THE IMPACT OF TRADE REFORM ON THE RESEARCH AND DEVELOPMENT INCENTIVES FOR CANADIAN DAIRY PRODUCERS

by

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Abstract

Canada has long been a proponent of free trade while at the same time defending the current supply management system that protects the dairy industry from import competition. In the most recent Doha Development Round of talks amongst nations belonging to the World Trade Organization, the validity of Canada's protectionist position has been questioned and it is conceivable that Canada may have to make significant changes in the dairy industry to allow more liberal trade policies to be enacted. The key purpose of this study is to find out how free trade will affect the research and development (R&D) incentives of Canadian dairy farmers. On one hand they may be induced to perform more R&D due to competition effects in order to lower costs and achieve a competitive advantage over the main competitor, the United States. On the other hand they may be induced to perform less R&D due to the spillover effect, which allows the Canadian R&D efforts to be used by the United States at no additional cost. It is found that the outcome of these two opposing forces depends on the market scale effect. If Canada is a net importer when the border opens the spillover effect may dominate and Canadian dairy producers may invest less into R&D than under the current protectionist policies. These results however will switch if Canada is found to be the net exporters. The results also depend on the level of the quota currently in place. If the current quota is chosen at a quantity relatively close to the amount supplied at the monopolistic level, a free trade regime may promote R&D efforts more so than supply management. On the other hand, if the current quota level in Canada is closer to the quantity that would be supplied in a competitive industry, Canadian dairy producers may invest less heavily in R&D efforts under a free trade regime than a supply management system.

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CHAPTER 1: INTRODUCTION

1.1 Background Discussion

The dairy sector is a key contributor to the Canadian economy. In 2005, dairy production ranked fourth in the Canadian agricultural sector, generating $4.84 billion in total farm cash receipts. According to Barichello (1981), Canadians spend almost one sixth of their total food budget on milk and dairy products, most of which are produced in Canada. In addition to its financial contribution, the dairy sector provided approximately 38 000 jobs on farms and about 26 000 jobs at the primary processing level (Agriculture and Agri-Food Canada - Trade Service 2006). The dairy sector continues to expand. In 1995, total Canadian production was 71.97 million hectoliters, while in 2005, it reached 74.92 million hectoliters (Canadian Dairy Commission, 2005). It is a common notion that the agriculture industry is a challenging sector to be in as agricultural production is wrought with unstable markets. In response to farmers' concerns over highly variable revenues, the Canadian government adopted a supply management regime in 1970. In effect, the quantity of milk that can be marketed at a predetermined price is restricted to a quantity that is expected to be consumed at the predetermined price. Provincial marketing boards issue marketing quotas to farmers allowing them to produce dairy.

As a supply managed industry, prices for dairy in Canada are well above world market levels (Meilke, Sarker, and Le Roy 1996, 241-272). Previously protected from foreign competition by import quotas, Canada was forced to replace these quotas with tariffs during the Uruguay Round of the World Trade Organization (WTO) trade talks. With the Doha Development Agenda (DDA) talks in progress, it is expected that these over-quota tariffs will be lowered, and Canada will eventually face a free-trade scenario in the dairy industry. Canada has long been resisting pressure from the WTO to dismantle the supply management tariffs, however it is becoming increasingly apparent that free trade is going to happen. Free trade will increase competition from external markets, including the United States. The competitiveness of Canada's currently isolated dairy industry is questionable due to the higher prices that are commanded under the supply management system.

Due to the rising concern of an open border with the United States as well as freer trade at the international level, existing on the leading edge of product and process development is vital for Canada in both local and international contexts. Science and innovation are the basis of efforts to support the future success and prosperity of Canada's agriculture and agri-food sector.

The success of the Canadian dairy sector can be attributed in part to research and development (R&D) efforts undertaken by various stakeholders in the industry. Two crucial objectives of R&D are process development and product development. By both reducing production costs and providing a superior product a producer can realize a competitive advantage over his rivals. As the border opens, the influx of foreign competition will make R&D in the dairy sector even more important. One might anticipate then that open borders would cause Canada's R&D efforts in the dairy industry to increase.

Process development may be achieved through finding more efficient inputs or better production technology. According to the Canadian Dairy Commission (2005), better feeding, disease control and genetic advancements have contributed to the increased amounts of milk being produced per cow.

Product innovation is an important issue for agriculture as it accelerates the development of new products and finds ways to improve upon existing ones. Consumer preferences continue to evolve and the ability to deliver products that meet consumer expectations is becoming more critical. The market for functional dairy products in Canada is very promising. Already several products have been developed such as probiotic yogurts and dairy products containing Omega-3 fatty acids (Agriculture and Agri-Food Canada - Trade Service 2006).

A key question concerning research and development in the Canadian Dairy Industry is who will do it? Throughout the 1900s, agricultural R&D was mainly performed through public institutions and the results of the research were openly accessible to the public (Huffman and Evenson 2006). In Canada publicly funded agricultural research has become much less common due in part to the shrinking constituency of agriculture and its diminishing influence on policy (Alston, Pardey, and Roseboom 1998, 1057-1071). As such there has been increased emphasis on the role of the private sector and, in particular, industry and commodity groups or producer associations in supporting agricultural research programs (Alston, Pardey, and Smith 1998, 51-82). Agricultural producer associations are quite common in Canada and can be found in the U.S. as well. Many producer organizations charge members a levy that is then used to finance a variety of activities such as product promotion, R&D, member education and administration. Since the early 1990s, producer groups in Canada have become key participants in agricultural R&D. The Dairy Farmers of Canada is the national policy, lobbying and promotional organization representing all dairy producers in Canada. Canadian dairy producers fund the operation. The Dairy Farmers of Canada in turn funds various research projects annually in areas such as health, nutrition and dairy production in Canada (Dairy Farmers of Canada 2007).

Given that producers will have an increased role in R&D, it is important to examine the incentives facing producers to conduct R&D. Specifically, will producers do more or less R&D as the border to the United States opens? On one hand, they are likely to do more due to increased competition. On the other hand, they may do less because R&D knowledge spillovers are more important in a free-trade environment than in a supply management environment. Moreover, free trade may result in a lower domestic market share, which also diminishes the incentive for producer R&D.

Despite the value of R&D, many studies have noted that it does not attract sufficient investment from private firms. d'Aspremont and Jacquemin (1988, 1133-37) attribute this to a "spillover effect" that renders it difficult for the investing firm to capture all the benefits created by the investment without having some benefits flow to a competitor. Competing firms may free-ride on the investment and reap the benefits without bearing the costs. Compounding this problem is a lack of excludability [1]. This reduces the losses of a firm (or national producer association) not investing in R&D since it can free-ride on an opponent's R&D investment. With a lack of incentives for private firms to invest in R&D and reduced funding from public institutions, the dairy sector could face stunted economic development and growth.

1.2 Problem Statement

With the World Trade Organization's Doha Development Agenda talks in progress it is expected that Canada will be forced to substantially lower the existing over-quota tariffs placed on dairy products, introducing foreign competition to this long-term protected industry. This new competition will increase the importance of conducting R&D in the dairy industry in order to keep Canadian producer's production costs down and remain on the leading edge of the industry. Not only would competition become more significant, but opening the border would make the spillover effect more relevant as well. Although spillovers do exist with the current supply management regime, they have minimal impact on R&D incentives. Spillovers become important to examine in a free-trade environment, where Canadian and U.S. producer associations select R&D levels in a non-cooperative game.

[1] The term "spillover" may be used equivalently with the term "lack of excludability."

With open borders, countries competing with the Canadian dairy sector, such as the U.S. may be able to appropriate the benefits of Canada's R&D efforts without accruing the costs, thereby giving them an advantage over Canada. Taking this spillover effect into consideration it would be expected that each country would have less of an incentive to invest their own resources into R&D with the chance of free-riding on a competitor's efforts. The main ambiguity is that on the one hand, competition will increase the incentive for R&D while on the other hand the presence of spillovers will decrease the incentive for R&D. It was noted above that through R&D efforts, reducing production costs and providing a superior product can help a producer realize a competitive advantage over its rivals. In the current situation of supply management and relatively closed borders, Canada does not have to worry about competition from rival producers as imports are restricted through the tariff rate quotas.

The results of this research will be important in determining to what extent the government should intervene in the R&D market through R&D tax credits and subsidies in the case that supply management is dismantled. If natural market forces provide Canadian producers with a strong incentive to conduct R&D in a free-trade environment, then the government does not need to worry. If natural market forces are weak due to spillovers, then significant policy intervention may be warranted.

Although there exists extensive literature on non-cooperative R&D, the particular scenario considered in this paper has not been previously examined. In standard models, firms are either competitive in both the product market and the R&D market or are non-competitive in both of these markets. The analysis in this thesis is unique because with free trade, the R&D market is characterized by a non-cooperative game and the product market is characterized by competition.

This thesis seeks to examine in what way will liberalized trade regimes affect the incentives of Canadian dairy producers to invest in R&D. The analysis will be illustrated by examining the currently supply managed Canadian dairy industry facing competition from the U.S. dairy industry.

The general theoretical framework that will be used to conduct the research is as follows. The market will be broken down in to two components: product market competition in stage two, and R&D competition in stage one. Under the current scheme, the product market in Canada is monopolized due to the supply management system, whereas the product market in the U.S. is currently competitive. The R&D market on the other hand is monopolized in both Canada and the U.S. because of producer associations. This study seeks to compare the current R&D incentives when there is monopoly in both the product market and R&D market with the R&D incentives when there is competition in the product market and monopoly in the R&D market, as would be the case should supply management be dismantled.

1.3 Objectives

The specific objectives of this thesis are to:

- Summarize the current characteristics of the dairy industry in Canada;
- Give an overview of the objectives of the World Trade Organization and consider in what way the Doha Development Agenda round is expected to affect Canada's dairy industry;
- Summarize the existing theoretical literature and empirical evidence on how monopoly versus competitive markets affect the incentives for firms to invest in R&D;
- Create a theoretical model that examines whether higher or lower levels of R&D will occur when opening the border accounting for spillovers;
- Provide a simulation and comparison of the results of the model by choosing realistic values from Canadian and U.S. markets and;
- Consider the implications of a free-trade scenario on the competitiveness of the Canadian Dairy Sector.

The analysis will begin with an examination of R&D incentives under a supply management and closed border situation as is the case facing Canadian dairy producers currently. Next the R&D incentives will be examined under the assumptions of a competitive Canadian milk market, closed borders, and monopoly control over R&D decisions. This case will provide a relevant benchmark to which other cases can then be compared. Then free trade will be introduced. First a case of free trade with no spillovers will be examined, and finally spillovers will be added into the analysis and the impact of these spillovers on the results will be assessed.

1.4 Outline

The remainder of the thesis will be structured as follows. Chapter Two will discuss the central practical considerations including research and development, trade and producer associations. The history of various trade agreements will be provided. A literature review will be provided summarizing issues pertaining to the structure of the dairy industry, R&D incentives and trade policies. Chapter Three will present the theoretical analysis beginning with a literature review of the existing theory and summarizing the relevant models. Building on this past literature, the current model will examine the industry first in a protected market structure, followed by an examination of the model under a free-trade regime. The results of the simulation and an interpretation of these findings will be presented. Chapter Four will conclude the paper with a brief discussion of the results and potential implications for the dairy industry in Canada.

CHAPTER 2: OVERVIEW OF CANADIAN DAIRY AND TRADE

2.1 Canadian Dairy Sector

The Canadian dairy industry has traditionally produced a wide range of consumer dairy products derived from basic raw milk. Demands for dairy products range from standard, lower value, relatively undifferentiated, products to higher-value, differentiated, specialized, and premium priced products. These range from processed dairy products themselves, such as fluid milk, butter, cheese, ice cream and yogurt, as well as functional and nutritional food ingredients designed for use in other food and beverage processing industries, as well as being used as industrial inputs for a variety of non-food manufacturing.

Canada's dairy sector plays an important role in the Canadian agriculture and agri-food economy. In 2006, dairy production generated $4.84 billion in total farm cash receipts and $11.5 billion in manufacturing sales. The dairy industry currently ranks fourth in the Canadian agricultural sector following grains, red meats and horticulture (Agriculture and Agri-Food Canada). In 1992, Canadian dairy farming and processing industries generated sales of more than $10 billion, ranking it the second of all Canadian agricultural commodities. In fact from 1991-93 dairy products generated average annual farm sales of $3.13 billion which accounted for 15 percent of market receipts for all agricultural products. At this time, dairy farms accounted for 11 percent of all Canadian farms (Agriculture and Agri-Food Canada 1996).

Canadian production costs are generally above those of the United States (and other competitor countries) in both raw milk production as well as dairy products processing. Some of these examples are shown in Table 2.1.

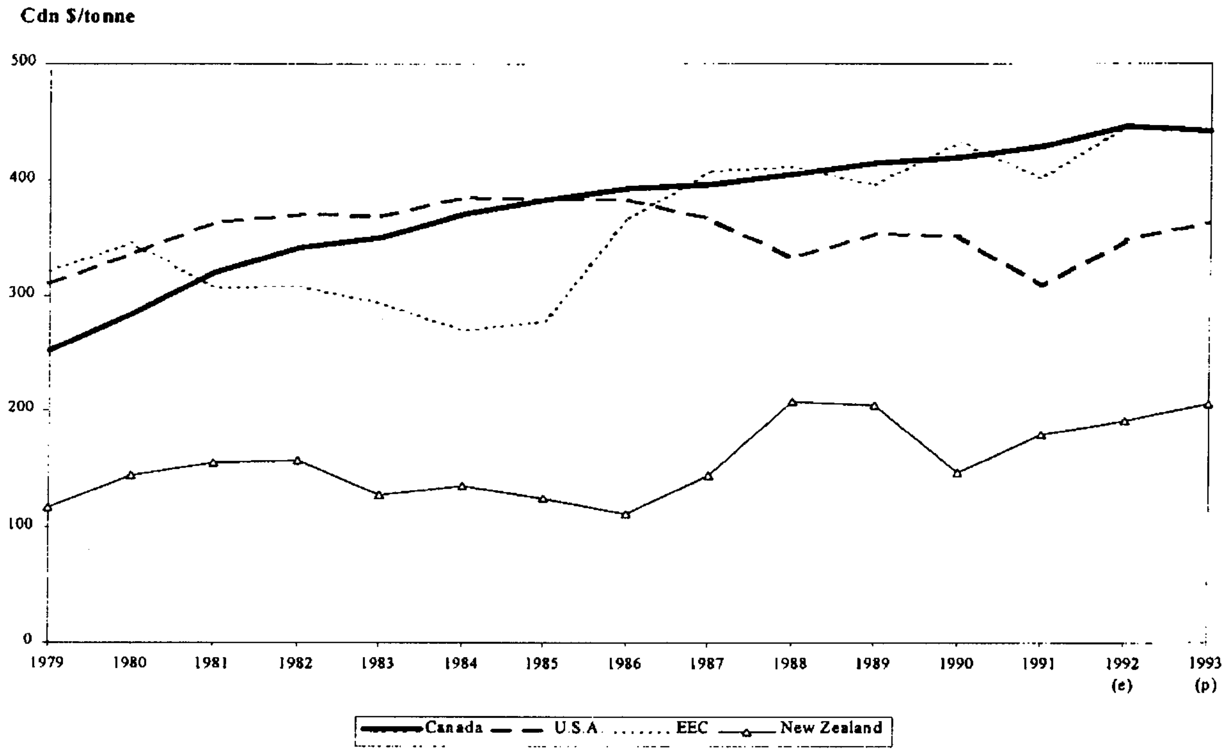
Table 2.1: Indices of Canadian and Competitors' Raw Milk Production Cost Estimates
(Index: Canada = 100)

Canada	100
U.S.	71
Netherlands	72
Ireland	45
New Zealand	30

Data Source: (Agriculture and Agri-Food Canada 1996).

In the case of milk production, the higher costs in Canada could be attributed to the higher input prices compared to other competitor countries as well as the efficiency or productivity of processing operations. Figure 2.1 illustrates Canada's higher farm gate milk prices in relation to some other selected countries.

Figure 2.1: Farm Gate Milk Prices for Dairy Products
1979-1993



Farm gate prices in Canada are generally higher than those found in the United States, New Zealand, and (with the exception of the years 1987 to 1996) the EEC (mainly European countries). It should be noted that Figure 2.1 shows data only up to 1993. More recent data shows that this trend has continued. The weighted average milk price in Canada for 2000/01 was 15.57 U.S. dollars per 100 pounds, while the average farm price of milk in the U.S. averaged at 12.40 per 100 pounds (Bailey, Kenneth, 2002). The recent increase in the Canadian dollar exchange rate may display a different picture. An increase in the Canadian exchange rate would cause the gap to widen. This diagram should be read with care, noting that the prices shown are in Canadian dollars per tonne. The importance of this diagram is that farm gate prices in Canada have traditionally been relatively high compared to other countries'.

Table 2.2 illustrates the observation that prices paid to milk producers have grown at a faster pace than prices for aggregate agricultural products, a trend that has generally been reflected in the prices that processors charged for their products. This large price differentiation for milk at the producer level however, has not led to a faster increase of prices at the consumer level, compared to the price index for all foods (Agriculture and Agri-Food Canada 1996) (this could potentially imply that processors are becoming more efficient, perhaps more so than the United States).

Table 2.2: Price Trends in the Canadian Dairy and Food Systems
1981-1993
(Index 1986 = 100)

	Farm Product Price Index		**Consumer Price Index**	
Year	*Agriculture*	*Dairy*	*All Food*	*Dairy*
1981	107	85	79	77
1986	100	100	100	100
1993	106	117	123	117

Data Source: (Agriculture and Agri-Food Canada 1996).

Net farm cash income for dairy farms has also increased substantially. It is now well above average for the agricultural sector and has almost the highest average net farm cash income in Canadian agriculture by farm type, coming in second only after the poultry sector (Agriculture and Agri-Food Canada 1996).

Price discrimination is practiced to a great extent in the Canadian milk market. For instance, in the dairy year 1992/93 there were more than 50 different prices for milk depending on the end-use purpose and the particular province in which it was produced. Prices paid for milk are based on the province of production, and to a lesser extent more recently, whether the milk is intended for the fluid market or the industrial market, and furthermore, the price may be differentiated between industrial milk classes (Agriculture and Agri-Food Canada 1996).

Industry Growth: Between the years of 1961 to 1993, the Canadian dairy processing industry grew relatively slowly, in terms of gross domestic product (GDP), compared to the rest of the food and beverage industry. In fact, the dairy processing share of food and beverage GDP fell from 16 percent in 1961 to comprising just 12 percent of the food and beverage GDP in 1993 (Agriculture and Agri-Food Canada 1996).

Compared with other types of farms, dairy farms have declined relatively faster than others, a shift noticed especially in the smaller family type of operations. About 29 thousand farms held quota (were allowed to sell or cream) in 1993, which is a considerable decline when compared with 174 thousand quota holders in 1968 (Agriculture and Agri-Food Canada 1996).

Industrial vs. Fluid: The Canadian milk processing sector provides milk to two main markets; fluid milk and industrial milk. Fluid milk production pertains mainly to fresh milk products but also involves some minimal manufacturing processes. Examples of fluid milk products include regular and low fat milk, buttermilk, chocolate milk, as well as organic milk and fresh creams. Industrial milk is sold mainly for use in the manufacturing of dairy products, which are then differentiated into two separate categories. The first of these categories being soft products, such as ice cream, yogurt, and cottage cheese, while the second category of hard products includes items such as butter, skim milk powder and hard cheese. Canada in fact, produces more than 460 different varieties of fine cheeses including raw milk, goat and sheep cheeses.

Industrial demands for dairy-based manufacturing inputs derive from the use of particular milk constituents in the manufacturing of products ranging from pharmaceuticals to virus combatants to beauty aids, glues, or even knitting needles. Dairy based inputs are also used for their functional properties in areas such as immunology or the prevention of tooth decay.

In 1992, approximately 27.3 million hectolitres (accounting for 39.7 percent of raw milk production), were sold for fluid purposes while 41.5 million hectolitres (accounting for 60.3 percent), were sold for industrial purposes (Agriculture and Agri-Food Canada 1996).

Fluid milk product prices have traditionally increased at a faster pace than prices for industrial milk products. A higher price obtained for fluid milk may be attributed in part to the less elastic demand of fluid milk products. This is due to the perishable nature of fresh milk, whereas industrial demand is relatively more elastic reflecting the storable nature of industrial products such as skim milk powder, cheese, butter and other similar items. In more recent times however, the difference between the prices of these two markets has become lesser as the market for traditional dairy products like milk, cheese and butter has declined. At the same time, many industrial products such as specialty cheeses, yogurt, ice cream, and fast-food products, such as pizzas and cheese burgers are constituting a growing segment of the market. In 2005, yogurt production increased, totaling 233 million kilograms, a 45 per cent increase from 2001 (Agriculture and Agri-Food Canada - Trade Service 2006). The use of dairy ingredients in further processed foods is also an increasing trend. The changing trend of demand for selected milk products is presented below in Table 2.3.

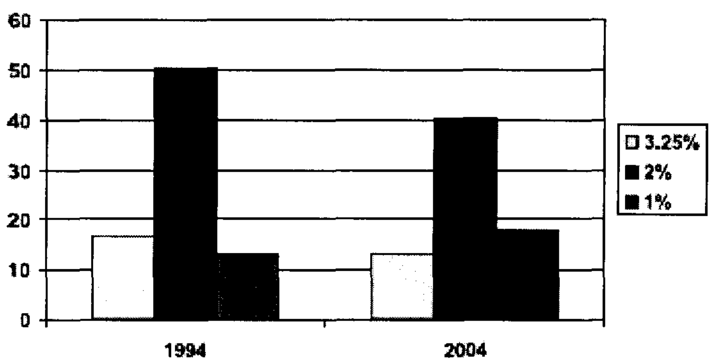
Table 2.3: Canadian Domestic Disappearance Per Capita of Dairy Products

Year	*1990*	*2000*	*2004*
Product			
Ice Cream (L)	11.47	8.78	9.28
Cheddar Cheese (kg	3.81	3.91	3.78
Specialty Cheese (kg)	5.64	7.16	7.36
Butter (kg)	3.28	3.10	3.54
Yogurt (L)	3.09	4.9	6.75
Powders (kg)	2.79	2.37	2.55

Data Source: (Agriculture and Agri-Food Canada - Dairy Section, Canadian Dairy Commission, and Dairy Farmers of Canada).

Figure 2.2 shows the decreasing demand for fluid milk products. It must be noted that during this same time period, domestic consumption of overall milk products has declined. The domestic market for traditional dairy products for instance milk, cheese and butter is in decline, while specialty cheeses, yogurt, ice cream, and fast-food products, such as pizzas and cheese burgers, are a growing segment of the market. The use of dairy ingredients in further processed foods is also a growing market. The former market control rules and the new rules agreed in various trade negotiations do not allow the same degree of market protection for value-added products as for traditional dairy products. As this market segment expands, internationally competitive ingredient pricing will be increasingly necessary to support domestic processing and further processing industries (Agriculture and Agri-Food Canada 1996).

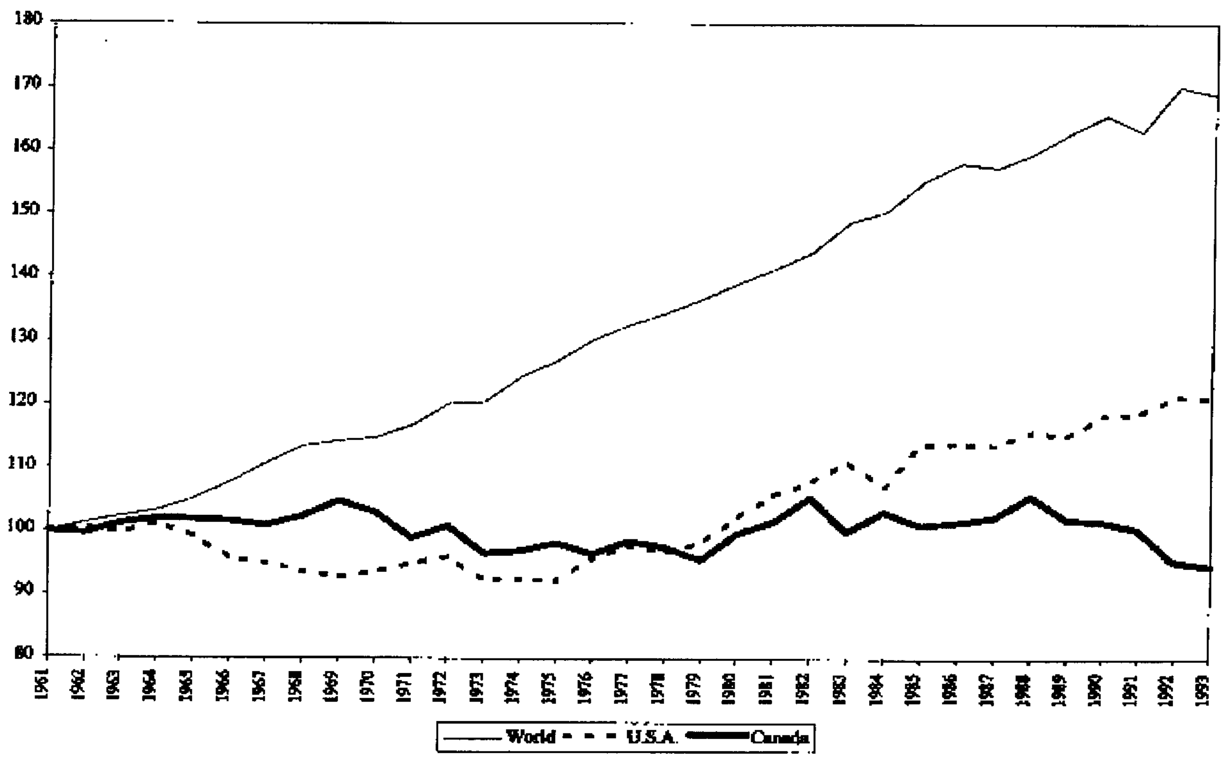
Figure 2.2: Canadian Per Capita Consumption of Fluid Milk
(in litres)



Source: (Agriculture and Agri-Food Canada - Dairy Section, Canadian Dairy Commission, and Dairy Farmers of Canada).

While Canadian milk production has been relatively stable over the last 40 years, production of other major commodities has increased substantially, as have both U.S. and world milk production. This trend is illustrated in Figure 2.3.

Figure 2.3: Domestic and International Milk Production
1961 to 1993
Milk Production (Index 1961=100)



Canada compared to competitors: The structure of family dairy farms in Canada is similar but smaller in size than European and U.S. dairy farms, however recently Canada is seeing a trend away from the family run farm towards larger size operations. It should be noted that dairy sales per cow tend to increase with the size of the enterprise (size being determined by the number of cows or the value of sales), suggesting that larger farms are more productive

While the United States has only 6 times the number of dairy processing plants as Canada, they are able to processes up to 9 times the dairy products (on a milk equivalent basis).

These surplus capacity problems can have an adverse effect on the overall cost competitiveness of Canadian dairy processing firms, a growing concern when considering increased competition from more transparent borders.

In addition to Canada's problem of excess capacity in the processing plants, there exists the supply management induced quota value cost. These quota values, while representing a considerable component of total capital assets of the Canadian dairy sector raise debt levels and associated financing costs for Canadian dairy producers over those faced by similar dairy farmers in the United States.

Market Structure: Dairy farming is one of the least concentrated major agricultural sectors in Canada, with only 28 percent of production realized by the largest 10 percent of dairy farms (Agriculture and Agri-Food Canada 1996). Processors on the other hand are mainly large multi product processing plants and have a higher degree of market concentration.

The supply management system in place in Canada has tended to constrain the degree of rivalry in the processing industry through factors such as restrictions on the movement of fluid milk between the province of origin, barriers to entry associated with quota systems (including plant supply quotas in some provinces), domestic industry protection from import competition, and difficulties incurred by processors in obtaining raw milk supplies for particular manufacturing purposes. The regulation of prices by provincial authorities for both fluid and (in some provinces) industrial milk, constrains rivalry within the industry on the basis of price. In spite of this fact, dairy processing plant numbers decreased from 880 in 1970 to 308 in 1992, allowing the remaining plants to increase in size (Agriculture and Agri-Food Canada 1996).

2.1.1Governmental Regulation

Regulation, by its very nature can be a double-edged sword. While regulation may arise from a desire to improve the efficiency of intrinsically imperfect markets, other demands for regulation include influencing market outcomes, for either compassionate or opportunistic reasons. Although optimal regulation can offer society with improved economic efficiency and increase welfare, poorly designed regulation can cause harmful distortions and stifle economic growth. Even the most beneficial regulations can become obsolete as new scientific knowledge and new technologies become available and economies, demographics, and social consensus change, hence reducing their usefulness.

Interference with market dynamics can reduce the rate of technological innovation and the efficient allocation or reallocation of resources across industries. Such interference can eventually reduce the rate of economic growth. For example, a world bank study estimates that if agricultural subsidies and protection in the industrialized world had been eliminated; taxpayers and consumers would have saved $100 billion US per year in the early 1980s with farm incomes falling by only about half of that (Carlton, D. and Perloff, J. 1994).

Regulation can promote industry interests in many ways. Many regulations set prices, allocate marketing quotas, or control the entry and exit of firms in an industry. These types of regulation impart market power on firms in the target industry, raising their profits to a similar extent as in a private cartel, but with the advantage of government approval and enforcement.

The system of supply management in Canada is one example of such government regulation. It is highly controversial with one side arguing that the current supply management system helps farmers enough to endure the costs imposed; others firmly believe that the system should be dismantled.

Advocates of the supply management system include many dairy farmers as well as many Canadian consumers. According to polls done by the Dairy Farmers of Canada (DFC), 90 percent of Canadians believe that supply management is advantageous. Moreover, 80 percent of Canadians say that the price of dairy products is fair and reasonable. Those who gain from regulation are milk producers and sellers of milk quota. Dairy farmers certainly have much at stake if the supply management system were to be dismantled. The high quota values now embedded in their cost structures would make adjustment to global markets more difficult. From their perspective, governments have created these quotas and have an obligation to assist them in moving away from them.

The DFC is an organization representing milk producers. This organization works in consensus with the federal government and has a strong influence on federal government decisions. They lobby for the present policy to remain in place in order to preserve rural production, population and employment. From their point of view, the current policy is successful in achieving a strong industry. They defend the opinion that prices are more stable, and at the time of introduction, supply management allowed the real price of milk to rise. Today, the price of milk continues to increase at a rate on par with the inflation rate.

Those who realize a welfare loss from the supply management system are milk consumers and purchasers of milk quota. Although in the past Canadian tax payers also realized a welfare loss, the supply management system in the last seven to eight years has removed the subsidy factors which caused tax dollars to be invested into the industry. Since that time there has been no taxpayer involvement. Opponents of the supply management system raise many points to show that the system should be deregulated. Opponents argue that it is unfair to consumers who face higher prices, unfair to farmers in other sectors whose opportunities to access foreign markets are stifled, and even unfair to dairy and poultry farmers who are inhibited by the constraints of the quota system to expand and become more efficient or productive. In Ontario, for example, it currently costs producers about $27,500 to gain the right to ship 26 litres of industrial milk a day which is approximately the amount of milk produced by a typical dairy cow (Penner 2004). Still others argue that the domestic dairy market is mature and offers little opportunity for expansion. The only way to expand is through exports, which would involve more transparent and less restrictive trade opportunities. Supporters of deregulation claim that dismantling the supply management system will increase efficiency and lower prices. If regulated prices are cost based (as is the dairy industry), firms have little incentive to cut costs. A common effect of the competition created by regulatory reform is increased innovation. Without the stimulus of competition associated with regulatory reform, many efficiency-enhancing, cost-saving innovations are not likely to be created.

On the opposing side of supply management are views such as the one expressed below by Michael Hart who states:

"When it comes to agricultural supply management in Canada, self deception has been the order of the day for far too long. Consumers are encouraged to deceive themselves into believing that high prices and limited choice are the necessary cost of reliable supply. Producers are eager to deceive themselves that stable prices and assured returns are better than the vagaries of competition" (Hart, April 2005).

Further arguments against supply management include the observation that supply management reduces incentives for growth, prevents efficient reallocation of production and processing among regions, and has added to the cost of rationalization within regions. These opponents note that the current supply management system has restricted the size and raised the costs of dairy farms as well as processing plants. They are quick to point out that Canadian milk production costs are noticeably above those of the United States and the Netherlands, more than double those of Ireland, and more than three times those observed by low cost producers such as

New Zealand. In fact welfare costs due to supply management induced productivity losses are estimated at $208 million per year (Barichello 1981).

2.1.2 Supply Management

Most markets in Canada operate in an unregulated fashion with cost efficiencies and market power being the primary determinates of price. The Canadian dairy industry deviates from this standard model as it is a supply managed industry. "Supply Management" (SM) refers to the policy framework that uses a combination of production, marketing and import quotas in order to manage total supply to satisfy estimated demand at a specific price which corresponds to the estimated farm level cost of production.

SM was originally introduced in order to address market failure stemming from three main factors; those being overproduction and uneven distribution of bargaining powers, rent seeking by various stakeholders in the industry through protection from imports and finally jurisdictional disputes that commonly occurred between the federal and provincial levels of the government. Put quite simply, the original purpose of SM was to stabilize farm prices and prevent surplus.

In this supply managed industry, domestic demand is predicted, the anticipated market is divided among farmers who own quota, and prices are set at levels high enough to cover production costs plus profit. In addition, imports are controlled in order to ensure that the prescribed domestic prices will not be undercut by foreign producers. Under the authority of provincial and federal legislation, an effective domestic monopoly is upheld.

The Dairy Farmers of Canada (DFC) define the term supply management in their own words:

> "Supply management systems are Federal-Provincial agreements initiated and supported by appropriate legislation that regulates the marketing of dairy, poultry and eggs in Canada. These systems are dependent upon the support of three equally important pillars:
>
> **a) Producer Pricing**
>
> Pricing mechanisms are based on farmers collectively negotiating fair market returns for milk, poultry and eggs; and reflect what it costs to produce the food.
>
> **b) Import Controls**
>
> Import control measures are essential to efficiently plan production to meet Canadian demand by permitting imports to the level of access agreed to at the World Trade

Organization. Proper mechanisms to administer and classify products that are imported under TRQs (tariff rate quotas) are also essential.

c) Production Discipline

Production discipline allows for the balance of supply and demand, thereby promoting price and market stability. Production is determined regularly to efficiently reflect changes in consumer demand."[2]

Various SM agencies have specific tasks which include allocating quota, determining pricing, licensing of producers, collection of levies, purchasing and disposing of products, as well as dairy promotion and R&D. Individual dairy farmers hold domestic quotas which determine the amount of production that farmer is allowed to sell into the domestic market at regulated prices. In effect, a production quota is a permit for a firm or farmer to sell milk. Fluid (or fresh) milk production quota is allocated to the provinces based on current provincial consumption, which in turn is based on consumer income, the price of milk as well as population demographics. The national quantity of industrial milk is set by the Canadian Dairy Commission (CDC) in consultation with the Canadian Milk Supply Management Committee (CMSMC). The CMSMC represents producers, processors and consumers.

The major obvious impacts of Canadian policy for the dairy processing sector are the relatively high wholesale prices for milk that primary processors face, the higher dairy ingredient prices that face further processors, and the tendency for profitability in this industry to be somewhat greater than in most other Canadian food industries.

Quotas on imports are known as tariff-rate quotas (TRQ)s with one tariff for imports within the TRQ and another for imports over the TRQ. As the current TRQs are in the range of 100 to 250 percent (Barichello, Josling and Sumner December 2005), protection remains high enough to effectively keep trade barriers in place.

Evolution of the Dairy Policy: The system of supply management stems from an agricultural sector that has been supported since the 1930s when Canadian parliament adopted the philosophy that farming is more than a just a business, it is "a way of life". Instead of operating

[2] From the response to the First Round of talks on the Next Generation of Agriculture and Agri-food Policy available at http://www.agr.gc.ca/pol/consult/index_e.php?s1=miss
http://www.agr.gc.ca/pol/consult/miss/pdf/a21.pdf

under a competitive system, legislators determined farm prices based on the average or in some cases the marginal supplier's costs of production. Many other forms of government support have also been given to agricultural producers throughout the years.

During World War II for example, subsidies were paid to farmers in order to maintain production under wartime price control systems. Post war assistance included deficiency payments from the federal government, which were given every year from 1958 to 1966. In 1964 alone for example, annual payments given to dairy producers under the Agricultural Stabilization Act totaled $117 million (Coffin, G. et. al. June 1994). As a result of these high prices offered by the government, overproduction mounted. The Canadian government responded by assisting farmers through exporting these surpluses (which were often dumped onto world markets at excessively low prices), and through the restriction of imports. Problems then began to arise. Due in part to this dumping of excess supply, export prices fell while world-wide export subsidies rose, closing off export opportunities.

Prior to the 1960's, Canada was a net exporter of dairy. In the late 1960s and early 1970s in response to the high cost of deficiency payments and decreased export opportunities, the Canadian government adopted the supply management system for the dairy (and poultry) industries. Most marketing boards were established in the 1930s under provincial legislation, however the use of marketing boards to restrict supply evolved later in the 1960s. In 1967 the Canadian Dairy Commission (CDC) was established in order to help coordinate milk supply management across the provinces. Supply management allowed the provinces to control the fluid milk market.

Beginning in 1988 and continuing through to 1994, the direct subsidy paid to farmers by the federal government was decreased, and estimates show that this aided in reducing the total subsidy from $270 million to $225 million (Agriculture and Agri-Food Canada 1996). Gradually, the dairy subsidy was phased out entirely. In fact, according to the Organisation for Economic Co-Operation and Development (OECD), total support to agriculture has decreased, falling as a percentage of GDP from 1.8% of GDP in 1986-88 to 0.8% in 2004-06 (Organisation for Economic Co-Operation and Development 2007, 1-288).

Canada has continued to made significant changes to agricultural support systems. The OECD uses the Producer Subsidy Equivalent (PSE) as a tool to measure the support to agriculture. The PSE measures the annual monetary transfers to farmers from market price support systems, budgetary payments and foregone budgetary revenue. From 1986 to 2005, the

PSE fell from a value of $8 047 million to $7 916 million (Organisation for Economic Co-Operation and Development 2007, 1-288). Today the remaining main source of market price supports is through supply management systems and related border protection. This type of support however continues to limit export opportunities and keeps consumer prices above average world dairy prices.

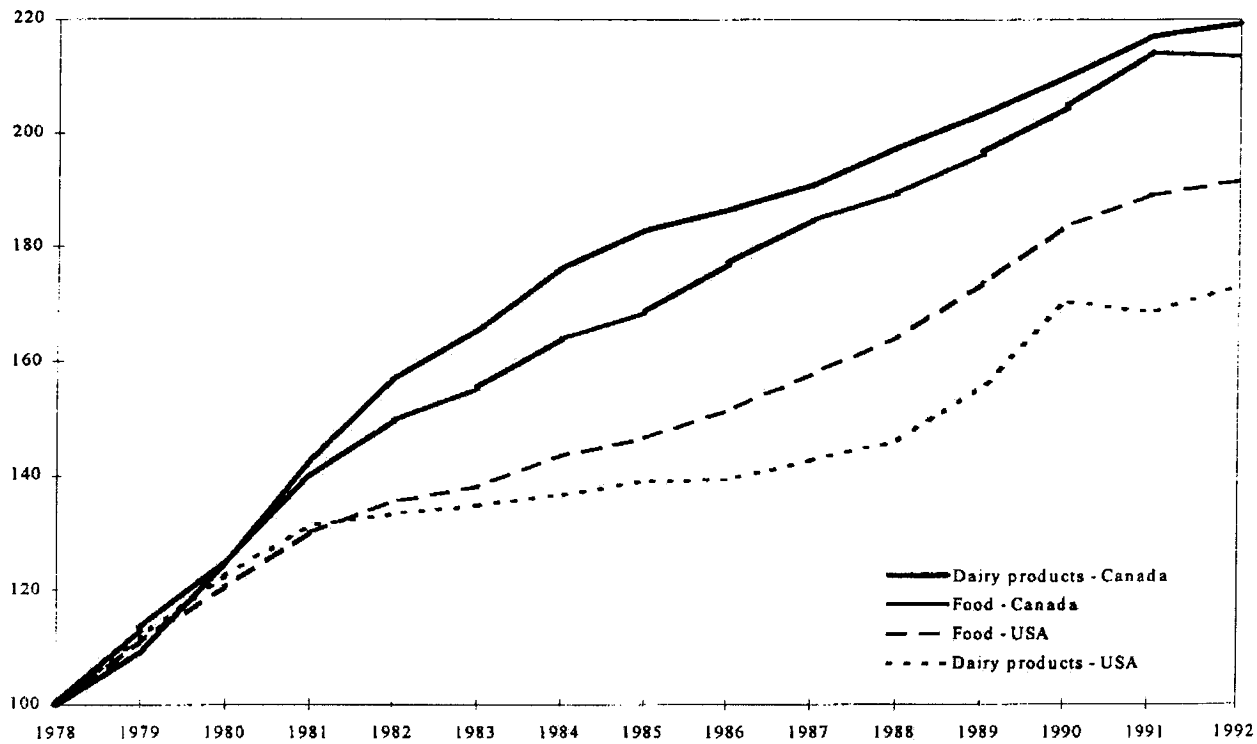
The recent policy changes have created a split in agricultural policy frameworks, with approximately 80 percent of agriculture (measured by sales) receiving modest government budget support and little border protection. This majority of agricultural producers receive world prices for their products, and collect a small level of support when world prices fall. The dairy (and poultry) sectors on the other hand remain heavily protected.

The dairy industry's supply management system has successfully achieved many of its initial objectives including increased farmer income, price stability for producers and consumers alike through methods of decreasing price instability and predicting price changes, as well as providing an adequate continuous year round supply of dairy products. In addition, farm family incomes in the dairy industry exceed the average family income of all other farm types (except poultry) and are higher than the average Canadian family income.

Several elements of the supply management system have however, imposed rigidities that constrict adjustments to more competitive forms of industry regulation. The supply management system in place in Canada limits the degree of rivalry in the processing industry through factors such as restrictions on the movement of fluid milk between the province of origin, barriers to entry associated with quota systems (including plant supply quotas in some provinces), domestic industry protection from import competition, and difficulties incurred by processors in obtaining raw milk supplies for particular manufacturing purposes. The provincial authority of price regulation for both fluid and (in most provinces) industrial milk, constrains competition within the industry on the basis of price. From 1970 to 1992, the number of dairy processing plant numbers decreased from 880 to 308, allowing the remaining plants to increase in size (Agriculture and Agri-Food Canada 1996).

Barichello (1981) noted that at the time of his publication, 30 percent of the federal agricultural budget was spent on the dairy industry. The dairy industry received the largest percent of all the agricultural sectors. In addition to these federal expenditures, consumers also bear a brunt of the costs of support. In fact, compared with the United States and other major competitors, Figure 2.4 illustrates that Canadian dairy prices are higher at all levels from farmers to consumers, and have also increased at a faster rate.

Figure 2.4: Consumer Price Indices for Canadian and U.S. Food and Dairy Products 1978-1992
Index: 1978 = 100



As noted previously, price discrimination is extremely evident in the Canadian milk market. In the1992/1993 dairy year (measured from August 1 through July 31) for example, over 50 different prices were charged for milk according to end-use and province of production (Agriculture and Agri-Food Canada 1996).

Today government regulation, in particular the supply management regime, remains a controversial topic, both domestically as well as receiving criticism from trading partner countries. Although it may have worked as a short-term solution, the ramifications of this decision years later involve a long-term commitment to the continued management of prices and supply and the development of increasingly rigid, unresponsive markets.

Protection in the dairy has remained strong because of the prohibitively high over TRQ tariffs (in the range of 100 percent to 250 percent) and small (3 percent to 10 percent of consumption) TRQ quantities. This system generates large economic rents. Farm level quotas are tradable and Statistics Canada estimated the value for the dairy and poultry industries as $24 billion in 2003. This works out to at least $1 million per farm, or $20,000 per cow in the dairy industry (Barichello, Josling and Sumner December 2005). With these values at stake, and in view of the annual net income flows that must exist to generate these quota values, there are very strong and effective lobbies defending them against any reforms, including reductions in trade barriers. These policies thus far have weathered all major trade agreements, many changes of government, widespread public debate, and numerous legal challenges by farmers and others inside and outside the system.

U.S. Agricultural Regulation: As in Canada, agriculture in the United States has long been characterized by price and quantity restrictions.

Government programs effectively guarantee minimum prices to growers of major crops such as cotton, rice, wheat, corn, and soybeans. Sugar and tobacco are marketed subject to government quotas, and many fruits and vegetables are subject to marketing orders that limit the quantity and quality that may be offered for sale (Anonymous).

There are three inter-related forms of government intervention affecting the U.S. dairy market. These include a price support program under which the federal government stands ready to buy selected storable dairy products at minimum prices; trade policies, including both import barriers and export subsidies that protect the U.S. domestic market from competition; and a marketing order system that regulates both regional milk prices paid by users and the way in which these prices are translated into farm level prices.

Price Support: The United States Department of Agriculture (USDA) will purchase butter, non-fat dry milk (NDM), and American cheese from processors at prices which are calculated to ensure that the farm price of milk used for the manufacture of those products will be above the legislated support price. Since 1990, a tax on milk production has been charged in order to limit milk output and offset dairy program budget costs.

Trade Policies: In 1995, the U.S. system of absolute quotas changed to a system of TRQs as a part of the Uruguay Round trade agreement. The TRQs are high enough to still limit imports of dairy products into the country. Subsidized exports have been used for years in order to dispose of excess stocks of dairy products acquired under the price support program.

Marketing Orders: Milk marketing orders are in place to establish specific minimum prices that must be paid for milk according to its end-use class (also known as classified pricing). These marketing orders are regional unlike the federally legislated price support programs and trade policies. Some regions have no marketing orders.

Agricultural support systems in the U.S. are no less controversial than those in Canada.

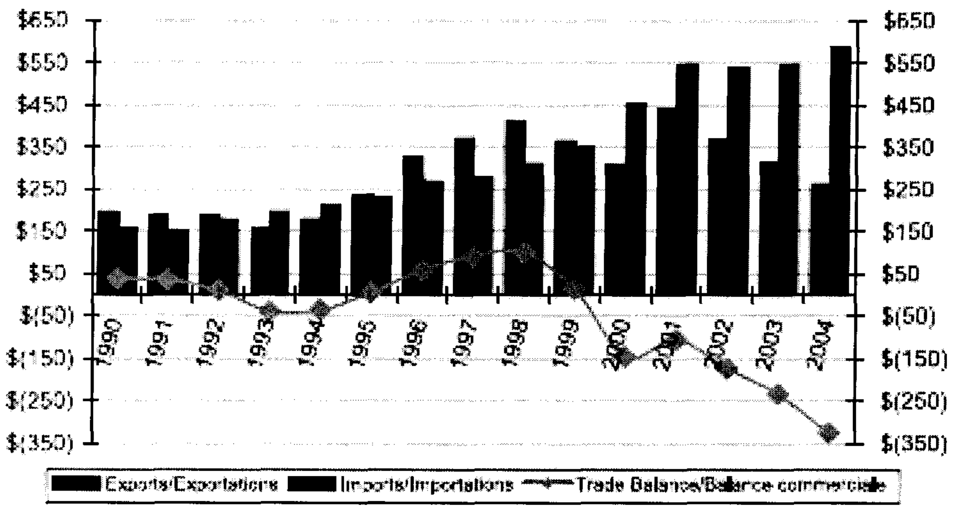
International Opportunities: Trade of agricultural products makes an important contribution to the Canadian economy. Canadian farmers export more than half of what they produce and imports consist of a third of total agricultural consumption.

Dairy products in particular, account for a relatively small fraction of Canada's agri-food exports, on the scale of one to two percent (Agriculture and Agri-Food Canada 1996). Domestic industry operations under a national supply management system have been largely insulated from international markets by the combination of quotas, tariffs, and other import control, industry support, and price stabilization arrangements discussed above. Canadian owned companies therefore, have comparatively little experience in dairy industry operations outside the domestic market. The largely domestic and regional focus of the Canadian dairy products industry limits participation in more dynamic markets elsewhere. It also limits development of expertise in international production, marketing, sales and distribution characteristic of more internationally oriented competitors in Europe, New Zealand, and the United States. In fact, while U.S. dairy imports to Canada make up approximately ten percent of total U.S. dairy exports, Canada accounts for only two percent of dairy import suppliers for the U.S., with the majority of dairy imports to the U.S. coming from more internationally adapt regions such as Western Europe (Levy Fall 2000).

The major export markets for Canadian dairy products in 2004 were the United States who received 48.1 percent of total dairy exports, the European Union receiving 12.2 percent of total dairy exports, and South Korea receiving 6.0 percent. The main dairy products exported by Canada in 2004 (in monetary value) were cheeses (28.9%), followed by dairy spreads (18.3%) and skim milk powder (14.9%). Canadian exports of liquid yogurt to the United States are not subject to tariff rate quotas or tariffs. Interestingly, this is the only Canadian dairy product that has had uninterrupted growth in exports throughout the past four years.

Canada's main dairy suppliers are the EU-25 who supplied 41.2 percent of total dairy imports, the United States who supplied 24.3 percent, New Zealand, who provided 24.1 percent, Switzerland providing 4 percent and finally Australia, who shipped 1.7percent of Canada's dairy imports. Canadian dairy imports increased by 7.4 percent over the past year, to $588.1 million. In terms of quantity, imports totaled 184.9 million kilograms, up 5.2 percent from 2003 (Agriculture and Agri-Food Canada - Dairy Section, Canadian Dairy Commission, and Dairy Farmers of Canada). Figure 2.5 shows the trade balance trend over the last two decades.

Figure 2.5: Canadian Dairy Trade Balance
(millions of dollars)



Source: (Agriculture and Agri-Food Canada - Dairy Section, Canadian Dairy Commission, and Dairy Farmers of Canada).

During the 1990s, a larger production base and lower dairy prices observed in the U.S. caused the U.S. to be a net exporter of dairy to Canada. In 1990 dairy imports to Canada from the U.S. totaled $35 million, while by 1995 U.S. dairy imports to Canada rose to a total value of $71 million. During the same time, U.S. imports of dairy from Canada also increased. In 1994 imports from Canada to the U.S. totaled $19 million, rising to $70 million in 1996. (Levy Fall 2000).

2.2 Trade Agreements

Beginning in 1948, the General Agreement on Tariffs and Trade (GATT) provided the rules for much of international trade and was intended to create a third institution to handle the trade side of international economic cooperation. Over 50 countries participated in negotiations to create an International Trade Organization (ITO) (World Trade Organization 2007).

In initial SM schemes, the CMSMC chose a quantity and price for dairy which caused very few, if any, imports to be permitted. This system of eliminating imports and inflating the price, created rents for domestic dairy producers.

However, under GATT negotiations, all import quotas were to be replaced by the system of tariff-rate quotas (TRQs). With a TRQ, a small quantity "in-quota" or Minimum Access Commitment (MAC) imports are permitted into the country with a relatively low level tariffs (in 1995, the MAC was set at three percent of 1988-86 domestic consumption, which rose to five percent by the year 2000 (Baylis and Furtan 2003, 145-161). The remaining "over-quota" imports are then subject to much higher tariffs. In the case of Canadian dairy, over quota tariffs were in excess of 250 which remained high enough to prohibit most imports.

In 1987, Canada and the United States signed the Canada-United States Trade Agreement (CUSTA) which came into force on January 1, 1989. Under this bilateral agreement, all tariffs on dairy products (that were not included on the Import Control List (ICL) subject to the GATT rules) were to be phased out completely out over the period of ten years. (Barichello and Romain 1996).

Then in 1992, the North American Free Trade Agreement (NAFTA) was signed by Canada and the agreements under CUSTA were integrated into the new NAFTA.

In 1993, the Uruguay Round Agreement (URA) was signed under the World Trade Organization (WTO, formerly the GATT). Prior to the Uruguay Round of the GATT, a quota (quantitative border restriction) was used to restrict dairy imports, with imports being allowed in only when needed to maintain a stable domestic consumer price. The URA required that all quota and non-tariff barriers were to be replaced by tariffs. This would later cause some confusion as under NAFTA, all tariffs were to fall to zero.

Members of the Organisation for Economic Co-operation (OECD) continue to negotiate bilateral and regional free trade agreements (FTAs). Many FTAs contain agricultural provisions, although many omit them. Negotiations on the Doha Development Agenda did not advance significantly in 2005-06. Some areas, such as trade facilitation discussions, have been progressing. Talks paused and then resumed, but agreement has not yet been reached in many areas. Agriculture remains an area of particular difficulty with significant issues still outstanding on all three pillars of the negotiations.

Canada has long supported open markets and free trade in all but the dairy and poultry sectors, which remain highly protected. In the bilateral CUSTA negotiations, in the trilateral NAFTA negotiations, and in the multilateral Uruguay Round negotiations, Canada fought to preserve its right to maintain supply management. Thus far, none of these negotiations have had a major effect on Canada's industry. Tariffs on dairy products remain high even after the 15 percent reductions that were required under the Uruguay Round of the GATT. Tariffs on butter and cheese remain prohibitive, at levels of 298.7 percent and 245.7 percent respectively (Reguly 2004, 2). Pressure has been mounting however from both the United States as well as other countries for Canada to remove the restrictive trade distorting policies which protect its dairy industry. Many countries including Switzerland, Australia, New Zealand and Korea amongst others, who originally backed up Canada's arguments for protection have since lowered their supports and no longer agree with Canada's views. Thus it is becoming increasingly clear that Canada will need to modify the current supply management system to allow for more a more internationally accessible dairy market. In the 2004 discussions of the Doha Round, the Trade Minister Jim Peterson admitted that Canada's fight to preserve supply management is falling on deaf ears. In an interview regarding this fact he was quoted as saying:

"In terms of supply management, and in the case of the Wheat Board, I have to be honest with you, we were under attack. It was one against 146. We had absolutely no allies at the negotiating table" (Reguly 2004, 2).

Helped by high commodity prices and WTO commitments, the use of export subsidies is on the decline, and so is their product coverage. Canada however, still used the full volume and value of permitted export subsidies on dairy products. Producer support levels also saw a decline in 2006 for most countries except notably Mexico and Canada. In Canada, progress has been made in reducing the level of producer support and reliance on the most distorting forms of support, with the exception of producer support for milk, eggs and poultry.

Canada/US Relations: The United States and Canada maintain the largest bilateral trading relationship in the world. In fact Canada is the largest single-country trading partner of the U.S. In 2005, total merchandise trade (exports and imports) exceeded $ 499.3 billion (Fergusson 2006).

It is not surprising that these two counties are trading partners due to their geographical proximity, similar culture, similar standards of living, and similar economies (both affluent and industrialized). Trade continues to grow and fortunately Canada is increasingly becoming an important market and source for U.S. trade. In fact from 1975 to 2004, Canada's exports to the U.S. grew by 8.4 percent annually (Barichello, Josling and Sumner December 2005).

While the economies of the two countries are similar, they diverge in numerous ways. The U.S. economy dwarfs that of Canada. The Gross Domestic Product (GDP) of the U.S. is over 11 times that of Canada in nominal terms. As a sector, agriculture in Canada makes up two percent of the GDP, while in the U.S. agriculture accounts for one percent of the GDP.

Agricultural trade has long been an integral feature in the trade relationship between Canada and the U.S. Since 1975, both the import and export shares have about tripled. By 2005, Canada supplied almost 21 percent of U.S. agricultural imports and was a market for 17 percent of U.S. agricultural exports (Sundell, P. and Shane, M. 2006). Canada experienced gains of over 92 per cent in its agri-food exports in 2002. Even with new markets for Canadian agri-food exports such as Mexico, exports still continued to consolidate in the United States, which took in over two-thirds of Canada's agricultural shipments in 2002 (Agriculture and Agri-Food Canada - Trade Service).

In fact trade of agricultural products accounts for approximately nine percent of all Canada-U.S. trade and is estimated to add up to a value of $ 45 billion annually. (Barichello, Josling and Sumner December 2005).

With such large trading volumes and high value of this trade relationship, some tension is inevitable. Most of the trade between the two countries occurs without dispute, however there do exist some contentious issues. Disputes concerning softwood lumber, an agreement on which has recently been implemented, wheat and the disposition of antidumping duties have been addressed by dispute settlement bodies at the WTO and NAFTA. A disproportionate number of these trade disputes tend to revolve around the dairy industry. Of the 51 complaints made by the Canadian International Trade Tribunal (CITT) between 1988 and 2003, 29 percent of these involved agricultural commodities. Out of the 12 cases brought up by the U.S. International

Trade Commission (USITC), 23 percent were related to agriculture (Barichello, Josling and Sumner December 2005).

Considering that agricultural commodities account for only nine percent of Canada-U.S. trade, it appears that agricultural trade is a particularly controversial issue. This is not a surprising observation in view of the particular protectionist policies held up by both countries.

In December 2005, Canada placed antidumping and subsidy duties on unprocessed grain corn from the United States. However, in April of 2006, the Canadian International Trade Tribunal ruled that these imports of U.S. grain corn have not caused nor pose to threaten Canadian domestic producers. This has meant that Canada may no longer collect duties and must refund those already collected.

In 2002, the U.S. Commerce Department alleged that the Canadian Wheat Board (CWB), a state trading enterprise that markets grain produced by western Canadian farmers, was subsidizing Canadian growers through loan guarantees and limiting transportation costs by subsidizing railcars. These subsidies, U.S. producers contended, encourage dumping of Canadian wheat into the U.S. market at below-market prices. The U.S. began antidumping and countervailing duty investigations on Canadian wheat.

Although both Canada and the U.S. share a common theme of having long supported agriculture, these domestic policies have diverged more recently. While U.S. governmental policy programs focus on providing farmers with protection against price volatility, Canadian policies tend to subsidize individual farms based on changes in net returns, and several sectors including the dairy industry continue to rely on supply management. Most of the recent policy changes made in the Canadian dairy industry have not addressed issues such as the higher prices faced by Canadian producers, processors and consumers than their American counterparts. As well, though the dairy industry in both nations is highly supported (in comparison to other agricultural sectors), the level of support in Canada remains higher than that in the U.S. For example, from 1980 to 1995, the average level of support for Canadian dairy was 69 percent while the U.S. level of support during the same time frame was 58 percent. Wheat support in Canada was only 29 percent, while in the U.S. the wheat market obtained a level of 23 percent support (Levy Fall 2000).

These differences in policy remain a major source of contention and current dairy trade tensions between the two countries.

Dairy Disputes: Prior to the Uruguay Round of debates in 1995, there were relatively few disputes involving the dairy industry, as previous agreements such as CUSTA and NAFTA left both countries' dairy policies relatively unaffected.

Although there exist no formal technical barriers preventing Canadian dairy from accessing U.S. markets, (Phillips 1996) argues that Canada is restricted through the use of non-tariff barriers as well as the Pasteurized Milk Ordinance which sets restrictive standards. He goes on to state that "The greatest barrier to future trade liberalization is the harassment potential of U.S. trade actions" (Phillips 1996 134).

In 1996, the U.S. brought a complaint regarding whether NAFTA or URAA had priority in the setting of import tariffs. While the URAA required that import quotas be replaced by tariffs, NAFTA required that tariffs fall to zero, following an implementation period. The U.S. reasoned that NAFTA prohibited tariff increases and required that the tariff reduction conform to the established time-period. However, the original CUSTA maintained preexisting quotas (at U.S. insistence) and allowed new ones for the U.S. under its GATT waiver. Canada argued that the intention of CUSTA was to continue to provide special protection to certain sectors and the URAA simply altered the form of protection from quotas to tariffs. This dispute covered margarine and supply managed poultry products, as well as dairy products. A NAFTA panel accepted the Canadian argument.

In 1997, the United States once again brought up a complaint with Canada regarding the subsidization of its milk product exports (New Zealand joined the U.S. argument a year later). The U.S. and New Zealand complained that some of Canada's categories for pricing industrial milk violated Canada's export subsidy commitments under the URAA. New agricultural export subsidies had been prohibited under the URAA, and Canada did not notify its trading partners of any previous export subsidies on milk products. The price of milk to be paid by processors for these special export classes was below the price of milk paid for products consumed domestically, leading the U.S. and New Zealand to claim that this constituted an export subsidy. Canada argued that this was not a direct subsidy because it was neither funded nor paid directly by Ottawa. After a five year dispute, the WTO panel decided that Canada was providing a direct export subsidy, which violated its commitments.

In 1998, a third dispute arose from a complaint, again brought by the U.S. which involved Canada's implementation of the tariff rate quota for fluid milk. The U.S. took issue with the unconventional procedure that Canada had regarding fluid milk quota levels. Rather than specifying a quota level and giving trading companies the right to import that quantity of milk, Canada implicitly gave this right to individual consumers who were buying fluid milk in the U.S. and bringing it into Canada. The amount of milk actually imported depended on how much consumers would choose to bring back, and this quantity was calculated by consumer responses to a sample survey. This case was resolved in Canada's favour.

Simply following the status quo means that Canada will continue to bear the costs of these disputes, lose possible domestic economic gains and maintain its relatively weak status not only in bilateral, but multilateral trade negotiations as well.

Options for Canada: As fore mentioned the current government policy of supply management is highly controversial and has several opponents. It is important to consider alternatives to this case, not only for the sake of domestic consumers, but also in the view of upcoming changes in trade agreements and requirements. The focus of this paper is to reveal in what way free trade will affect Canada as a competitor in more competitive situations. The scope is not broad enough to go into detail but there are a few good sources that propose recommendations for what Canada can do in terms of transitioning from the status quo to a more competitive environment. For details of some options the interested reader may refer to Barichello (1981) who analyses two main options, one being deregulation of the domestic market while retaining import restrictions. The outcome being consumers seeing a gain, producers realizing a loss and the domestic price of milk would fall. This option may be too late to put into place as the competition's main complaint with Canada is the import restrictions. The other more drastic but realistic alternative would be complete deregulation resulting in a competitive domestic market and no international trade restrictions. Barichello (1981) estimates that under this option, total milk production would decrease, consumers would gain, producers would realize a loss, and an amount of the current domestic production of milk would be lost to international markets. As there would be sizable economic rents lost by producers by dismantlement of the supply management system there would be some compensation required.

Michael Hart (Hart April 2005) looks to the conversion of the Canadian wine sector from a mainly domestic market to an international competitor; as well as to Australia's successful transformation of dairy policies that were once similar to Canada's.

Prior to the 1980s, the Canadian wine industry was regulated through forced consumption and trade barriers. After the bilateral trade negotiations with the U.S. in the 1980s, Canada committed to a six year phase out of the existing policy and throughout the course of the six years offered compensation for adjustment purposes. The result today is a prize winning, internationally successful Canadian wine industry.

Australian dairy farmers once relied on support structures similar to Canada's. In 1999 the government began a phase out program of the supply management system into a market based system. The results have been increased production as well as international export opportunities. Australia now in fact exports over 55 per cent of their total milk production at international prices (Dairy Australia).

For more extensive consideration of this topic, the interested reader should refer to Barichello and Romain (1996).

2.3 Research and Development

Research and development is imperative in any industry not only to remain competitive, but as well as to expand and improve. Economic growth is grounded on the utilization of scientific knowledge gained through R&D efforts. R&D may be used to improve products or lower the cost of production of already existing technologies. The incentive to innovate is the difference in profit that a firm can earn if it invests in research and development compared to what it would earn if it did not invest.

Although the true economic worth of research is tough to forecast, there exits much evidence that R&D is an important determinant of productivity. Many studies have proven that the rate of return on agricultural R&D is quite high. (Ulrich, Furtan, and Schmitz 1986, 103-129) notes that in a study on hybrid corn research, the rate of return was over 70 percent.

Demand for new livestock technology by farmers is derived from consumer demand for the final products. Industrial demands for dairy-based manufacturing inputs derive from the use of particular milk constituents in the manufacture of products such as pharmaceuticals, virus combatants, beauty aids, glues, or knitting needles, as well as from their functional properties in such areas as immunology and the combating of tooth decay. Thus it is important to maintain R&D funding in these areas in order to continue to provide quality products to meet demands.

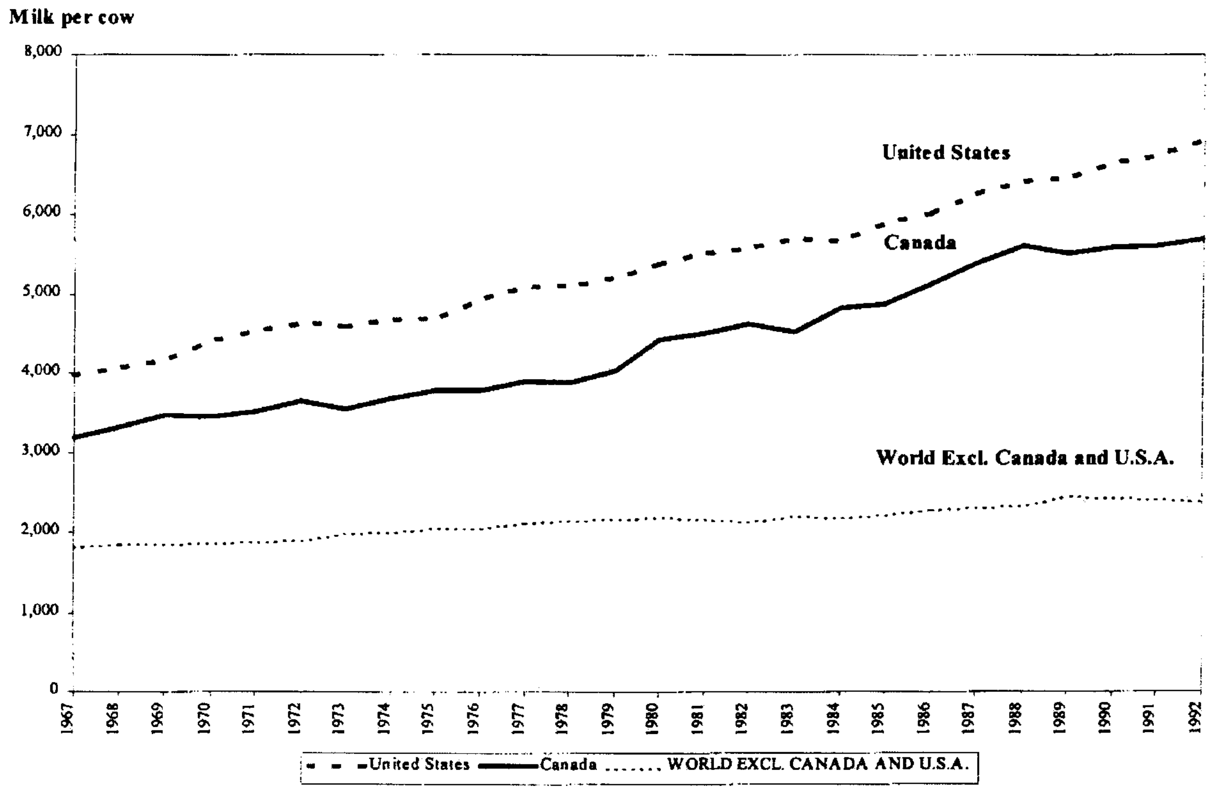
Improvements in filtration technologies are enhancing the ability to extract specific ingredients and to develop niche market products. These technologies are also allowing the extraction of water reducing the volume and the weight of the product allowing for transportation over greater distances.

Milk production research in Canada embraces a wide variety of topics. Cattle nutrition and health, along with genetic improvement, are now traditional areas of study. Better feeding, disease control and genetic advancements have increased the amount of milk produced per cow.

Government policies in areas such as dairy food safety and quality regulations, as well as research and technology development activities contribute positively to both cost and product competitiveness. In 1991-1992, total federal, provincial and industrial investment in dairy related R&D was $130 million (Agriculture and Agri-Food Canada 1996).

Major advances have occurred in the past decade to improve reproductive technology. They speed up the process of genetic improvement, reduce the risk of disease transmission, and expand the number of animals that can be bred from a superior parent. In addition to these innovations, genetic improvements such as embryo transplants, improved methods of genetic evaluation and selection, as well as enhancements in management practices have been a factor in the increase in cow productivity. These improvements are augmented by developments in biotechnology such as the recent introduction of recombinant bovine Somatotropin (rbST). rbST is a synthetic hormone which has been found to increase milk production in cows. Recent estimates suggest that national production increases in the order of 4 percent are realistically attainable, although for individual cows the increase may be as high as 10-15 percent (Agriculture and Agri-Food Canada 1996) (while rbST is currently being used in the U.S., Canada has banned the use of this hormone due to animal health and welfare concerns), and although average yield per cow in Canada is below that for the United States (see Figure 2.6) productivity per cow has increased continually over the past several decades, a positive trend which can be attributed to the R&D in this area.

Figure 2.6: Average Yield Per Cow for Canada, United States, Rest of World



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Financing of R&D: The benefits of R&D funding in agriculture are not realized immediately, and farmers on their own find it difficult to finance this important initiative. (Ulrich, Furtan, and Schmitz 1986, 103-129) cites in his paper that the benefits of R&D expenditures in agriculture have a mean lag time of seven years. Once the R&D expenditures stop however, the benefits continue to flow as long as the new processes are being utilized. In part due to this long lag time of realizing benefits, R&D funds are susceptible to being underprovided.

Canadian public research institutions are turning increasingly to the private sector for additional financial support. In the short run, this lessens the need for public research expenditures, but may, in the long run, be very costly to the economy as a whole. Worldwide as well, the role of the private sector and, in particular, industry and commodity groups in supporting agricultural research programs has increased. In developed nations, private spending on agricultural R&D increased from U.S. $4 billion in 1981 to over U.S. $7 billion in 1993. On the contrary, public funds into agricultural R&D increased relatively slowly at an annual growth rate of only 1.8 per cent (Alston, Pardey, and Smith 1998, 51-82).

Dairy research dollars in Canada are provided mainly through the Federal Government and various producer organizations. In 1991, the governmental share of research expenditures was 31 percent of the total, while the private sector contributed 69 percent of the total (Agriculture and Agri-Food Canada 1996). Government contributions to R&D involve work done collaboratively between the government, universities and private institutions.

The Dairy and Swine Research and Development Centre is a national research centre with a mandate of ensuring that the Canadian dairy sector remains competitive. Most of the research done through the Dairy and Swine Research Centre is focused on process development rather than product development (Agriculture and Agri-Food Canada 2007).

The University of British Columbia recently built a research facility that puts particular emphasis on the study of dairy cattle behaviour and comfort. Mastitis research has also received a lot of attention, with the creation of the Canadian Bovine Mastitis Research Network in 2002. This research network is funded mainly through the Natural Sciences and Engineering Research Council of Canada (NSERC) as well as many private and governmental partners.

The Dairy Farmers of Canada (DFC) (the national policy, lobbying and promotional organization representing Canadian dairy farmers) outline their priority research areas as including the following: realizing greater efficiency; improving animal health and welfare; improving dairy research facilities in Canada; as well as making funds available to finance genetic improvement and breeding programs.

In 2005, three of the 19 agri-food related research centres of Agriculture and Agri-Food Canada (AAFC) put a particular emphasis on dairy (Agriculture and Agri-Food Canada - Dairy Section, Canadian Dairy Commission, and Dairy Farmers of Canada).

Table 2.4 shows the breakdown of funding in particular areas of dairy research in 2005 by group [3].

[3] This Table shows static data from 2005. It would be interesting in future studies to note a time trend in funding sources.

Table 2.4: Various Financing Groups and Research Areas in 2005

	Research Area	Milk Production	Genetic Improvement	Processing
Funding Source				
AAFC		3,998,000	500,000	1,085,000
DFC		750,000	400,000	NA
Novalait[4]		250,000	NA	250,000
NSERC		1,200,000	NA	900,000

Data Source: (Agriculture and Agri-Food Canada - Dairy Section, Canadian Dairy Commission, and Dairy Farmers of Canada).

The United States tends to invest more into R&D than does Canada (as a percent of GDP) (Fergusson 2006). This could account for the higher productivity per cow obtained by the U.S. over Canada as displayed in Figure 2.6.

In an analysis comparing North American dairy production, it was found that Wisconsin fluid mild producers have a comparative advantage over Alberta fluid milk producers. This is probably due to the faster rate of improved facilities, management ability and herd gene make up through increased R&D efforts (Jeffrey and Richards 1996).

2.4 Spillovers

R&D is unlike expenditures on conventional goods and services because R&D has properties of a public good. After discovery of a new product or process, others can use the invention at a cost that is a fraction of the cost of the original discovery.

The profitability of research can be undermined if other firms are able to copy a new technology and sell it to producers, or if farmers can reproduce the technology themselves. This phenomenon is termed the "spillover effect." Copiers can afford to use or sell the technology more cheaply than the original inventor because they do not have to recoup the initial sunk costs of research and development.

Market failure in agricultural R&D seems to be widely taken for granted. The main reason is the inability to capture all benefits. Competitors can "free-ride" on an investment in research, using the results and sharing in the benefits without sharing in the costs. Hence, private benefits to an investor (or group of investors) are less than the social benefits of the investment.

[4] Novalait is a major source of funding for dairy research in the province of Québec. It is a 50/50 partnership between dairy producers and processors. Its investments generate an additional $1.5 million in investments from other sources.

Studies have shown that private R&D efforts provide both private as well as social gains, with the social being up to twice as high (Ulrich, Furtan, and Schmitz 1986, 103-129), and as a result, some socially profitable investment opportunities remain unexploited.

There are two main negative effects of the inability to appropriate all gains from R&D expenditures. The first is a reduction in the expected return of innovation, the second being a reduction in the loss stemming from a failure to invest in R&D, since a firm can gain from the competitor's investment. In fact, the greater the extent to which the research innovations are adopted by competitors, the lower the producer benefits for the innovator (Brennan, Aw-Hassan, and Nordblom 2003/0, 471-485).

For this reason, the private sector is likely to under invest in research and the active participation of government in supporting science and technology can improve economic well-being.

Spillovers occur not only at the domestic firm level, but also internationally. In a world with international trade in goods and services, a county's productivity will depend not only on its own R&D, but the R&D efforts conducted by its trade partners. Domestic R&D tends to bring about more effective use of existing resources, as well as enhancing a county's benefits from foreign technical advances. Together these effects can raise the productivity of the country. Foreign R&D benefits a country through learning about new technologies and materials and production processes. Not only does a country's total productivity depend on its own R&D investments, but also on the R&D efforts of its trade partners. In fact (Coe and Helpman 1995, 859-887) found in an empirical study that rates of return on R&D efforts performed by foreign competitors are quite high. Past studies have shown that benefits from crop research conducted in international centers have yielded great profits for the U.S. and Australia (Alston, Pardey, and Roseboom 1998, 1057-1071).

2.5 Producer Associations

Throughout the 1900s, agricultural R&D was mainly performed through public institutions and the results of the research were openly accessible to the public (Huffman and Evenson 2006). In Canada publicly funded agricultural research has become much less common due in part to the shrinking constituency of agriculture and its diminishing influence on policy (Alston, Pardey, and Roseboom 1998, 1057-1071). As such there has been increased emphasis on the role of the private sector and, in particular, industry and commodity groups or producer associations in supporting agricultural research programs (Alston, Pardey, and Smith 1998, 51-82). Agricultural producer associations are quite common in Canada and can be found in the U.S. as well. Many producer organizations charge members a levy that is then used to finance a variety of activities such as product promotion, R&D, member education and administration. Since the early 1990s, producer groups in Canada have become key participants in agricultural R&D.

Often individual producers find research difficult to finance due to the long term, large scale and sometimes risky nature of it. As access to R&D results previously obtained through the public sector has decreased significantly, a producer association may benefit these individual producers by allowing them to collectively contribute funds towards R&D initiatives. These same producer associations may offer a stronger bargaining power to the producers as a group.

Historically, Canadian dairy processing firms were cooperatives who held leading positions in milk marketing and dairy products processing. Dairy co-operatives are producer-owned dairy processing and marketing businesses run by professional management teams. They allow producers to control more of the marketing process as their milk moves off the farm to the consumer. Today dairy co-ops play a minor role mainly in Quebec and Ontario.

The Dairy Farmers of Canada (DFC) was established in 1934 and plays the role of being the national lobby, policy and dairy product promotion organization representing all dairy producers in Canada. Funded by producers, it is a non-profit organization structured as a federation of provincial milk marketing boards, dairy producers' associations, co-operatives and national dairy breed organizations. The organization ensures that the views of dairy producers are considered in any matter pertaining to the industry.

The Canadian Dairy Commission came into existence in 1966/67. It administers the National dairy policy and its objectives include providing dairy producers the opportunity of obtaining a fair return for their labour and investment capital as well as providing a continuous and adequate supply of high quality dairy products of high quality to consumers. The CDC has three main roles; those being to set national target prices for milk, purchase butter and skim milk at these prices if prices fall below a certain threshold, to collect producer levies, and with advice from the Milk Supply Management Committee, set the output level. The Commission co-operates closely with provincial governments, milk marketing boards and agencies, as well as producers, processors, further processors, consumers and exporters. Prior to 1995, the CDC received money from levies collected by provincial boards and agencies. Under the WTO agreement that came into place in 1995, it became illegal to collect levies from producers so in 1996, a national quota market was created.

Many researchers believe that levies are an under-used source of funding for R&D. In New Zealand, marketing boards have used levies to support market development and research programs since the 1920s. In 1990, the New Zealand government passed the Commodity Levies Act under which industry groups were given authority to impose mandatory levies to fund sector-specific research and other market improvement activities. As a result, new commodity group funds have been established for several agricultural products such as kiwi fruit and tomatoes. Similar legislation has been used in Australia since the mid-1980s. Legislation in 1985 and 1989 created R&D corporations to manage research funds generated by industry levies with dollar-for-dollar matching funds to be provided by the government (Alston, Pardey, and Smith 1998, 51-82). These ventures have provided these nations with the ability to conduct R&D in order to remain internationally competitive.

CHAPTER 3: THEORETICAL CONSIDERATIONS

This chapter will begin with a literature review of theories that discuss the way in which various market structures affect the level of research and development efforts undertaken. In this examination, Canada's currently supply managed dairy industry will be considered a monopoly since (for simplicity) we assume closed borders with no imports or exports of dairy (in this paper the term "free trade environment" will be synonymous with a competitive environment, and the term "supply management regime" will infer a supply restricted situation).

Following a brief literature review, the model will be introduced. To begin with, the model will assume a closed border, supply managed system with no spillovers. Next the benchmark case will be presented which involves a closed economy, with a competitive market. Both of these models will then be assessed assuming spillovers are present, and the results will be proven analytically along with some intuition behind the results.

In the next section of the chapter an open economy model will be used. This section searches for a Nash Equilibrium in a non co-operative two player game. First of all a base model will be introduced which can be modified for the cases in question. The base model is first modified to show the impact of pure competition, in which there exists identical market demand and pre R&D production costs for both countries. Next a pure market scale effect is studied where the domestic producers are assumed to have a smaller market share when the border opens. Each of these cases is examined first with no spillover and then with a spillover, and the results are presented along with some intuition behind the outcome.

3.1 Review of Relevant Articles

In order to maintain an effective supply management marketing system Canada's dairy industry has largely been protected from import competition. The main concern facing Canadian dairy farmers is the potential for increased import competition. Of major interest in this paper, is the question of whether or not R&D incentives will increase under a competitive open economy as compared to the current closed supply managed system. This section provides a brief overview of relevant studies previously done on how market structure affects innovation. Although there remain conflicting opinions, these studies are important, since understanding which market structures are most conducive to innovation is a key policymaking issue.

Various theories show that a competitive environment stimulates more R&D than does a monopoly situation. These theories are based on the findings of Arrow (1962) who showed that if a firm does not worry about a competitor creating a new product or cost saving production method first, they will have less of an incentive to invest money into the R&D required to realize this opportunity. Under the assumption that an innovator has perfect and perpetual exclusive property rights to its invention, Arrow (1962) shows that a pure monopoly unexposed to competition for existing and new technologies has less incentive to invest in R&D for a process invention than does a firm in a competitive industry. A firm in a monopoly position obtains a flow of profit that it enjoys even if no innovation takes place. Arrow (1962) shows that a competitive firm earns profits from new processes over more units than a monopoly does. In this theoretical model, the full social benefits of input cost reducing R&D are greater than the return to a firm in a competitive industry, which are higher in turn than the returns realized by a monopolist. These findings would support the assumption that R&D tends be under-invested in, regardless of whether or not the market is a monopoly or competitive environment.

Consistent with this contention is the fact that in the presence of competition, firms who fail to innovate end up producing at a higher cost than their competitors resulting in lost market shares. In terms of the dairy industry, in an unregulated, competitive market, advanced technology will cause a decrease in milk prices, which in turn will increase the disparity between those producers who adopt the new technology and those who don't, providing more incentive to invest in this research.

Gilbert (2006, 159) summarizes that competition is likely to provide greater incentives for innovations under certain conditions. First of all, competition in the pre-innovation market must be relatively intense, which lowers the pre-innovation profit for a competitor and increases its incentive to invent. The second condition is that the innovation must make the old technology obsolete, which means that the monopolist's gain from the innovation does not exceed the gain obtained by a new entrant [5].

Other theorists believe that monopoly power promotes R&D more so than competition. The Schumpeter hypothesis shows a positive relationship between monopoly power and innovation.

Schumpeter (1950) hypothesized that technological change would be greater in industries in which firms could exercise some monopoly power, as this would provide them greater incentive to invest in research and development. Through exercising monopoly power to raise

[5] This condition is based on the assumption that the monopolist will face competition in the near future. In many monopoly situations the monopolist is protected from competition by various policies as is the current case of the Canadian dairy industry.

the price of its products, a firm may recoup the costs of product innovation. A monopolist may also have greater incentive to invest in R&D in order to deter potential entrants in the market (see footnote 5).

The Schumpeterian hypothesis (reducing the number of firms reduces the probability that none of them invests in R&D) is validated by Dasgupta (1988, 66-80). The explanation is that with many firms or producers, each of them tries to free-ride on the positive externality of any of the competitors. As soon as there is one innovator, the others who imitate benefit more. The greater the number of competitors, the more pronounced this free-ridership becomes. By limiting the number of competitors, a stronger drive to rely on one's own efforts in order to get an innovation is established.

In conclusion, under the assumption of non-exclusive rights to process innovation, competition decreases R&D incentives, both because it lessens the amount of cost-reduction realized by each firm and because it results in redundant R&D expenditures.

There does not appear to be a monotonically increasing relation between concentration and innovation. On the contrary, Kamien, M. and N. Schwartz (1968), find that a market structure intermediate between monopoly and perfect competition promotes the highest rate of inventive activity (Cayseele 1998, 391). This is because there are both positive and negatives involved in each situation. In highly competitive markets the incentive to innovate may be low because the innovator's small scale of operations may limit the benefit it gains from a new technology. In markets that are highly concentrated (monopolies), Arrow's findings may dominate. As well, monopolies that are protected from innovation competition are reluctant to innovate because they merely replace one profit flow with another, while new competitors capture the entire benefit of an innovation. But with non- exclusive rights, competitive markets limit incentives to innovate because the innovator can appropriate only a fraction of the total benefits.

In an empirical test of Schumpeter's hypothesis, Scherer (1980) found that some monopoly power does encourage private investment in research, however too much monopoly power in an industry actually reduced the incentive to innovate (Narrod and Fuglie 2000, 457-470). Levin, Cohen, and Mowery (1985, 20) initially found an inverted-U relationship between industry concentration and both R&D intensity and the rate of introductions of innovations which is consistent with the findings of Scherer, however the results were less significant under later investigations which included more variables.

Although the theories and results are inconclusive, Gilbert (2006, 159) observes a general trend. That is, the incentives to invest in R&D increase with the profits that a firm can earn or protect by innovating and decrease with the profits that a firm can earn if it does not innovate.

Although the results may seem conflicting, this is not necessarily the case. Market structure involves many aspects in addition to market concentration that may affect the market structure - R&D intensity relationship. Due to endogeneity problems it is hard to empirically predict which type of market structure will cause more R&D, since innovation itself in fact tends to change market structure. It is hard to empirically test which market structure promotes R&D due to limited data on innovative activity and market competition, the inability to decipher whether or not the innovator has exclusive rights to the new technology, differences in process versus product innovations as well as differences in technological opportunities.

Timing of Research and Development: In terms of who will innovate faster, it has been found through general models that the producer who lags in R&D may initially be induced to perform more R&D than the competitor in order to catch up while exploiting the previous knowledge obtained from the rival. As success of R&D tends to increase with experience, the producer in the lead may reduce R&D expenditures while taking advantage of past investment knowledge (Gilbert, 2006). These predictions are applicable to producers in a competitive environment. A monopolist faced with the threat of competition may be induced to perform R&D faster than a competitive producer in order to keep potential entrants out of the market If the monopolist faces no threat of entrants into the market, and the spillover level is low, a competitive producer will have more incentive to invest sooner in R&D in order to realize a competitive advantage.

Open Verses Closed Economies: An additional speculation of interest to Canada is whether or not open markets will cause more or less R&D to be done in comparison to a closed market. The consensus from past literature on this topic is that open borders will create more incentive for R&D to be carried out.

An increase in the size of the potential market will strengthen incentives to invest in research that develops new products and innovations, as a larger market increases the returns to research. However, in an empirical study done by Coe and Helpman (1995, 859-887), it was found that more open economies extract larger productivity benefits from foreign R&D than less open economies, strengthening the free-rider problem. If the spillover effect is great enough, this may discourage R&D investment if each producer sees the benefits of free riding on the competitor's efforts.

Of specific interest in Canada is the quota value aspect of supply management. Coyle (1989) found that increasing dairy quota values tended to divert funds away from investment in such things as improved stock. Therefore high quota values could be threat to long-term viability of industry if foreign competitors who currently operate at lower costs are allowed to enter Canada's market. If imports are brought into Canada, comparative advantage will determine the producer who will capture the market. If Canada operated under a competitive market, access to equivalent technologies and genetic material would imply that similar rates of productivity growth could be realized and it would be a fair playing field. However, Canadian producers must invest in quotas, which as noted may divert from investing this money in R&D. Since U.S. producers do not have to divert finances towards quota, they may experience greater rates of technological progress and therefore have a greater chance of having the competitive advantage once the border opens. Canadian dairy producers may have a great amount of equity associated with the quota that they own, but this money may not have been invested in R&D under the assumption that comparative advantage has traditionally not been a concern.

3.2 Model Under A Closed Economy

In this closed economy model two cases will be modeled. In the first instance a closed supply management situation will be considered. This mimics the present scenario that Canadian dairy producers face. Next a closed economy with a competitive market will be modeled. Although this case is not likely to occur in reality, it will provide a benchmark in which to compare the rest of the results to.

3.2.1 Supply Management Model

In this two-stage model, the home county's dairy industry is under a supply management regime and protected by import restricting trade policies. Output quantity in stage 2 is set exogenously in accordance with a political process that establishes an aggregate production quota at a level which ensures producers earn a pre-defined rate of return on farm capital. This aggregate quota level, which is denoted Q^0, will be somewhere between the pure competition level and the pure monopoly level. Consumer demand is exogenous so the value of Q^0 necessarily implies a market price and a level of industry revenues. Industry revenues, together with the industry's cost function, determine stage 2 producer surplus.

In stage 1 a mandatory producer association of dairy farmers collectively contribute to R&D through an industry check-off scheme. The R&D in stage 1 reduces stage 2 production costs, which in turn increases stage 2 producer surplus (this paper considers process development rather than product development which would shift the demand curve). Define stage 1 producer welfare as stage 2 producer surplus minus the stage 1 cost of R&D. The objective of the producer association is to choose a level of R&D that will maximize stage 1 welfare taking the output quantity (determined by the quota) as fixed. It is assumed that the producer association can set the check-off levy at a level corresponding to the welfare maximizing level of R&D[6]. In effect, through its choice of R&D, the producer association is selecting the position of its stage 2 supply schedule.

This model makes various assumptions in order to keep the analysis straightforward. It is important to recognize that as the welfare of the producer association changes the regulator may chose to adjust the quota. For the purpose of simplicity this model will assume a constant quota;

(3.1) Q^0 = constant.

As mentioned above, it will be assumed that there is no trade that occurs, while in reality some exchange is made. It will also be assumed that the quota is the same level for both fluid and industrial milk. For the purpose of the model no distinction will be made between the two types. Finally, a representative farm is used as a proxy for the aggregate industry supply, whom in this case is the producer association. Additional assumptions will be stated where appropriate.

Stage 2 marginal cost for the representative producer is linear with a slope of one (for simplicity) and intercept h:

(3.2) $Q^s = -h + P$ where $h \geq 0$.

Similarly, market demand is linear with a slope of negative one, and intercept *H:*

(3.3) $Q^d = H - P$.

Production quota is set at Q^0 and will be greater than the quantity produced under a monopoly situation (Q^M) and less than the quantity produced under a competitive environment (Q^C).

The monopoly level Q^M is obtained by equating marginal cost with marginal revenue from industry demand. These two schedules are respectively given by

$$MC = h + Q \text{ and } MR = H - 2Q.$$

The optimal quantity produced in a monopoly environment is therefore

[6] This assumption implies that the voting procedures undertaken by the producer association are such that the collective welfare of the group is maximized. In reality, free-riding problems and voting procedures are unlikely to allow the optimal outcome.

$$Q^M = \frac{H-h}{3}.$$

The competitive level, Q^c, is determined by equating the producer's marginal cost with market demand. Setting equations (3.2) and (3.3) equal to each other gives the competitive price

$$P^C = \frac{h+H}{2}.$$

The quantity produced in a competitive situation can then be determined by substituting this expression for P^C into equation (3.3):

$$Q^C = \frac{H-h}{2}.$$

As indicated above, the quota will be set between the competitive and monopolistic quantity levels. That is,

(3.4) $$\frac{H-h}{3} \prec Q^0 \prec \frac{H-h}{2}.$$

The price received by the producer when selling milk and the producer's supply price can be respectively expressed as

(3.5) $P^r = H - Q^o$ and $P^p = Q^o + h$.

Producer surplus obtained in stage 2 is given by

(3.6) $$PS^{SM} = Q^0(P^r - P^p) + \frac{1}{2}Q^0(P^p - h).$$

This is illustrated by the shaded region in Figure 3.1.

Stage 1 R&D is assumed to shift down in a parallel fashion the stage 2 marginal cost function for the producer. Specifically,

(3.7) $h(x) = (h_0 - x)$

where x is the amount of R&D undertaken by the producer in stage 1 and

h_0 is a pre-R&D intercept parameter for the producer's stage 2 marginal cost function.

By substituting equations (3.1), (3.4) and (3.5) into equation (3.6), the producer's stage 1 welfare can be expressed as

(3.8) $$W^{SM} = \left[Q^0(H - 2Q^0 - h_0 + x) + \frac{1}{2}Q^{0^2}\right] - \frac{\gamma}{2}x^2.$$

Within equation (3.8), the term $\frac{\gamma}{2}x^2$ represents the stage 1 costs of doing R&D. Notice that this expression is characterized by a rising marginal R&D cost of achieving a unit reduction in stage 2 marginal production cost.

In stage 2, the producer chooses the amount of R&D to invest in during stage 1 in order to maximize stage 1 producer welfare, which is given by equation (3.8). The first order condition for this maximization can be expressed as

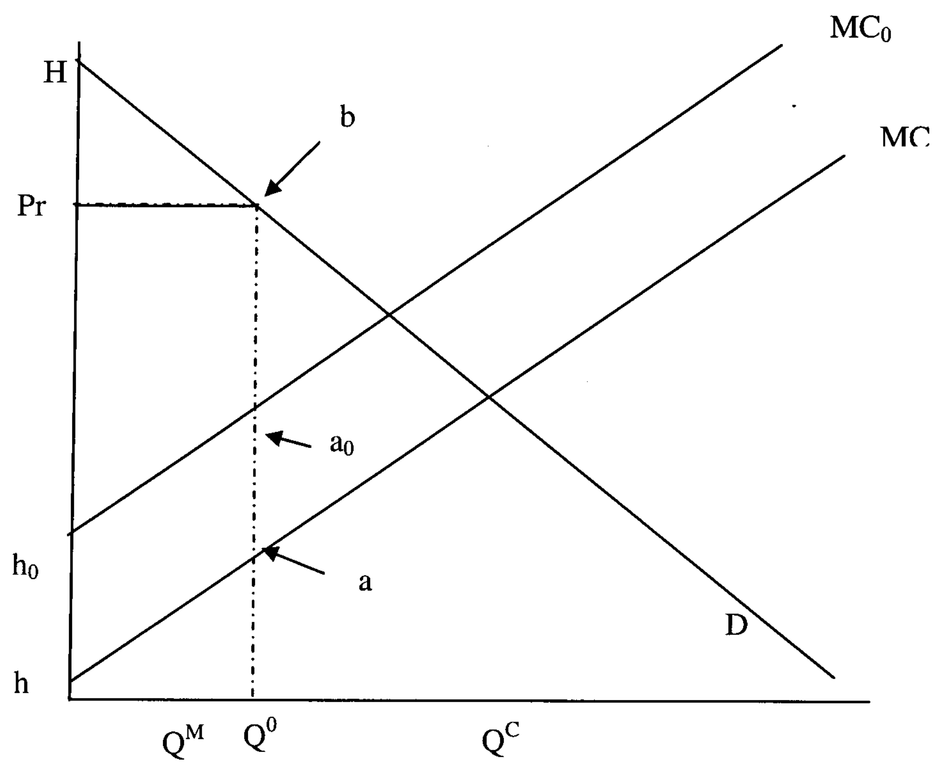
$$\frac{\partial W}{\partial x} = Q^0 - \gamma x = 0 .$$

The solution to this equation is

$$(3.9) \qquad x^{*sm} = \frac{Q^0}{\gamma} .$$

Equation (3.9) shows the optimal amount of R&D for the producer in a supply managed industry to invest in in order to maximize stage 1 producer welfare.

Figure 3.1: Stage 2 Producer Surplus



The shaded region of figure 3.1 illustrates the producer surplus obtained in stage 2. The quota level, Q^0, has been set between the monopoly, Q^M, and competitive level, Q^C outcomes of quantity. The marginal cost of supply has been reduced from MC_0 to MC through R&D efforts thereby increasing the stage 2 producer surplus from the area $P_rba_0h_0$ to the area P_rbah.

Allow R&D to spillover: Now we assume that although borders are closed, R&D knowledge spills over the border. In this case we assume that the foreign country's R&D efforts lower the unit production costs of the home country (and vice versa, although our analysis focuses only on the home country). This will affect the stage 2 marginal cost intercept of the home producer which now becomes:

(3.10) $h^s(x, x_f) = (h_0 - x - \delta x_f)$

where x_f is the level of R&D effort expended by the foreign country producer association and δ is the spillover parameter and $\delta \in (0, 1)$. A larger value for δ represents a greater amount of R&D benefits, which spill over from the foreign to the domestic producer.

Referring to equations (3.4), (3.5) and (3.10), stage 1 producer welfare can be expressed as

(3.11) $W^S = \left[Q^0(H - 2Q^0 - h_0 + x + \delta x_f) + \frac{1}{2}Q^2 \right] - \frac{\gamma}{2}x^2.$

The producer's objective once again is to maximize W^S by choosing the proprietal amount of R&D to invest in during the first stage.

The first order condition for this maximization problem can be written as

$$\frac{\partial W^s}{\partial x^s} = Q^0 - \gamma x^s = 0.$$

In this case the optimal amount of R&D to invest in during the first stage works out to be

$$x^{*s} = \frac{Q^0}{\gamma}.$$

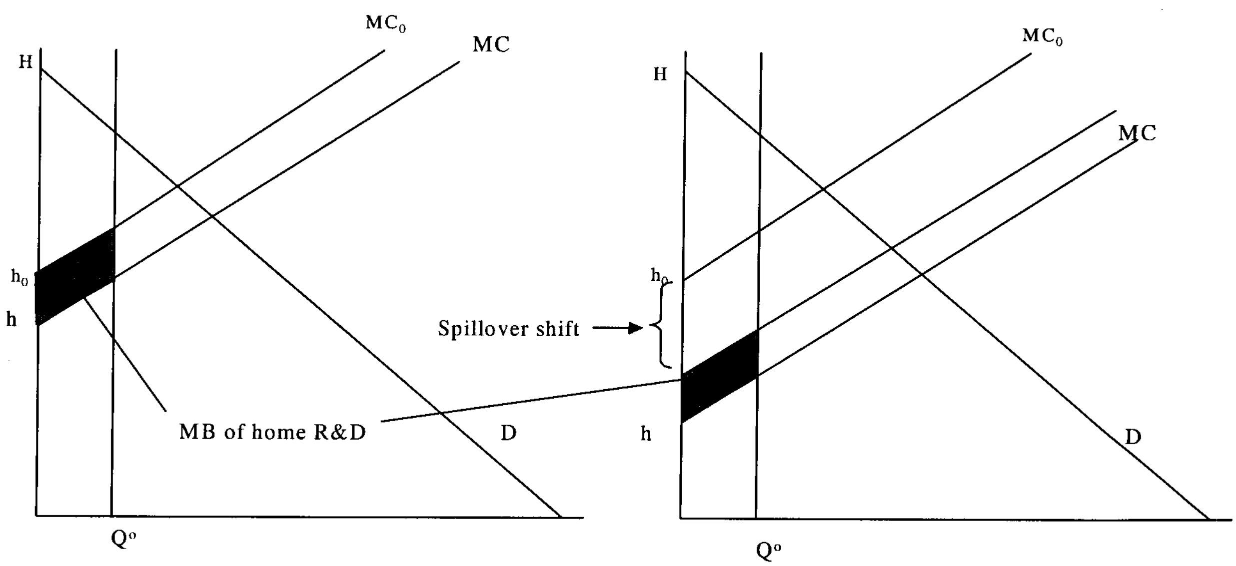
The following result can now be established:

Result 1: $x^{*SM} = x^{*s} = \frac{Q^0}{\gamma}.$

Result 1 shows that in a closed supply-managed economy, the level of spillover has no impact on the amount of R&D that the domestic country invests in.

Intuition Behind result 1: As can be seen in Figure 3.2, the effect of the spillover does not change the incentives for the home country to invest more or less heavily in R&D. Although the total stage 2 producer surplus (and therefore) stage 1 producer welfare will be greater and the home country will benefit in this way from the spillover, the actual marginal benefits of proprietal stage 1 R&D by the domestic country are the same whether or not there is a spillover. Since the quota level is keeping supply fixed, the increase in the producer surplus is the same irregardless of the position of the supply curve.

Figure 3.2: The Effects of the Spillover on The Domestic Producer



It can be seen in this figure that although the domestic producer will capture a greater stage 1 welfare, the spillover effect will not impact the producer's choice of R&D. The marginal benefits of proprietal R&D are represented by the shaded regions and are the same in both the case with a spillover and without.

3.2.2 Competitive Environment in a Closed Economy

We will now consider the case of a closed competitive economy in order to create benchmarks that are used in the general analysis below, where a closed economy with supply management is compared with an open-border competitive environment. Specifically, the benchmarks will enable us to distinguish the pure competition effects from the pure open trade effects. This model retains the assumption of a closed economy, however the stage 2 market is now assumed to be competitive rather than supply managed. R&D decisions in stage 1 are still made by a monopoly producer association.

The producer's marginal cost function now becomes the market supply function. Industry demand is unchanged. Thus, using equations (3.2) and (3.3), the equilibrium price is determined competitively where market supply meets market demand:

$$(3.12)\quad P^{*c} = \frac{H+h}{2}$$

Equilibrium quantity in stage 2 is determined by substituting equation (3.12) into equation (3.3) giving

$$(3.13)\quad Q^{*c} = \frac{H-h}{2}$$

Stage 2 producer surplus for the closed economy competitive case is given by

$$(3.14)\quad PS^{c} = \frac{Q^{*c}(P^{*c}-h)}{2}.$$

Stage 1 producer welfare is obtained by substituting equations (3.12) and (3.13) into equation (3.14) and then subtracting off the stage 1 cost of R&D:

$$(3.15)\quad W^{c} = \left(\frac{1}{8}(H-h_0+x+\delta x_f)^2\right) - \frac{\gamma}{2}x^2.$$

As in the above case, during stage 2, the producer chooses an effort level to expend in R&D, *x*, in stage 1 to maximize his welfare. The first order conditions for this maximization problem can be written as

$$(3.16)\quad \frac{\partial W^{c}}{\partial x} = \frac{1}{4}(H-h_0+x+\delta x_f) - \gamma x = 0$$

The optimal level of stage 1 R&D is given by the solution to equation (3.16):

$$(3.17)\quad x^{*c} = \frac{H-h_0+\delta x_f}{4\gamma-1}.$$

Of interest in this analysis is how the producer's choice or R&D with a closed-border supply-managed economy, x^{*sm}, compares with the producer's choice of R&D with a closed border competitive economy, x^{*c}. The difference in R&D levels, which is denoted

$$\Delta = x^{*sm} - x^{*c},$$

can be expressed as

$$(3.18)\quad \Delta = \frac{Q^0}{\gamma} - \frac{H-h_0+\delta x_f}{4\gamma-1}.$$

To establish the sign of equation (3.18), it is useful to examine the two extreme cases where Q^0 is set the competitive level (i.e., $Q^0 = Q^C = (H-h)/2$), and the case where Q^0 is set at the monopoly level (i.e. $Q^0 = Q^M = (H-h)/3$). Recall that the stage 1 equilibrium level of R&D determines the value of h in stage 2. Specifically, $h = h_0 - Q^0/\gamma$, which implies that $Q^0 = \frac{\gamma}{2\gamma - 1}(H - h_0)$ when Q^0 is set at the competitive level and $Q^0 = \frac{\gamma}{3\gamma - 1}(H - h_0)$ when Q^0 is set at the monopoly level. Thus, $x^{*sm} = \frac{H - h_0}{2\gamma - 1}$ when Q^0 is set at the competitive level and $x^{*sm} = \frac{H - h_0}{3\gamma - 1}$ when Q^0 is set at the monopoly level.

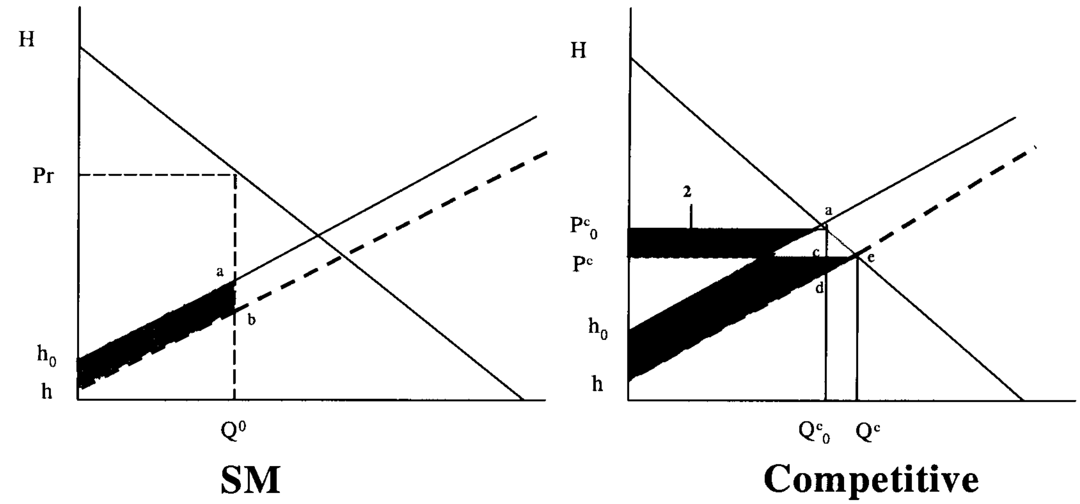
The following formal result can now be established.

Result 2: If the spillover is not too large, then $x^{*sm} > x^{*c}$.

Proof: It is sufficient to prove Result 2 for the case where Q^0 is set at the monopoly level because the value of x^{*sm} is smallest in this case (i.e., $\frac{H - h_0}{3\gamma - 1} < \frac{H - h_0}{2\gamma - 1}$ so if Result 2 holds for the monopoly case it must hold for all values of Q^0). When Q^0 is at the monopoly level, then $\Delta = \frac{H - h_0}{3\gamma - 1} - \frac{H - h_0 + \delta x_f}{4\gamma - 1}$. This further reduces to $\Delta = \frac{\gamma(H - h_0)}{(3\gamma - 1)(4\gamma - 1)} - \frac{\delta x_f}{4\gamma - 1}$. This expression takes on a positive value unless the spillover, δ, takes on a sufficiently large value. Q.E.D.

Intuition behind Result 2: The intuition of Result 2 is illustrated in Figure 3.3 for the case where the spillover is zero. The areas labeled "1" are the gain in producer surpluses which in the supply management case is always going to be a positive net gain. In the closed competitive case there is an area gained but the lower price causes a loss in producer surplus. This loss is the area labeled "2". Depending on the elasticity of demand, the net gain in the competitive case may be positive or negative.

Figure 3.3: R&D Level Effects on Producer Surplus



This figure illustrates that that the net gain of increased R&D is always positive in the SM case. The gain from increased R&D in this case is the area h_0h ba (area 1). In the competitive case, the producers will gain the area h_0heb (area 1), however they will lose the area $P^c_0P^c$ba (area 2) due to the decreased price effect.

This diagram also illustrates Arrow's observation that producers in a competitive market are able to earn profits over more units after investing in R&D than do monopolistic producers, as the quantity produced is not constrained by the quota as is the case in the present supply management model. There are two observable effects influencing the change in producer surplus. R&D increases the quantity base for the competitive firm, however these quantity gains are more than offset by the price effects. This is providing the competitor with less incentive to invest in R&D.

3.3 Open Economy Model

3.3.1 Base Model

In this scenario a free-trade situation between two countries is considered. The base model assumes that in stage 2 the two countries are producing an identical product and are competing in a free-trade output market. The producer associations each face a stage 1 decision regarding the amount of R&D to invest in. The two stage model is solved backwards with equilibrium prices and producer surpluses being calculated in stage 2 and welfare maximizing levels of R&D chosen in stage 1 of a non-cooperative game.

Stage 2 consumer demand and producer supply are linear with intercepts of H and h (for the home country) and slopes of b and B respectively (for simplicity let the slopes be equal to one). Similarly, F and f are used for the foreign country.

$$\text{(3.19)} \quad \begin{array}{ll} Q^d = H - P & Q^s = -h + P \\ Q^d = F - P & Q^s = -f + P \end{array}$$

Where: $h = h_0 - x_h - \delta x_f$;

$f = f_o - x_f - \delta x_h$;

h_0 and f_0 are the pre-R&D supply curve intercepts;

x is the amount of research done in stage 1; and

δ is the spillover parameter, $0 \le \delta \le 1$.

Stage 1 R&D reduces the production costs of both the producers. As shown through the above equations, the spillover effect of the foreign producer investing in R&D is to lower the home producer's production costs and vice versa[7].

The excess demand for the home producers ($Q_h{}^d - Q_h{}^s$) can be expressed as $ED = H + h - 2P$, and similarly, the excess supply for the foreign producers ($Q_f{}^s - Q_f{}^d$) will be $ES = -(f + F) + 2P$. Under free trade, excess demand is equated with excess supply. Equating the above equations will determine P^W, the world price.

$$\text{(3.20)} \quad P^W = \frac{H + h + F + f}{4}.$$

The producers will use this world price to determine the amount they will supply. Therefore, substituting equation (3.20) into equation (3.19), the home producers will supply an amount of milk equal to

$$\text{(3.21)} \quad Q^s{}_h = -h + \frac{H + h + F + f}{4}$$

and the foreign producers will supply an amount

$$\text{(3.22)} \quad Q^s{}_f = -f + \frac{H + h + F + f}{4}.$$

[7] Assumptions are made for this model that R&D efforts for one producer association are equally useful to the other. In reality producers may attempt to specialize their R&D so that a spillover effect would not be applicable.

Using equations (3.19), (3.20) and (3.21), producer surplus in stage 2 for the home country can be expressed as:

$$(3.23)\quad PS_h = \frac{1}{2}\left(-h + \frac{H+h+F+f}{4}\right)^2.$$

As in the previous section, the stage 1 fixed costs of R&D for the producer association is given by $(\gamma/2)x^2$. Taking these R&D costs into account, as well as the spillover effects defined above under equation (3.19), the home producer's welfare in stage 1 can be defined as

$$(3.24)\quad W_h = \frac{1}{2}[K - h_o + \left(\frac{3}{4}-\frac{\delta}{4}\right)x_h - \left(\frac{1}{4}-\frac{3\delta}{4}\right)x_f)^2 - \frac{\gamma}{2}x_h^2$$

Similarly, stage 2 producer surplus for the foreign producer association is

$$PS_f = \frac{1}{2}\left(-f + \frac{H+h+F+f}{4}\right)^2$$

and stage 1 foreign producer welfare is

$$(3.25)\quad W_f = \frac{1}{2}[K - f_o + \left(\frac{3}{4}-\frac{\delta}{4}\right)x_f - \left(\frac{1}{4}-\frac{3\delta}{4}\right)x_h)^2 - \frac{\gamma}{2}x_f^2$$

This model seeks a Nash equilibrium in a non-cooperative game. Hence, the objective of each individual producer association is to maximize its respective stage 1 producer welfare by choosing the optimal amount of proprietal R&D to invest in during stage 1, while taking the other player's choice of R&D as given. The first order condition for the home producer association can be expressed as

$$(3.26)\quad \frac{\partial W_h}{\partial x_h} = \left[\frac{1}{4}(H+F) - \frac{3}{4}h_0 + \frac{1}{4}f_0 + (\frac{3}{4}-\frac{\delta}{4})x_h - (\frac{1}{4}-\frac{3\delta}{4})x_f\right]\left[\frac{3}{4}-\frac{\delta}{4}\right] - \gamma x_h = 0$$

while the first order conditions for the foreign producer association will be

$$(3.27)\quad \frac{\partial W_f}{\partial x_f} = \left[\frac{1}{4}(H+F) - \frac{3}{4}f_0 + \frac{1}{4}h_0 + (\frac{3}{4}-\frac{\delta}{4})x_f - (\frac{1}{4}-\frac{3\delta}{4})x_h\right]\left[\frac{3}{4}-\frac{\delta}{4}\right] - \gamma x_f = 0$$

To simply these expressions, let $M = (\frac{3}{4}-\frac{\delta}{4})$ and let $N = (\frac{1}{4}-\frac{3\delta}{4})$.

Substituting in M and N into equations (3.26) and (3.27) gives the reaction functions for the home and foreign producer associations respectively as

$$(3.28)\quad x_h = \frac{M}{\gamma - M^2}\left(K - f_0 - Nx_f\right)$$

and

$$(3.29)\quad x_f = \frac{M}{\gamma - M^2}\left(K - h_0 - Nx_h\right)$$

The equilibrium level of R&D effort for both producer associations can be calculated by simultaneously solving equations (3.28) and (3.29):

$$(3.30)\quad x^*_h = \left[\frac{\gamma - M^2}{MN} - \frac{MN}{\gamma - M^2}\right]^{-1}\left[K - h_0 - \frac{MN}{\gamma - M^2}\left(K - f_0\right)\right]\frac{1}{N}, \text{ and}$$

$$x^*_f = \left[\frac{\gamma - M^2}{MN} - \frac{MN}{\gamma - M^2}\right]^{-1}\left[K - f_0 - \frac{MN}{\gamma - M^2}\left(K - h_0\right)\right]\frac{1}{N}.$$

where $K = \frac{1}{4}(H + F + h_0 + f_0)$ and let $J = (\frac{\gamma}{M} - M)^{-1}$.

Equations (3.28) and (3.29) represent the reaction curves for the R&D choice of each producer association. That is, each producer association will choose the amount of R&D to invest in taking the competitor's choice as given. These reaction curves are downward sloping, which implies that the choices are strategic substitutes; if one association chooses a higher level of R&D, the other association will respond by decreasing their level of R&D.

Proving some of the results analytically in the open economy model is difficult. As an alternative, a series of numerical simulations are presented which support the theoretical predictions. Table 3.1 shows the base case parameter values that are used for the simulations.

Table 3.1: Base Case Parameter Values

Parameter	**Value**
h_0	30
H	200
f_0	30
F	200
γ	10

The various parameter values were chosen for ease of presentation while trying to maintain a relatively realistic situation. The domestic and foreign producer's supply and demand intercept values were chosen simultaneously in order to keep the price and quantity supplied positive. The R&D cost function intercept value was chosen in order to present positive opportunity for investing in R&D while keeping consumer prices and quantity supplied positive as well.

3.3.2 Pure Competition Effects

To focus on how pure competition affects the R&D choice of the domestic producer association in an open economy, it is useful to assume zero spillovers, identical market demand for milk across the two countries, and identical milk production costs for the producer associations prior to the R&D decision (i.e. assume that $\delta = 0$, $H = F$ and $h_0 = f_0$). This means that if both countries chose the same level of R&D, there would be no trade because demand and supply would be equal in both countries.

Prior to R&D choice, the equilibrium level of trade in stage 2 is zero because market demand and market supply are identical in the two countries. The country that chooses the highest level of R&D in stage 1 will achieve the lowest level of production cost in stage 2, obtaining a comparative advantage, and thus will become a net exporter in stage 2. It is the incentive to move from a zero trade position to that of a net exporter position which is termed the "pure competition effect". This is where it is useful to refer back to the benchmark case of the closed competitive model presented in section 3.3.2 to find out how pure competition affects R&D choices.

Result 3: Suppose there are no R&D spillovers, and domestic and foreign countries have identical market demand and identical costs of milk production. If the current quota level is close to that obtained in a competitive economy, then pure competition effects are such that $x^{*C} < x^*_h < x^{*SM}$. That is, the domestic firm's choice of R&D is highest in a supply managed economy, followed by the optimal choice obtained in a free trade environment and will be the lowest in the closed border competitive environment. If however the supply management quota level is at a value close to that obtained in a monopoly environment, then pure competition effects are such that $x^{*C} < x^{*SM} < x^*_h$., that is the domestic firm will chose to do more R&D under a free trade environment than under the supply managed economy.

Proof: Unfortunately, proving Result 3 analytically is difficult. To compare the R&D choice of the domestic firm with and without a closed economy, it is necessary to simulate the R&D choice of the domestic firm in a closed economy. In addition to the base case parameters identified in Table 3.1, it is necessary to specify a value for the production quota, Q^0. As indicated above, this value should be chosen somewhere between the pure competition level and the pure monopoly level. With the base case parameters, the monopoly output is 56.7 and the competition output is 85. Two different levels are chosen. A value of $Q^{0C} = 70$ is used to represent the quota level which is close to a competitive level. A lower value of $Q^{0M} = 60$ is used for the simulation results under the assumption that the current supply managed quota level is closer to that obtained in a monopoly situation. With a value of Q^{0C} and the base case parameters, the optimal choice of R&D for the domestic country in a closed economy is given by $X^{*SM} = 7$ for the supply management case (see Result 1) and $X^{*C} = 4.35$ for the competitive case (see equation 3.17). With a value of Q^{0M} however, the optimal choice of R&D for the domestic country in a closed, supply managed economy falls to a value of $X^{*SM} = 6$.

The second column in Table 3.2 shows the values for the endogenous variables of the model for the base case parameters and zero spillover (i.e., $\delta = 0$). Notice from these results that optimal R&D for the domestic country in an open economy for the pure competition case is $x^*_h = 6.2$. It therefore follows that in the base case, under the assumption of a high quota level, $x^{*C} < x^*_h < x^{*SM}$, and under the assumption of a lower quota level, $x^{*C} < x^{*SM} < x^*_h$ which is Result 3.

Table 3.2: Base Case Simulation Results

Parameter	**Value**				
	H=F=200, h_0=f_0=30				
δ	**0**	**0.3**	**0.5**	**0.7**	**1**
h	23.37	22.19	21.63	21.26	21.05
f	23.37	22.19	21.63	21.26	21.05
x^*_h	6.62	6.00	5.57	5.13	4.47
x^*_f	6.62	6.00	5.57	5.13	4.47
P^W	111.68	111.09	110.81	110.63	110.52
Q^S_h	88.31	88.90	89.18	89.36	89.47
Q^S_f	88.31	88.90	89.18	89.36	89.47
Q^d_h	88.31	88.90	89.18	89.36	89.47
Q^d_f	88.31	88.90	89.18	89.36	89.47
ED_h	0.00	0.00	0.00	0.00	0.00
ES_f	0.00	0.00	0.00	0.00	0.00
W_h	3680.13	3771.60	3821.23	3861.28	3902.70
W_f	3680.13	3771.60	3821.23	3861.28	3902.70

Table 3.3 shows the simulated outcomes for the domestic firm's optimal stage 1 choice of R&D intensity for the three scenarios considered: closed economy with supply management, closed economy with competition and a free trade economy pure competition effect when spillovers are zero. Refer back to Tables 3.1 and 3.2 for the parameter values used

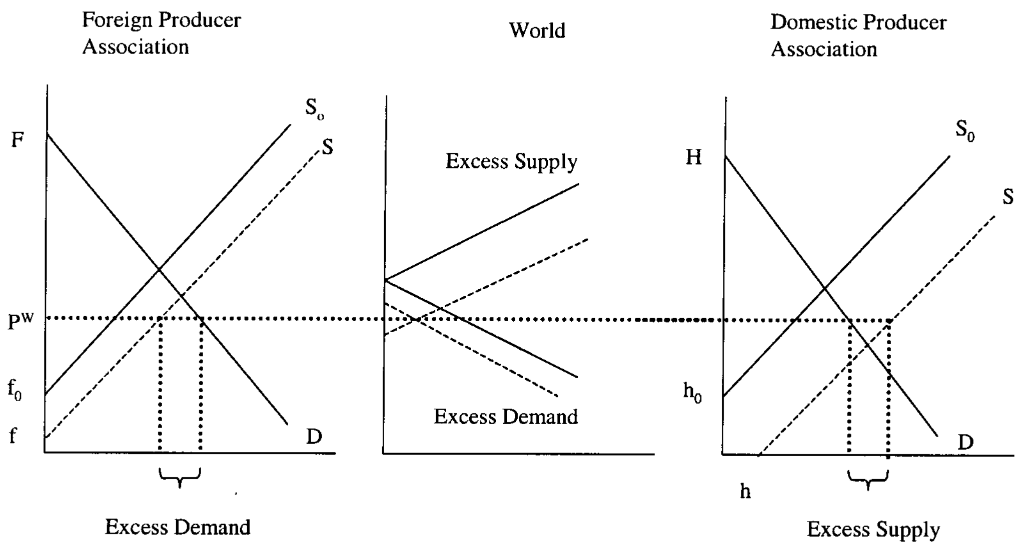
Table 3.3: Domestic Producer's Optimal R&D Levels Under Pure Competition

	SM		Closed Competition	Free Trade
	low Q	high Q		
Optimal R&D intensity	6	7	4.35	6.62
Stage 1 Welfare	4980	4795	3705	3680

As can be seen in Table 3.3, the domestic country has the greater incentive to invest in R&D under a free trade economy model than a closed competitive economy when spillovers are zero. It is the concern over lost market share which persuades the producer to invest more heavily in R&D.

Intuition of Result 3*:* Perhaps the clearest way to show the intuition of Result 3 is through an illustration, which is provided in Figure 3.4. In Figure 3.4 the domestic producer association has invested more intensively in R&D resulting in the reduction of their supply cost from S_0 to S which is a greater reduction than realized by the foreign producers. The world price is determined at the point where excess demand meets excess supply. The domestic producer's equilibrium price is lower than the world price, generating incentive for the foreign competitors to import milk from the domestic producers. This gives the domestic producer the advantage of greater world market share. Investing more heavily in R&D gives the advantage of being a net exporter. In the closed economy case the domestic producer does not face the threat of competition and cannot gain any trade surplus advantages. Therefore they have less of an incentive to invest in R&D than in the free trade situation.

Figure 3.4: Pure Competition Effects



3.3.3 Pure Competition with Spillover

In this section, the results of the previous section for the pure competition case are re-examined under the assumption that the spillover effect is positive rather than zero. This will give an idea of the impact of spillovers on R&D investment decisions due to pure competition effects.

Result 4: Suppose that R&D spillovers take on a positive value. As the spillover parameter, δ, increases, both countries have less and less incentive to invest in R&D (i.e. x_h* decreases as δ increases).

Columns 3 through 6 of Table 3.2 support Result 4. As can be seen, when the spillover is close to zero, the competitors have a greater incentive to invest in R&D than when the spillover approaches a value of one. As the spillover approaches one, the incentive for the producer associations to invest in R&D comes closer to the incentive level found in the closed competitive case.

Intuition of Result 4: The goal of investing in R&D is to lower marginal costs. This decrease in marginal cost results in a higher stage 2 output level. In the competitive environment, as marginal cost is lowered and stage 2 output is increased, the market price effectively goes down. This decrease in stage 2 prices effectively lowers the marginal profits realized by both producer associations, and therefore the competitor has less of an incentive to invest in R&D. This shows the effect of the free rider problem. The domestic producers are able to free ride on the foreign producer associations' investments in R&D and vice versa. This finding is validated given the above note about the reaction curves being downward sloping; hence the R&D decisions of the two associations are substitutes.

3.3.4 Pure Market Scale Effects

This analysis relaxes the assumption that both trading partners are equal in size. In this case the domestic country is assumed to be a net importer after the border opens, but prior to choosing R&D levels. This implies that once the border opens, the domestic producers will hold a smaller market share than their foreign trading partners[8]. This is referred to as the "market scale" effect. In terms of the model, in equation (3.19), H = F (i.e., demand remains equal) however $h_0 > f_0$ implying that the home producer association faces higher supply costs prior to stage 1 R&D decisions. As done in the case of pure competition effects, to get the pure market scale effects, the case of no spillover will be modeled first implying that once again $\delta = 0$.

Result 5: Suppose the domestic country is a net importer after SM has been dismantled, but prior to stage 1 R&D effort choice. Allow the spillover to be zero. The domestic producer association has greater incentive to invest in R&D than in a competitive closed economy, however the domestic producer association has less incentive to invest in R&D than the larger foreign competition. That is, $x^{*C} < x^*_h < x^*_f$. If pre-R&D imports are large, the domestic producer association has less incentive to invest in R&D than when pre-R&D imports are smaller, that is x^*_h (large pre-R&D imports) $<$ x^*_h (small pre-R&D import levels).

These results are presented in column two of the following tables. Table 3.4A shows the base case scenario with pre-R&D imports being relatively large. Refer again to Table 3.1 and Table 3.2 for the parameter values used. The difference is that now f_0 is given a value of 10. This new

[8] For theoretical analysis purposes one country must be chosen as the net importer. In this case without sufficient empirical data the domestic country has been chosen arbitrarily as the importer.

parameter value allows the domestic producer association's initial supply curve to be sufficiently higher than their competitor's meaning that open border imports will be relatively high. Table 3.4B presents the case in which the pre-R&D supply intercepts have been chosen such that the open border imports to the domestic country are smaller than the first case (f_0 is now 20).

Table 3.4 (A): Market Scale Simulation Results (Large Imports)

Parameter	Value				
	H=F=200, h_0=30, f_0=10				
δ	0	0.3	0.5	0.7	1
h	23.80	22.23	21.47	20.93	20.53
f	2.18	1.24	0.82	0.57	0.53
x^*_h	6.20	5.65	5.25	4.86	4.23
x^*_f	7.82	7.06	6.55	6.02	5.23
P^W	106.49	105.87	105.57	105.37	105.26
ED_h	10.81	10.49	10.32	10.18	10.00
ES_f	10.81	10.49	10.32	10.18	10.00
W_h	3226.95	3337.97	3398.56	3447.94	3500.41
W_f	5134.99	5223.91	5271.85	5309.99	5347.78

Table 3.4 (B): Market Scale Simulation Results (Small Imports)

Parameter	Value				
	H=F=200, h_0=30, f_0=20				
δ	0	0.3	0.5	0.7	1
h	23.58	22.22	21.55	21.10	20.79
f	12.78	11.72	11.23	10.92	10.79
x^*_h	6.41	5.82	5.42	5.00	4.36
x^*_f	7.22	6.53	6.06	5.58	4.86
P^W	109.09	108.48	108.20	108.00	107.89
ED_h	5.41	5.24	5.16	5.08	5.00
ES_f	5.41	5.24	5.16	5.08	5.00
W_h	3449.82	3551.48	3606.79	3651.67	3698.82
W_f	4377.34	4468.26	4517.43	4556.85	4596.85

Intuition behind result 5: As pre-R&D imports increase, the domestic producer association has less incentive to invest in R&D. Since the market share captured by the domestic producer association is relatively small, the potential gain in market share from performing R&D is also smaller. The value of performing R&D is reduced by the fact that the producer association captures a small market share to begin with.

3.3.5 Pure Market Scale With Spillover

The above analysis is now considered under the assumption that the spillover parameter takes on a positive value.

Result 6: Suppose that R&D spillovers take on a positive value. As the spillover parameter, δ, increases, both countries have less and less incentive to invest in R&D (i.e., x_h^* decreases as δ increases). In the case where pre-R&D imports are relatively large, and the spillover is also large, the domestic producer association has less incentive to invest in R&D in the open economy case than in the closed competitive economy. That is x^*_h (large pre-R&D imports) < x^{*C}.

Columns 3 through 6 of Tables 3.4 (A) and (B) show the results of this pure market scale analysis as the spillover parameter increases. As can be seen from these simulation results, as the spillover parameter increases, both of the producer associations invest less into R&D. By comparing Table 3.4 (A) with Table 3.4 (B) it can be seen that in the case of sufficiently large pre-R&D imports and a large spillover, the incentive to perform R&D is smaller in the open border case than in the closed border economy (a value of $x^*_h = 4.24$ as compared to $x^{*C} = 4.35$ when pre-R&D import levels are 10).

Intuition behind Result 6: Consistent with the intuition of results 4 given above, the decrease in price resulting from investing in R&D by either producer association effectively lowers the value of performing R&D by the other. In addition to this dis-incentive, each producer association has the chance to free ride on the competitor's efforts thus lowering their own production costs without bearing the investments required. In accordance with the intuition behind result 5 above, a smaller market share decreases the value of performing R&D. In fact if the original market share is sufficiently small, the value gained from performing R&D will be diminished, especially if the producer association can benefit from the competitor's efforts due to a high spillover parameter.

CHAPTER 4: CONCLUSION

This section provides a conclusion to the study. It will begin with a summary of the findings and key results. Implications of the findings will then be considered. In addition, suggestions for further work and future studies in this area will be proposed.

The results of this analysis provide some insight into the incentives that promote or restrict investment into R&D under different scenarios. The problem of too little investment towards R&D efforts has been examined extensively in previous studies and has been discussed briefly in this paper. The controversies surrounding supply managed verses competitive economies and the issues around government intervention in markets have also been touched upon in the current paper, drawing on literature and data from previous analyses. The current paper considers open border effects and in what ways increased competition and the spillover effect change the incentives for a supply managed industry producer to invest in proprietal R&D.

The first result found that in a supply managed economy, the spillover effect has no effect on the amount of R&D that the domestic producer association will invest in. Although a spillover will cause the domestic producer association's welfare to increase, the marginal benefits of proprietal R&D will not change.

Next the model was used to examine a closed border situation and the question was whether a supply managed economy would foster more or less R&D than a competitive economy. This result was used as a benchmark case. It was found that more R&D would occur in a supply managed economy than under a competitive situation. Although R&D can increase the quantity base for the competitive firm, these gains may be offset by the negative price effects. The producer in the supply managed economy faces no losses caused by a decrease in price.

The paper then questioned open border effects and asked the main question of whether Canadian producer associations will have more or less incentive to invest in R&D under a competitive open border situation as compared to the present supply managed, trade restricted situation.

In terms of comparing the present supply managed system with an open trade competitive situation, the level of R&D performed by Canadian producers may increase or decrease depending on where the actual current quota is set. In the case of the current quota being set close to that obtained in a monopolistic economy, Canadian producers will have more incentive to perform R&D under an open border situation than in the closed supply managed system. If however the current quota is set at a higher level, close to that which would be supplied under a purely competitive economy, Canadian producers may have less of an incentive to perform R&D when the border opens. In this situation it may be important for the government to provide some incentives to conduct R&D, as this is an essential component of economic development. It is important to recall that Canada was assumed to hold a smaller market share than the U.S. This assumption needs to be tested in future studies using current empirical data. In terms of the findings and outcomes of this analysis, the assumption does not take away from the validity of the results. If Canada is found to hold a greater market share than the U.S., the effects will be the same, however the results found for the foreign (assumed larger market share holder) country will actually apply to Canada, while the domestic results will apply to the U.S. producers.

The interplay of three main effects is interesting to note. There are two opposing forces that influence the amount of R&D that a producer will invest in. These are the competition effect, which leads to increased R&D, and the spillover effect that decreases R&D investment incentives. The market scale effect may increase or decrease optimal R&D levels depending on the size of the market that the country holds prior to making R&D decisions.

In terms of the pure competition effect, an open border situation will always promote more R&D than a closed border competitive environment. In other words, free-trade fosters more R&D than closed border competition when there are no spillovers present. When comparing the current supply managed economy to the open border economy, it is important to note where Canada's current quota is set. As discussed above, the level of R&D may increase or decrease.

The competition effect is countered by the spillover effect. Results of the model showed that as the spillover effects increase, the optimal level of R&D decreases.

The size of the market share was found to be the determinant of which effect would dominate. The producer association whom holds the smaller market share (the importer) will have less incentive to invest in R&D than the producer association whom holds a larger market share (the exporter). An increase in imports causes the importing producer association to decrease R&D efforts, while the competitor will increase their efforts. As the market share captured by the importer is relatively small, the potential gain from R&D is reduced and vice versa.

If it were the case that Canadian dairy producers invest too little in R&D, the Canadian government could look at introducing programs such as those seen in Australia and New Zealand. In these countries the government has given authority to industry groups to impose mandatory levies which fund sector specific R&D. In some cases these dollars are matched with funds provided by the government. Many of these ventures have helped Australia and New Zealand to remain internationally competitive.

The evidence from this study regarding whether or not disassembling of supply management will induce more or less R&D efforts was found to depend on the size of the market that Canada holds relative to the U.S. as well as the level of the spillover. Empirical data will be important to gather to investigate further the full effects of an open border situation between Canada and the U.S.

The model used here is very simplistic but could provide a base for more thorough studies to be done. Many simplifying assumptions were made which are not realistic, for instance at this time there is minimal but some trade between Canada and the U.S. in terms of dairy. As well, Canada was assumed to be the importing country when trade occurs. In reality, the high value of quota could actually give Canadian dairy producers a cost advantage and may imply that Canada is the net exporter. There are many aspects that influence which country will be the importer and further investigation in this area could include empirical studies that use actual data from the Canadian and U.S. dairy industries. The background information section of this paper supplies data that give a broad overview of trends in the Canadian and U.S. dairy industries, but this data is quite outdated. More recent data is needed to determine where Canada stands today in relation to other competitors.

It would also be interesting to look at co-operation models in R&D between the U.S. and Canada. It is not all that surprising considering the findings of this study that despite ongoing trade frictions and immense competition for buyers, Canada and the U.S. have developed cooperative agreements in regards to R&D. In particular, both the BC Blueberry Council and the Washington Blueberry Commission contribute part of their check-off funding to the North American U.S. Highbush Blueberry Council in order to conduct R&D and promotional activities. In essence these two competitors belong to a common research joint venture (RJV). Belonging to a RJV can reduce costs of R&D faced by each competitor as research is not duplicated, however this type of agreement also limits the competitive advantage realized by R&D not subject to spillovers. In a theoretical model presented by d'Aspremont and Jacquemin (1988), it was found that at low spillover levels the players are induced to over-supply R&D resulting in duplicate R&D results and profit loss realized by both producers. With relatively high spillover levels, each player will under invest in R&D also leading to profit loss. The best scenario in either of these cases is to cooperate. At this point there is considerable evidence of cooperation in R&D in the domestic agriculture industry as seen in the many agricultural co-operatives and producer associations. It would be an asset to have studies done on what the advantages might be to Canadian dairy producers for investing in a RJV with U.S. dairy producers before and after the border opens.

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