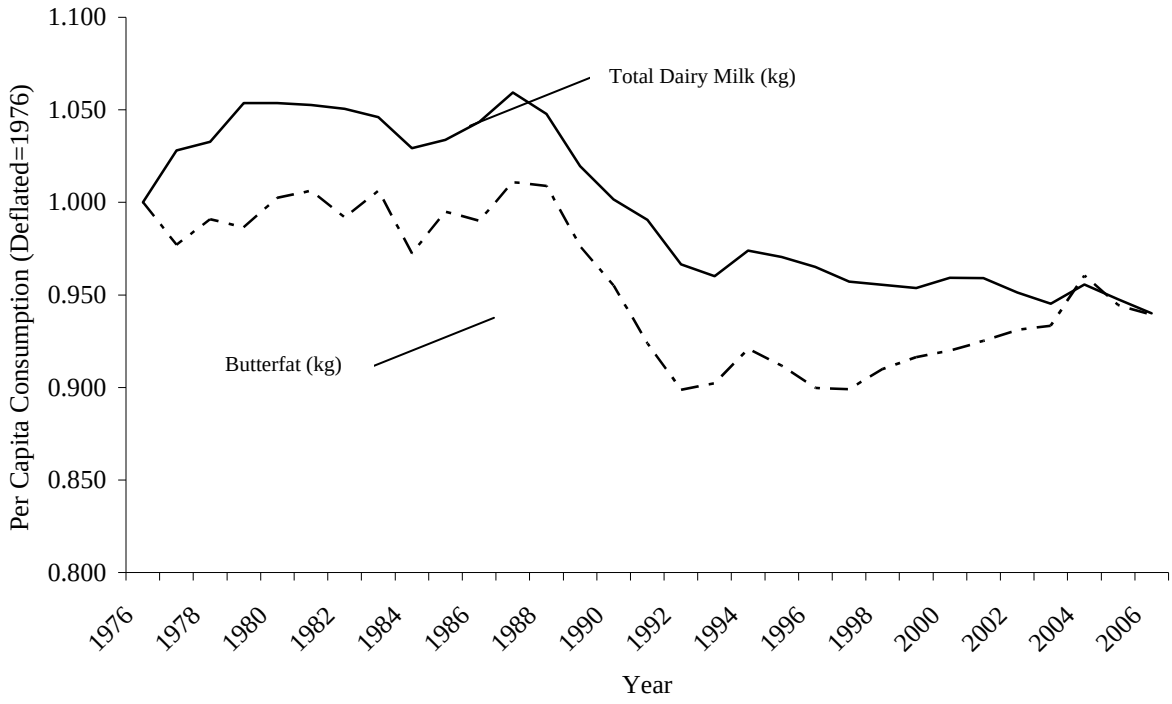
Empirical relationship between kilograms and butterfat.

To determine if butterfat is an inferior factor of production would require estimates of the processing cost function of dairy products. The derivative properties of this cost function (with respect to the price of fat) could then be examined to determine factor inferiority. To the best of our knowledge such data do not exist and therefore precluding determination of butterfat factor inferiority. In what follows, a more modest empirical analysis of the relationship between kilograms of butterfat and kilograms of dairy will be presented to determine if kilograms of dairy is an adequate proxy for kilograms of butterfat.

The traditional literature on dairy in Canada has used kilograms of dairy as a proxy for consumer demand. Furthermore, kilograms of dairy has been used to study dairy policy even when the focus of attention is on butterfat (e.g. Gray and Malla (1998)). If dairy kilograms and butterfat are in fixed proportions, then these two series ought to perfectly track one another over time.

Figure 3 presents a plot per capita plot commercial disappearance per capita of these two time series from 1977-2006 normalized by commercial disappearance in 1977 (1977=1.0). Data used for this analysis was obtained from Statistics Canada, Canadian Dairy Information Centre (**CDIC**), and Canadian Dairy Commission (**CDC**). From 1977 to approximately 1992 the two series seem to track one another fairly well, with the fluctuations in one series closely following the fluctuations of the other. Since the early 1990's the series seems to diverge however, if per capita disappearance of kilograms falling and per capita disappearance of butterfat rising. This is inconsistent with fixed proportions between butterfat and kilograms of dairy.

Figure 3: Per Capita Consumption of Total Dairy Milk and Butterfat, 1976-2006



While figure 3 rules out a fixed proportions deterministic relationship between kilograms and butterfat, it could be true that there is a significant stochastic relationship. Table 1 presents the results of regressing fat and a time trend on kilograms. The table indicates that there is a significant and positive relationship between fat and kilograms, but only after controlling for a negative trend. The importance of the trend in the relationship is demonstrated by the significant time trend in the regression. The fact that there is an important time element in the relationship indicates that the use of kilograms as a proxy for butterfat would be less accurate as time progresses and certainly would distort the situation towards the end of the time series.

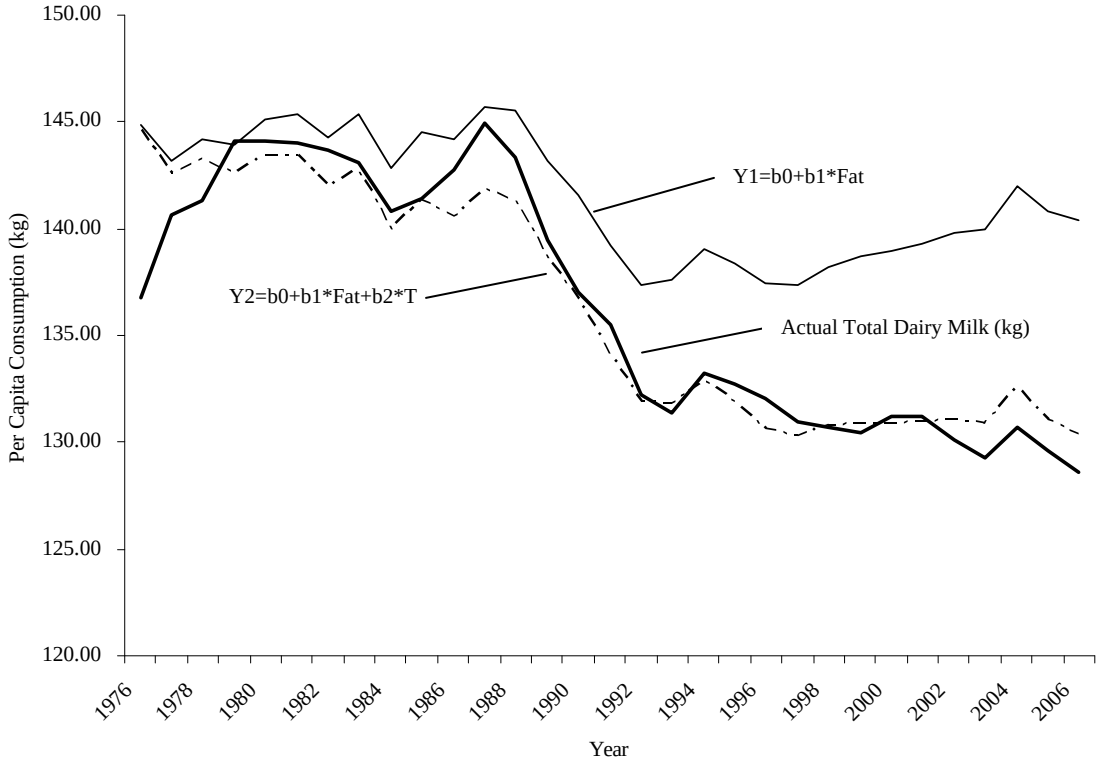
Table1: Regression Analysis of the Consumption of Total Dairy Milk on Butterfat

Estimates (t-values)	Constant b_0	Slope b_1	Trend b_2
$Y_2=b_0+b_1Fat+b_2T$	70.59 (5.29)	7.19 (5.60)	-0.32 (-5.64)

T-values are in parenthesis underneath the estimates.

A plot of the predicted relationship presented in Figure 4 with the actual data demonstrates the magnitude of the distortion over time. The solid bold line is per capita commercial disappearance in kilograms per capita. The line with dashes interspersed with dots is the predicted relationship including the time trend. The solid line (not bold) is the predicted relationship without the trend. The difference between the solid lines bolded and not bolded is the predicted amount by which butterfat and kilograms diverge over the sample time period by a deterministic time trend, and represents an estimate of the increasing distortion in using kilograms as a proxy for butterfat.

Figure 4: Actual and Predicted Per Capita Consumption of Total Dairy Milk



While highly suggestive, the results presented in table 1 could be spurious if the data contain unit roots. If kilograms is an adequate proxy for butterfat, then these two variables ought to be cointegrated (e.g. Engle and Granger (1987)). Cointegrating relationships identify long run relationships among variables. It seems reasonable that if kilograms of milk can be used as a proxy for butterfat then there should at least be a long run relationship between these two variables. The relationship estimated in Table 1 may be spurious if the data contain unit roots rather than time trends and the relationship estimated in Table 1 misrepresents the true relationship between these two variables.

Table 2 presents the results of undertaking a cointegration analysis between kilograms of dairy and butterfat. The first column of the table presents the augmented

Dickey-Fuller (ADF) test for a unit root in each time series. Comparing these values against the tabulated critical values found in Dickey and Fuller (1979), unit roots in each series cannot be rejected. The next step is to test for cointegration between the two time series. Cointegration between the two time series was tested using two approaches: (1) Park J_1 Superfluous Variable Addition test using canonical cointegrating regression (Park (1990)) and (2) the Johansen's eigenvalue statistic using a maximum likelihood estimator (Johansen (1991), Hamilton (1994)).

Results of undertaking these two tests on the series are also presented in Table 2. For Park's J_1 test the null hypothesis is that the two variables are cointegrated. The table indicates that the null hypothesis is rejected in the case of one, two and three superfluous regressors (see Park (1992) for further details of this test).

Table 2: Unit Root and Cointegration Tests of Total Dairy Milk on Butterfat

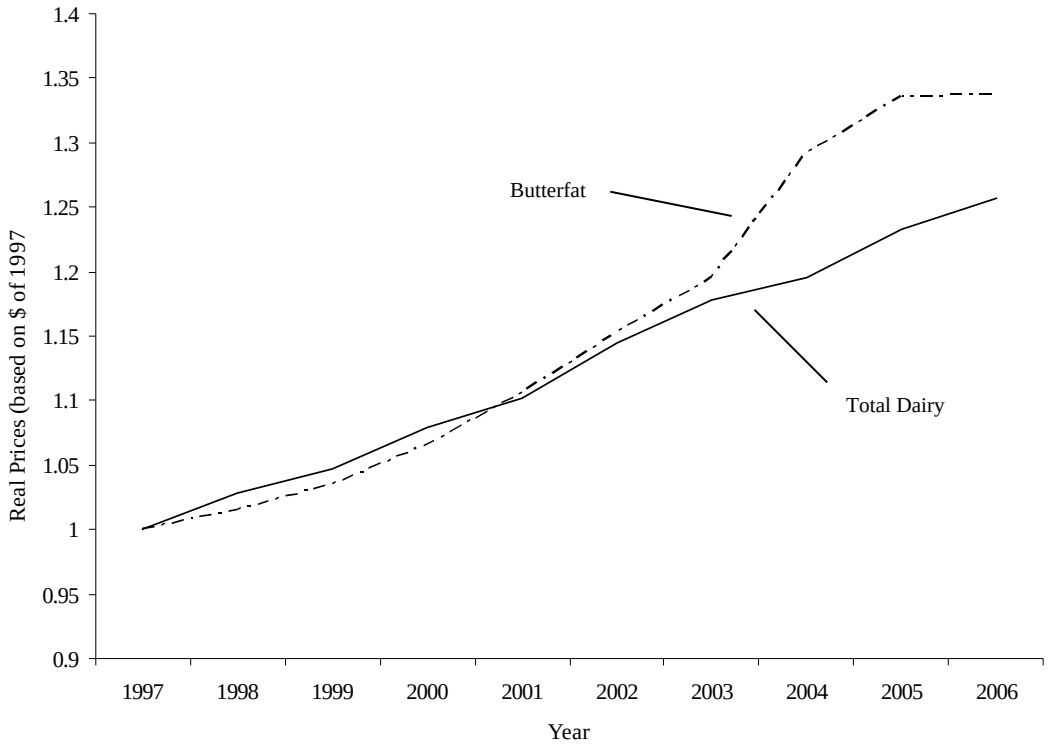
Dickey-Fuller		**Park J_1**			**Johansen's Approach**			
Milk	-2.588	**2**	**3**	**4**		**Case 3**	**Case 4**	**Case 5**
Butterfat	-1.456	9.936	10.010	11.539	Max. E	3.489	16.804	14.355
		(0.0016)	(0.0067)	(0.0091)	Trace	3.523	20.201	16.009

The conclusions regarding the Park J_1 test are also consistent with Johansen's test, also presented in Table 2. The three cases presented are case 3 (demeaning the data), case 4 (demeaning and detrending the data) and case (5), demeaning the data and including a trend in the cointegrating relationship (see Hamilton (1994) for details). The table indicates that in all cases the null hypothesis of two unit roots (no cointegrating vectors) is not rejected, indicating that no long run relationship exists between these two variables.

The Importance of Butterfat in the Component Price of Milk

Recall from figure 2 that, if butterfat is an inferior factor of production, then controlling the price at the retail level will increase the farm level demand for butterfat at thereby increasing its price. Figure 5 plots the butterfat component of Class 2 (yogurt, ice cream, and sour cream) milk against the total component price of dairy from 1997 through 2006. The Dairy Price Index and the Class 2 weighted average milk prices paid by processors for butterfat were used to determine the real prices for butterfat. Then, the change in the real price of butterfat and the change in the dairy price index were deflated, with 1997 as the base year. These values were plotted to examine the growth in the real prices of butterfat and total dairy milk.

Figure 5: Growth of Real Prices of Total Dairy Milk and Butterfat



As shown in Figure 5, the real price of butterfat has been rising over time at a faster rate than total dairy. This is consistent Figure 2, especially if butterfat is inferior and other components are normal factors of production. Such monopoly pricing at the retail level, as practiced by several Provincial marketing boards, creates an increase in demand for butterfat at the farm level.

Summary and Conclusions

The research results have shown that the demand for total dairy milk does not represent the demand for butterfat. That is, the butterfat content of dairy is a characteristic of the composite commodity and not the composite commodity itself. Using kilograms of total dairy milk as a proxy for butterfat is inappropriate. This means that studies that use kilograms of dairy as a proxy for butterfat are seriously flawed.

Furthermore, it could be that butterfat is an inferior characteristic of dairy products as opposed to a normal input as assumed in previous studies, then using dairy demand elasticity based on total dairy milk may result errors in direction and not just magnitude.

Milk and other dairy products are marketed based on butterfat not milk. In fact, milk production quotas and the largest element of the component milk price is based on kilograms of butterfat. Marketing dairy on the basis of butterfat has likely contributed to a strong link between the marketing practices of the Canadian dairy industry and the overall health of Canadians. The relationship between the consumption demand of dairy butterfat and consumers' overall health is important in Canadian health policy. Of special concerns are obesity problems in teenagers and coronary heart disease as the

probability of being obese and being inflicted with coronary heart disease increases with the dietary intake of fats.

There have been few studies on the relationship between the Canadian milk marketing practices and overall health of Canadians, with the exception of study done by Gray and Malla (1998). In light of the results from this study, the underlying assumption of a fixed relationship between kilograms of total dairy milk and kilograms of butterfat made by Gray and Malla seems inappropriate. That is, the critical assumption made by Gray and Malla that butterfat is a normal characteristic of milk and other dairy products may discredit the results of their analysis. According to Clark (*et. al*, 2006), although dairy has a positive elasticity of demand, the butterfat content of dairy has a negative demand elasticity. Thus, the conclusions drawn from Gray and Malla's analysis and their commendation of the NSMS for internalizing the healthcare externality relating to dairy fat may be incorrect. In fact, if butterfat is an inferior input, then the actions of the NSMS may be increasing the externality as the consumption of butterfat has been rising.

In other words, the structure of the NSMS has resulted in an increase in the demand for butterfat, which has led to an increase in the price of butterfat. If butterfat is inferior, then increasing the price of butterfat encourages consumers to choose high-fat dairy products as they are considered low quality. Increasing the price of dairy products would cause consumers, particularly those with limited disposable income, to switch their consumption to dairy products with higher fat content. Thus, the healthcare externality may not internalized by the policies of the Canadian dairy industry, but the externality may be increased.

At first glance, it may not make logical sense to impose monopoly power control at the retail level for milk. However, if butterfat is an inferior characteristic of dairy, then designing policies for the Canadian dairy industry to provide price supports at both the farm and retail levels ensures a strong market for butterfat. Imposing a monopoly power control at the retail level creates a larger demand for butterfat, hence, a larger supply of butterfat is demanded by processors. This, in turn, increases the demand for butterfat at the farm level. This fulfills the objective of the NSMS, which was to address the unstable markets, uncertain supplies, and highly variable producer and processor revenues.

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