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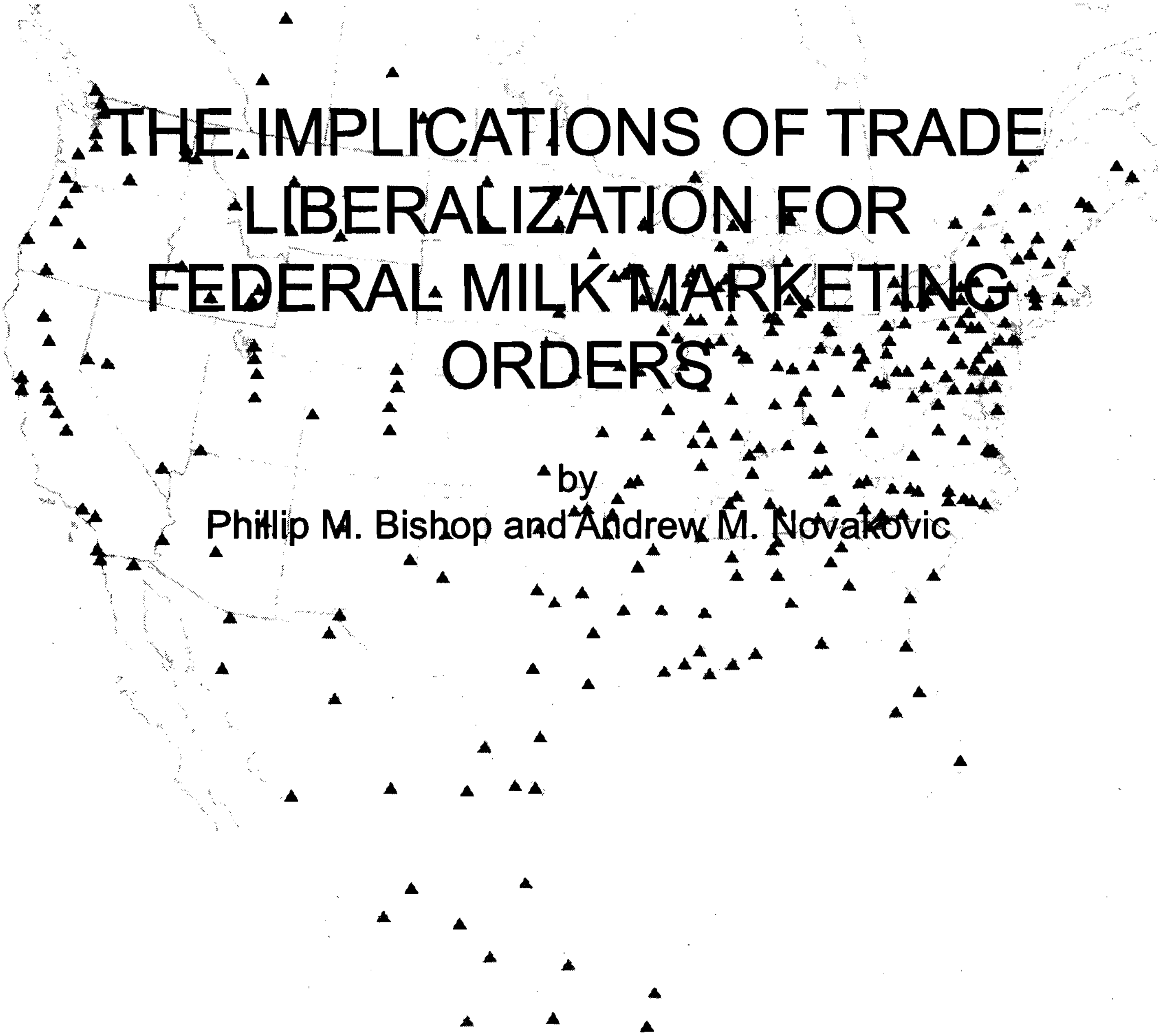

THE IMPLICATIONS OF TRADE LIBERALIZATION FOR FEDERAL MILK MARKETING ORDERS

by
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PREFACE

Phillip Bishop is a Senior Research Economist with the New Zealand Institute of Economic Research. Andrew Novakovic is the E.V. Baker Professor of Agricultural Economics. This research was supported by a grant provided from the U.S. Department of Agriculture, Agricultural Marketing Service, and it formed the basis of Mr. Bishop's Master's thesis.

The Uruguay Round Agreements Act (1995) directed the USDA to study the potential implications of the new General Agreement on Tariffs and Trade for Federal Milk Marketing Orders. This research was conducted to comply with that requirement. The analysis described in this publication incorporates revisions to the model used in the original analysis, reflecting extensions and updates developed in conjunction with another study (*cf.* Pratt *et al.*, "A Description of the Methods and Data Employed in the U.S. Dairy Sector Simulator, Version 97.3," *R.B. 97-09*, Department of Agricultural, Resource, and Managerial Economics, Cornell University, 1997). Of primary relevance here are changes in transportation costs which result in broader implications for North American trade in milk and dairy products.

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EXECUTIVE SUMMARY

For over sixty years, Federal Milk Marketing Orders (FMMOs) have regulated the terms and conditions under which grade A milk is purchased from farmers. During the years since the program's inception, it has come to be viewed as the cornerstone of U.S. dairy policy. However, as the U.S. joins many other countries in a move toward a more liberal trading environment, particularly in the agricultural sector, some serious questions arise concerning the role of marketing orders in a more internationalized environment, and their ability to perform as intended.

The fundamental problem for FMMOs in a world with freer movement of milk across national borders is that processors of fluid (beverage) milk have an incentive to avoid pricing regulation by locating plants outside the U.S., yet they remain able to supply packaged fluid milk to U.S. markets. Recognizing this, the 103rd Congress mandated that the USDA determine the effects of the Uruguay Round Agreement on the Federal Milk Marketing Order system. Taking an even broader approach, the objective of this study was to examine and quantify the extent to which freer dairy trade in general will impact marketing orders. Although the Uruguay Round GATT, when fully implemented, portends additional exports and imports of dairy products, this is most likely to be in the form of manufactured dairy products. While this may be significant to the U.S. dairy industry, it is not particularly significant to the operation or efficiency of FMMOs, *per se*. When combined with NAFTA, prospects for much freer trade between North American countries rise in importance. Thus, the departure point for this study is a future scenario of total trade liberalization combined with current price regulation in the U.S.

Marketing orders seek to address the basic problem of maintaining orderly marketing arrangements for a good that many in the industry would argue is inherently predisposed to disorderly marketing. Farmers producing grade A milk have on their hands a commodity which must be marketed daily, otherwise it will spoil and become worthless. The various users of milk each value that milk differently. Furthermore, the demand for fluid milk, which places the highest value on raw milk, exhibits considerable variability on both a seasonal and a daily basis. The volume of raw milk required by fluid milk processors on any given day varies, giving rise to a situation where, in the absence of regulation, producers could receive a materially different price for identical milk from one day to the next.

Marketing orders use a complementary system of classified pricing and pooling. Regulated processors of milk are required to pay a price for milk which is determined monthly according to the milk's end use, and the revenues arising from the sale of milk to these processors are pooled. The reserve, or surplus, milk is priced at the lower manufacturing value while the cost of doing so is equitably shared among all producers in a marketing area. Milk used for fluid uses, or class I, must be paid for at a price equal to the basic formula price plus the class I differential. Such differentials vary by order, and even within orders, but are in the range of $1.20 to $4.18 per cwt. of milk, averaging about $2.50.

A process of constant monitoring and adjustment has seen the program cope with many changes, and by many measures it has worked relatively well; consumers have received a reliable and safe supply of beverage milk, producers have been able to market their milk in an orderly manner, and fluid milk processors have been able to procure all the milk they need to meet demand while the balance has always found its way to a manufacturing plant. However, until now, the U.S. dairy sector has been insulated from neighboring countries. Moving into an era where that insulation is removed provides handlers a means of escaping regulation. Plants located in Canada or Mexico could procure milk either locally or from U.S. producers, and then sell their products into regulated U.S. markets. The incentive to incur the additional marketing and transportation costs associated with doing so comes about because such processors no longer have to pay producers a price determined by regulators. In fact, unregulated foreign plants would need only offer a price which marginally exceeds the blend price to elicit a supply of milk. Quite logically, the incentive to avoid regulation would be strongest in areas near the border. The negative impact on producer prices as class I utilization diminishes would also be most strongly felt in these areas.

The model constructed for this research is formulated as a single-time period, multi-component transshipment model and is solved within a linear programming framework. Geographically, the model includes the U.S., Canada, Mexico, and an aggregate rest-of-the-world region. FMMO regulatory structure was added in the form of class I differentials. The model was designed to be spatially detailed and includes 275 points representing the supply of raw milk; 416 potential locations for processing each of the five final and four intermediate dairy product types; and 278 consumption points. Given estimates of raw milk supply, dairy product consumption, and the costs of assembling raw milk, shipping intermediate products between plants, and distributing final products, the model seeks to minimize the total of these costs while determining an efficient pattern of processing locations and milk and milk product movements. The model represents raw milk, intermediate products, and final dairy products as combinations of fat and solids-not-fat in predetermined fixed proportions. Thus it is able to reconcile the joint production of milk and dairy products that is so characteristic of the dairy sector.

Turning now to the analysis, a base solution was first generated to provide a point of reference from which comparisons could be made. The first experiment addressed the central question of the impact on marketing orders when both raw milk and dairy products are able to move freely across national borders. The key assumption underlying this simulation was that the USDA has no legal authority to regulate prices paid by plants located outside the U.S. The analysis made it abundantly clear that to the extent that liberalizing trade with Canada and Mexico places pressure on the ability to regulate the purchase price of grade A milk, U.S. dairy farmers in many areas, especially the border areas, could be significantly to severely harmed. Freer trade would have a measurable impact on 13 federal and six state orders. In all, 36 percent less fluid milk was distributed from U.S. plants when compared with the base case and this was replaced with shipments from Canada and Mexico. Under the assumption of no change in total milk production, the U.S. did increase processing activity at class II and manufacturing plants by more than 6 percent but all of this milk is procured at the lower manufacturing price making U.S. producers worse off. The resulting declines in producer blend prices ranged from just a few cents to over one dollar, and as much as $1.60/cwt. in the most affected region. Small gains in the blend price occurred in two orders due to a large fall in producer deliveries causing class I utilization to increase.

A second simulation considered how a so-called class I credit would lessen the impact of freer trade on producer prices. While the class I credit effectively removed the arbitrage incentive created by class I differentials, there was a high cost associated with doing so. In fact, the cost, expressed in terms of blend price changes, was so high that producers were generally worse off than under free trade. Moreover, the incidence of the cost occurred disproportionately with some producers experiencing improvements over the free trade outcome while many others were much worse off. Milk and milk product movements, as well as the location and level of processing activity, were very similar under this scenario to that of the base case.

The third scenario examined how things would change if foreign plants could be regulated under the terms and provisions of U.S. marketing orders. Understandably, such a situation results in practically no effect on marketing orders, *per se*, as marketing costs rather than class I differentials determine from where and to where milk is procured and distributed.

A fourth simulation explored the likelihood of Mexico using imported dairy ingredients to satisfy more of its own fluid milk requirements thereby increasing available local supplies of raw milk for export to the U.S. as packaged fluid milk. This simulation revealed that a considerable opportunity exists for Mexico to exploit import-substitution as a means of increasing packaged milk exports to the U.S. over and above those already attained under the foregoing trade liberalization scenario. Such exports increased by almost 21 percent to reach 8,028.25 million pounds. Moreover, this was accomplished by drawing almost one-third less raw milk from U.S. sources.

The final experiment concerned the level of class I differentials and how it influences the incentive for processors to avoid regulation. Here it was found that even with differentials at 25–50 percent of current levels, the incentive to avoid regulation remained significant—particularly if a plant was close to the border and not too far from the U.S. markets being served.

In summary, the analysis shows that the Federal Milk Marketing Order program may be unable to maintain significant class I prices and producer revenues if free trade in milk and dairy products becomes a reality in North America. Moreover, the adverse affects will be concentrated in specific regions. Both state and federal orders in these regions will be impacted. As milk is diverted from these areas to fluid processing plants in Canada and Mexico, the disorderly conditions that federal orders sought to, and indeed did, alleviate may well begin to reappear.

Key to this conclusion is the requirement that Canada reform its own pricing system to exploit this potential. If they fail to do so, the tables could be turned. Thus, this study explores a 'worst case' scenario for the U.S.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

THE IMPLICATIONS OF TRADE LIBERALIZATION FOR FEDERAL MILK MARKETING ORDERS

by
Phillip Bishop and Andrew Novakovic

INTRODUCTION

For the past sixty years, Federal Milk Marketing Orders (FMMOs) have regulated the terms and conditions under which grade A milk is purchased from farmers. Their permanent authorization in 1937 was a response to many years of disruptive conditions in the nation's markets for milk and was the culmination of several less-than-successful attempts by both state and federal governments to regulate milk markets. At the heart of the program is a complementary system of classified pricing and revenue pooling. Regulated processors of milk are required to pay a price for milk which is determined according to the milk's end use, and the revenues arising from the sale of milk to these processors are pooled. Such an arrangement arose after nearly forty years of bitter experiences with a myriad of pricing schemes that were tried prior to the adoption of marketing orders but all of which ultimately failed to impose a satisfactory discipline on the market place (Cassels, 1937). After decades of self-imposed relative isolation from the rest of the world, the U.S. dairy industry is now entering an era characterized by the internationalization of what were once distinct and largely independent domestic milk markets. It is the purpose of this research to understand how Federal Milk Marketing Orders may fare in this new environment.

An immediate problem raised by the specter of trade liberalization concerns the ability of FMMOs to maintain the integrity and performance of their most fundamental tools, classified pricing and pooling, when barriers to trade are either removed or relaxed. Federal marketing orders replaced state regulation because the prevalence of interstate commerce in milk rendered state authority ineffective. At issue now is whether international commerce will similarly reduce the effectiveness of federal regulation. Marketing orders regulate milk processors, not farmers nor processor's customers, and do so through the use of minimum price regulation. Because it is fluid handlers who are required to pay a higher price, it is they to whom trade liberalization provides an incentive to avoid regulation. For example, it is easy to imagine a fluid milk processor located just across the U.S. border processing milk purchased either locally or from nearby U.S. farmers, and then selling class I products in regulated U.S. markets. Such a handler, by virtue of being located in another country, would avoid the class I pool obligations to the order in which it makes its sales. Quite simply, the potential to profitably engage in this type of arbitrage, within the scope of any particular order, depends on the extent to which the increased milk assembly and distribution costs are outweighed by the difference between the class I price and the prevailing blend price.

While the overall objective of this study is to understand the implications of trade liberalization for Federal Milk Marketing Orders, a number of more specific objectives quite naturally emerge. They are:

A. Develop an understanding of the interrelatedness of milk marketing orders and trade liberalization.

B. Investigate provisions of orders that might apply to milk and/or dairy product movements between the U.S. and its neighboring countries.

C. Estimate the magnitude of product flows that would occur due to normal economic incentives under alternative scenarios. Scenarios are to represent various assumptions about 1) the ability of FMMOs to enforce pricing provisions across country boundaries; 2) the level of price differentials within federal orders and across competing areas. Competing areas include foreign countries and those parts of the U.S. not regulated by federal orders; and 3) the degree of trade liberalization and policy reform.

D. Quantify the magnitude of class I trade flows that might occur under conditions where FMMOs could and could not regulate foreign handlers.

E. Identify the non-economic factors which may mitigate or compound the effects of trade liberalization on FMMOs.

In addressing the above objectives, the study will be restricted to factors directly impacting the integrity or performance of FMMOs as an agent for achieving economic performance objectives in the U.S. dairy sector. The implications of freer trade for price levels, export opportunities, or other factors that are of importance to the dairy sector but which do not have particular and direct implications for FMMOs will not be addressed. Although this study is primarily concerned with FMMOs, the impact of trade liberalization on similar state marketing programs is a simple and logical extension.

Until quite recently, U.S. dairy imports have been strictly controlled with import quotas. Both NAFTA[1] and the Uruguay Round GATT[2] treaty have changed that. Import quotas, which were in place for over forty years, have been replaced with tariff rate quotas (TRQs), albeit with relatively high tariffs initially. Furthermore, GATT requires that access to the U.S. market be made available for a range of dairy products in amounts which exceed prior import levels. The dairy industry is clearly about to chart new waters with respect to trade policy. The question of how trade policy might influence federal orders has simply not been a pressing issue until now. Indeed, there exists considerable literature on both FMMOs and trade liberalization, but very little has been written to date that brings these two strands of inquiry together. This stems largely from the fact that FMMOs are typically thought of as being a strictly domestic program and therefore unrelated to issues of trade. There is an urgent need to better understand how trade liberalization will impact the milk marketing order system.

When deliberating ratification of the Uruguay Round GATT treaty, the U.S. Congress recognized that information enabling informed judgments about the GATT's impact on federal orders was sparse. Section 425 of the Uruguay Round Agreements Act (1995) therefore mandated that the Secretary of Agriculture conduct a study to determine the effects of the Uruguay Round Agreements on the Federal Milk Marketing Order system. This research fulfills that Congressional mandate.

The initial phase of this research was conducted in 1995 and reported in Bishop (1996). Further analysis was then undertaken which explored additional aspects of the problem not addressed by Bishop. A preliminary briefing was provided to the Agricultural Marketing Service (USDA) in April of 1996 and this final report was first completed shortly thereafter. However, at the same time, a comprehensive effort was begun to update and revise the model for use in a study looking at reform of FMMOs (Pratt *et al.*, 1997). This effort resulted in significant changes to a number of the model's cost parameters which would likely lead to different results. Consequently, the present analysis was repeated incorporating the new cost information.

This report is organized as follows. First, a few pages are devoted to describing marketing orders and trade liberalization. The intent here is to focus on those aspects of trade liberalization that are likely to affect marketing orders rather than the dairy sector in general. Following this is a description of the model and the data used to conduct the analysis. The three key simulations are then described followed by a brief presentation of three secondary scenarios. The results of all analyses are then discussed and compared. Some final remarks conclude the report.

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[1]The North American Free Trade Agreement.
[2]The General Agreement on Tariffs and Trade.

FEDERAL MILK MARKETING ORDERS AND TRADE LIBERALIZATION

Federal Milk Marketing Orders regulate the terms under which handlers of grade A milk purchase that milk from farmers. Their longevity can, in large part, be attributed to the poor bargaining position of dairy farmers that stems from the inability to store milk for prolonged periods; an asymmetry that marketing orders explicitly address. At the time of this analysis, there were 32 federal orders regulating the purchase of approximately 80 percent of all grade A milk marketed in the U.S. This equates to roughly 72 percent of all milk marketings. In addition to federal orders, there are a number of state orders which have similar objectives and function analogously—the California state order being the most significant of these. In all, over 99 percent of the U.S. grade A milk supply is priced under some type of federal or state regulation.

The essential difficulty for farmers that milk marketing orders seek to address is one of securing a reliable outlet for farm milk while at the same time ensuring an equitable pricing arrangement. The demand for fluid milk, while relatively stable from year-to-year, is quite variable within a year and from day-to-day. Production of milk, on the other hand, is a biological process and has a pronounced seasonal pattern. It also varies from one year to the next depending on weather, feed conditions, and a host of other factors. Thus there is a need for the industry to maintain a reserve supply of milk that is of a suitable quality for meeting the day-to-day consumer demand for fluid milk. And therein lies the problem; milk for fluid use commands a higher price than milk used for manufacturing purposes yet it is to manufacturing that the reserve milk must be channeled. This then leads to price disparities for milk of equal quality and location. Moreover, it leaves farmers in the unenviable position of having to negotiate a price for their output in an oligopsonistic market (Boynton and Novakovic, 1984). The situation is exacerbated because buyers (handlers) understand that the product will spoil if the farmer cannot sell it immediately. Milk marketing orders, by virtue of their classified pricing arrangements, are able to price the reserve milk at the lower manufacturing value while equitably sharing the cost of doing so among all producers.

Central to the FMMO program are the notions of classified pricing and pooling of returns. The price that a handler must pay for grade A milk is determined by the use to which the milk is put. Uses of milk are divided into classes with class I, or fluid, products being the most valued. Most orders employ four main product classifications; class I, II, III, and IIIa. The price of class III milk is identical in all orders and is set equal to the so-called Basic Formula Price (BFP) which is calculated monthly and is intended to reflect a competitively determined market price. Class III milk, often referred to as manufacturing milk, is deemed to be of low value relative to milk destined for fluid uses. Class IIIa refers to milk used in the manufacture of nonfat dry milk (NDM). Class I differentials, which vary by order and sometimes by marketing zones within orders are added to the BFP to arrive at the price of class I milk. Within each order, the revenues arising from the sale of producer milk to regulated handlers are pooled under the supervision of the order's Market Administrator. Producers are then paid the "blend" price, a class-weighted average price. Thus, all producers selling grade A milk to handlers who are regulated by a particular order receive the same basic minimum price for their milk regardless of the use to which it is put by the handler they happen to sell to. It follows then, that class I handlers contribute to the pool while processors of manufactured products draw from it.

In practice, the program is, of course, much more complex than suggested here. In fact, each order is a very precise regulatory instrument with quite specific provisions which vary from one order to the next. Such specificity is required because one of the features of orders is that they require handlers to pay minimum prices. Throughout this study, only the most fundamental elements of marketing orders which are common across all orders will be considered. Because the central issue under study concerns the viability and effectiveness of pooling in the presence of unregulated handlers purchasing milk for class I uses, it is sufficient to assume that for pricing purposes, only two classes exist; classes I and III. Besides, the differential values of class II and IIIa milk compared with class III are quite small relative to that of class I.

The principal provisions of FMMOs are now briefly reviewed.[3] Doing so will also serve to explain some of the nomenclature that accompanies marketing orders. An order's regulations apply to all regulated handlers who sell their products in a designated marketing area. Such an area may encompass just a few counties or several entire states and is designed to include all of an area where handlers compete with each other for sales of milk. However, advances in packaging and transportation technologies as well as changes in marketing practices and shopping habits have made it increasingly difficult to define marketing areas as distinguishable and separate entities. Hence, the area of milk procurement has become increasingly important in defining a marketing area. A key point regarding marketing areas is that a regulated processing facility need not be located within the geographic confines of the order under which it is regulated. The administration of an order is carried out by the office of the Market Administrator, under the supervision of the Dairy Program of the Agricultural Marketing Service of the USDA.

As mentioned earlier, it is the milk handlers purchasing grade A milk who are regulated. Unfortunately it is not particularly easy to categorize handlers because of the wide variety of arrangements that exist for buying, processing, and distributing fluid milk. Also, handlers don't typically confine their sales to a single marketing area and can thus become subject to regulation by more than one order. There are three main classifications of handlers; (1) operators of pool plants, who are fully regulated, (2) operators of nonpool plants, who are partially regulated, and (3) cooperative associations, who either operate pool plants or market their member's milk by delivery to pool or nonpool plants. Generally speaking, handlers of class I milk will contribute to an order's pool, or producer settlement fund as it is more properly called, while all other handlers will draw from the pool. Because any plant operator wishing to procure milk would need to offer producers at least the blend price, there is an obvious incentive for handlers to arrange their affairs in such a way that they become regulated, especially those using grade A milk in the production of products not classified as class I. However, there may be effective minimum performance standards to be satisfied in order to maintain a certain pool status.

The blend price is the uniform minimum price within the order that handlers must pay producers for their milk. To the extent that class I utilization within an order increases, the blend price in that order will increase too. Class I handlers have the ability to pay more for their milk because they are selling more highly valued products. As a practical matter, not all of the proceeds from the sale of producer milk to handlers physically passes through the producer settlement fund. Rather, the difference between what a handler pays producers and the utilization value of the milk is either paid to or received from the fund. The utilization value is simply the pounds of milk a handler utilizes in a particular class multiplied by the applicable class price.

While the blend price is uniform within an order, the actual price received by producers is not. A number of adjustments that differ across producers could be made. One such adjustment is the butterfat differential. Reference prices are announced for milk containing 3.5 percent butterfat. Because the milk from individual producers is likely to differ from this, an adjustment is made based on the actual butterfat test of a particular milk supply. Increasingly, many orders also determine milk prices on the basis of protein or skim solids content. Secondly, there may be location differentials. These adjustments recognize that milk located closer to the primary consuming area is worth more than milk at a more distant location. Thus, minimum class prices are usually adjusted according to the zone location of the plant of first delivery such that milk shipped to plants in zones farther away from the consuming area is priced lower. Location differentials encourage efficient plant location decisions. Typically, we observe fluid milk plants closer to demand markets while manufacturing plants tend to locate nearer to the source of milk supplies (Bressler, 1958). Additional adjustments not specifically contained in orders may also result in producer prices deviating from federal order minimum blend prices; for example, hauling assessments or competitive premiums.

[3]Much of this material is drawn from USDA (1989).

Besides classifying milk according to use, regulating prices, and operating the pool, the Market Administrator's office has the important task of auditing the regulated handlers. Effective auditing is crucial to the integrity of the entire program. Regulated handlers are required to submit to the Market Administrator reports showing their receipts and utilization of milk and their payments to producers.

Finally, it is perhaps useful to make mention of a few things that orders do not do. FMMOs do not control milk production, limit or in any other way determine milk marketings, control from whom a handler shall buy or to whom a handler must sell, or even directly regulate the behavior of milk producers. They do not fix farm or retail prices, set sanitary or quality standards, or guarantee farmers a buyer for their milk. Nor do they in any way restrict or prohibit the interstate trade of raw milk and milk products.

The discussion now turns to matters concerning trade liberalization. In recent years, the U.S. has ratified two trade agreements which may adversely affect the operation and performance of the FMMO program; NAFTA and the Uruguay Round GATT treaty. These agreements represent a policy attitude which is slanted towards reform and liberalization. For a variety of reasons, budgetary pressures being a significant one, such an attitude seems likely to persist and intensify. In fact, the NAFTA agreement, which is now several years into its ten to fifteen year-long implementation phase, has already caused industry participants and analysts to ponder responses to the very issues raised in this report.

The first type of impact on FMMOs that can be foreseen arising from the liberalizing of trade might be termed the overall consumption effect. That is to say, *ceteris paribus*, the availability of cheaper imports would lead to increased total demand, but reduced demand for those goods produced domestically. Of course, this assumes that imports are close substitutes and that domestic prices remain higher than those of comparable imported products. In 1993, the U.S. imported some 2.81 billion pounds of dairy products (milk-equivalent, milkfat basis), most of it cheese. This figure represents less than 2 percent of U.S. milk production. U.S. dairy exports in that year, with most of it benefiting from export subsidies, were 8.64 billion pounds, or less than 6 percent of U.S. milk marketings. Historically, U.S. exports have more typically equaled imports. Both imports and exports were comprised almost exclusively of manufactured products. The GATT agreement requires that the U.S. must expand market access for imports to 5 percent of the U.S. market by the year 2000. At the same time, subsidized exports must be reduced by 21 percent from base year quantities. Non-subsidized exports are not limited by the treaty. Depending on how much world prices strengthen as a result of GATT, U.S. exports of butter and nonfat dry milk may well be possible without subsidies. A small volume of exports of value-added products are already occurring and may well increase over time, being limited primarily by the purchasing power of net-deficit countries and the market access allowed by higher income, net exporting countries.

In the past, many dairy industry participants, especially at the producer level, have expressed concern and anxiety about the impact of liberalizing trade. This was inspired by low-priced imports, largely due to massive European subsidies. Now, it is difficult to imagine how the degree of liberalization that GATT has wrought could lead to anything worse than minor downward pressure on domestic producer prices. World prices are simply not that different from domestic U.S. prices for those products most directly affected by GATT, that is, class III-type products. Moreover, as other countries, especially the European Union, reduce export subsidies, one would expect world prices to strengthen. If increased imports of such products were to lead to a lower class III price for milk, the resulting class I and blend prices would also be reduced. However, this is a manifestation of competitive pressure on the sector as a whole, rather than a specific problem for FMMOs. Indeed, it has no bearing at all on the operation of milk marketing orders.

The NAFTA treaty, on the other hand, is an entirely different proposition due to the close proximity of Canada and Mexico to major U.S. fluid milk markets. NAFTA currently excludes Canada from its dairy provisions, although the U.S. and Canada continue to disagree over the interpretation of the GATT treaty and its interaction with NAFTA. It is expected that dairy trade between the U.S. and Canada will increase when trade does become freer. Between the U.S. and Mexico, NAFTA will result in completely free trade by the year 2004 for all dairy products except

NDM which will take until 2009. Given Mexico's deficit situation with respect to milk, the U.S. can reasonably expect to become an increasingly important supplier of milk and milk products to Mexico as a result of NAFTA. As with the GATT treaty, NAFTA's impact on markets for manufactured dairy products is of no serious consequence for FMMOs. However, unlike GATT, the implications of NAFTA for U.S. fluid milk markets may well be serious. It is concerns related to fluid milk markets to which the discussion will now focus.

The second major issue raised by trade liberalization, that of undermining the system of classified pricing and pooling, speaks directly to the integrity and performance of FMMOs and is considerably more subtle than the direct trade, or consumption, effect. It is also of far greater importance and is more difficult to analyze and quantify. As alluded to earlier, there are two mechanisms by which the intent of the FMMO program might be disregarded or avoided. One is for U.S. raw milk to be transported to a neighboring country, be processed into class I products, and then shipped back to markets in the U.S. The other is for neighboring countries to simply process their own raw milk supplies into class I products for shipment to U.S. markets. Both of these mechanisms assume an inability on the part of milk Market Administrators to regulate and audit fluid plants located outside the U.S., regardless of the nationality of the plant's owner. More significantly, both mechanisms lead to a breakdown of pooling and classified pricing. Furthermore, both mechanisms are legitimate under the strict rules of origin clause contained in the NAFTA treaty. These rules state that the ingredients of products crossing borders under the terms of NAFTA must originate in a NAFTA country. While unlikely, it remains to be seen if U.S. Market Administrators can regulate fluid plants located in Mexico or Canada which distribute packaged milk products to regulated U.S. markets.

Market Administrators have not in the past had a need to audit foreign plants and no protocol for doing so exists (USDA , 1993). However, federal order provisions as currently formulated would accommodate the pricing of milk (raw or partly processed) and cream shipped from U.S. plants to foreign plants. The burden is on the first handler, in this case the U.S. handler, to report how the milk was ultimately used. Therefore, such U.S. handlers generally request that the unregulated handler voluntarily submit to verification through audit by USDA personnel. In the absence of such verification, the first handler is required to pay the class I price for the milk, regardless of the use to which the unregulated handler puts the milk. The possibility, however, of pricing milk shipped directly from U.S. producers to foreign handlers under the current terms of federal orders is slim indeed without the explicit cooperation of those handlers.

The arbitraging of raw milk and/or dairy products between the U.S. and its neighboring countries leads directly to the avoidance of pooling obligations and therefore it effectively diminishes class I utilization in affected FMMO markets. While such activity would obviously originate in areas close to the U.S. border, it could conceivably have a ripple effect radiating throughout the FMMO system. Handlers able to avoid regulation while still purchasing grade A milk could bid milk supplies away from regulated handlers by offering producers only marginally more than the blend price. As milk is thereby effectively depooled, class I utilization decreases and leads to a lowering of the blend price paid to producers. This in turn increases the incentives available to those handlers seeking to avoid regulation, and thereby allows them to bid away yet more milk at an even lower price.

The possibility of a similar situation developing for processors of manufactured, or non-class I, products is of no concern to federal orders, nor is it likely. Manufacturers benefit from being pooled on federal orders; hence they have no incentive to escape regulation. If other factors were to make manufacturing in Mexico or Canada desirable, then this in and of itself would have no consequence for the integrity of the order system, although it may have implications for the competitive position of U.S. dairy product manufacturers.

It has just been argued that the aspects of trade liberalization most likely to impact FMMOs are not the provisions of agreements such as GATT and NAFTA which call for reduced subsidies, more access, and lower tariffs on manufactured products, but rather the ability to move raw or packaged milk across national borders. Thus, the focus must be on trade with those countries sharing a border with the U.S. as it is simply not economical nor feasible to haul bulky, perishable milk over long distances or to transport it by sea.

It is the differential value that FMMOs place on milk destined for fluid uses versus manufacturing that provides the incentive to incur the additional transportation costs associated with avoiding having to pay the class I price. This incentive is directly influenced by the proximity of major U.S. fluid milk demand markets to the nearest border with a neighboring country. Finally, there are some important legal or regulatory authority questions facing the FMMO program which impact the economic issues raised by trade liberalization. Non-economic factors which may mitigate or exacerbate the direct economic impacts of trade liberalization will be discussed toward the end of this report.

MODEL

In this section of the report, the model used to perform the analysis is described. Assumptions about the structure of the dairy sector which have important implications for the way it is modeled are also discussed. The United States Dairy Sector Simulator (USDSS), a model previously constructed and maintained by the Cornell Program on Dairy Markets and Policy, was extended and modified for use in this study. This section begins by briefly describing a stylized view of the structure of the North American dairy sector and serves as the basis for discussing the modeling framework.

The dairy sector, for the purposes of this study, comprises the dairy sectors of Canada, the U.S., Mexico, and an aggregate rest-of-the-world (r.o.w.). The focus, however, is on the U.S. Broadly speaking, the sector can be described as one where a primary commodity, milk, is produced on geographically dispersed farms from where it must be transported to processing facilities where it is then transformed into intermediate and final consumer products. Intermediate products are shipped to other processing points where they undergo further transformation while final products are distributed to consumers. The spatial separation of farms from large population centers, with both broadly scattered across the region, makes this a complex spatial markets problem. For analytical purposes, the sector can be logically segmented into three market levels; production, processing, and consumption. A critical point is that representation of at least these three market levels is essential to the present analysis.

The first market level to be considered is the farm level. Here the production of raw milk occurs. An important point to note is that milk, despite its appearance, is not a homogenous commodity. Its composition varies in response to a wide range of factors; type of feed, breed of cow, and stage of lactation being the most significant. The variation in composition is such that it is common for adjacent farms to each produce milk with materially different composition. Certainly one would expect to find considerable regional and national variability in milk composition. Because processors of milk require the components of milk rather than milk *per se*, this point has a particular significance to them and therefore to this analysis. Milk and milk products are represented in the model on the basis of both their fat and solids-not-fat (SNF) content. Thus, the process of producing milk at the farm level can really be viewed as one of making available to the processing sector supplies of fat and SNF.

Before milk can be processed it must first be assembled at processing facilities. Processing facilities of five types are identified; one for each product class included in the model. They are: class I which includes products destined for fluid consumption such as whole and skim milk, lowfat milk, and flavored milk drinks; class II which includes "soft" products such as cream, yogurt, ice cream, and cottage cheese; and three types of class III products—cheese which includes all cheese types other than cottage cheese; butter which refers to butter and anhydrous milkfat (AMF); and powder which includes dried milk products as well as condensed and evaporated milk. Casein, which is not manufactured in the U.S., and whey products are ignored in this study.

Once the raw milk has been assembled at plants it is ready for processing, the second market level to be considered. In the case of beverage milk, this process may be as simple as standardizing the composition, pasteurizing, and then packaging the milk. Conversely, the milk may undergo considerable physical transformation to produce products such as cheese or dry milk. Fundamentally, what occurs at the processing plant is that the components of milk are first separated, then transformed and/or recombined into desired product forms. Composition varies immensely across product types and classes, and it is frequently quite different from the composition of the raw milk input. The task of allocating the supply of milk components to the multitude of uses for those components falls to the processing sector.

Interplant movements of milk and milk products are an important part of the balancing act which goes on at the processing level. The task is further complicated by the biological nature of milk production on the one hand and the need to meet variable consumer demands on the other. The production of storable products such as NDM and butter using "surplus" milk is the principal means of balancing milk supply with demand on a daily as well as a seasonal basis. It should be noted that interplant movements can, and indeed do, occur across national boundaries. For example, the U.S. exports NDM to Mexico where it is typically reconstituted into fluid milk. The role of the processing sector in the marketing chain is quite complex, not to mention important. For computational simplicity and because collecting the necessary data is difficult, it is frequently ignored in analyses of the dairy sector even though much of the decision making and virtually all of the policy implementation occurs here.

The final market level to be considered is where final products are consumed. Connecting this level of the marketing chain with the processing sector is the distribution system. Under a typical arrangement, finished products are either transported from processing plants directly to retail stores, particularly in the case of perishable products, or they enter some kind of warehousing system from which they are eventually shipped to stores and are purchased by consumers.

Now that the structure of the market to be modeled is understood, the discussion turns to the model itself. The USDSS has been specifically constructed to analyze the U.S. dairy industry. A major distinguishing feature of the model is the highly disaggregated manner in which it handles raw milk assembly, interplant, and final distribution movements. The model represents the dairy sector as the sum of milk supply and dairy product demand locations which are linked by a transportation network passing through a set of milk processing facilities. The model is highly disaggregated and permits a detailed analysis of the implication of marketing costs for milk assembly, the utilization and location of milk processing facilities, the use and interplant movement of intermediate milk products in manufacturing, and the distribution of dairy products as represented by five key categories of products.

Figure 1 provides a concise representation of the model and highlights the structural detail which it embodies. Ten distinct blocks of constraints are identified. Further insights can be gained from the

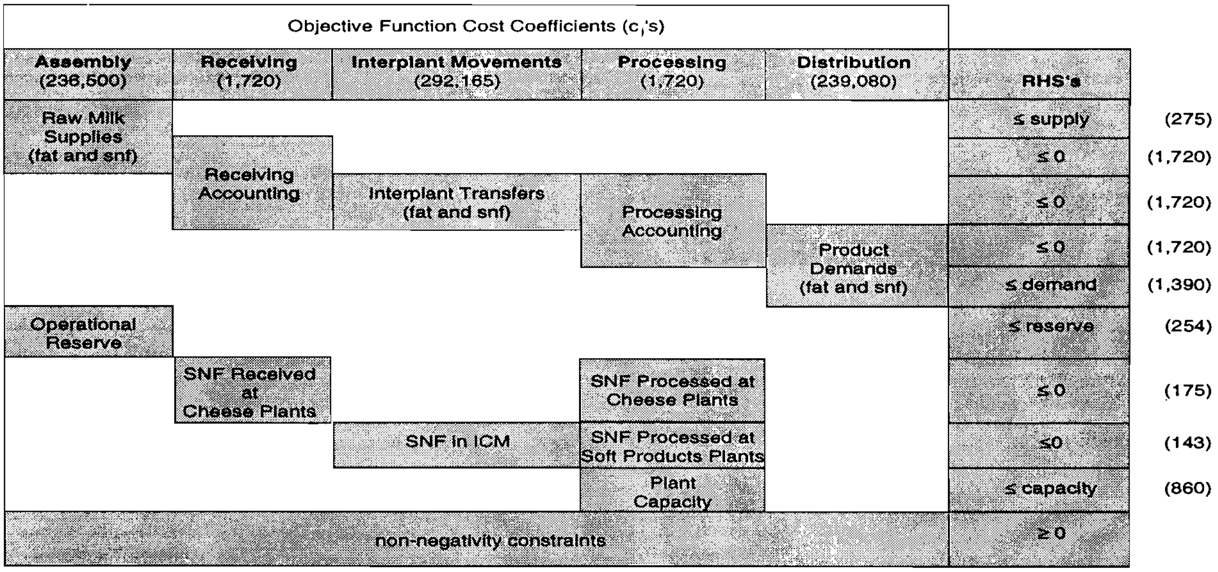


Figure 1. Tableau Representation of the Model

discussion of the data which follows.[4] The model is a quite straightforward, albeit large, linear programming (LP) problem. While technically solved as a linear program, its formulation is along the lines of a network transshipment model. The objective function minimizes the combined costs of assembling milk, moving intermediate products between plants, and distributing final products. Processing costs were assumed to be regionally uniform and were thus ignored.[5]

The constraints in the assembly block are of two kinds. First there are 275 supply constraints, one for each supply point. These constraints require that the sum of the shipments of raw milk from each supply point to receiving (processing) plants must not exceed the quantity of raw milk available at each supply point. Second, there are 1,720 (860 processing nodes times 2 milk components) inequalities which take care of the fat and SNF constraints associated with raw milk supply. That is, they require that the quantity of fat and SNF received at each plant be no more than the sum of what was contained in the raw milk shipments from the supply points. There are 236,500 (275 supply points times 860 processing nodes) variables, or activities, in the assembly block. Note that constraints refer to rows and activities refer to columns in the tableau of Figure 1. The receiving block is nothing more than an accounting activity containing 1,720 variables.

The interplant movement block contains 1,720 (860 processing nodes times 2 milk components) constraints and 292,165 (*i.e.* 13 interplant movement types among the 860 processing nodes) activities. Here the constraints require that the amount of fat and SNF received entering each plant, either in the form of raw milk or as an intermediate product, must at least exceed the amount of each component which that plant ships out. The components shipped out of a plant can, of course, take the form of intermediate products destined for another plant, or they can be in the form of final products headed to the consumption sector. Just like receiving, the processing block is an accounting activity, and it too contains 1,720 variables.

Next, we have the distribution block which is responsible for ensuring that the quantity and composition of each product demanded at each of the consumption points is satisfied by the processing sector. This block contains 239,080 (860 processing nodes times 278 consumption points) activities and 3,110 constraints. The first 1,720 (860 processing nodes times 2 milk components) constraints ensure that the component requirements of the demanded products are satisfied. The following 1,390 (278 consumption points times 5 product types) constraints in the distribution block ensure that the quantity of final product shipped to each consumption point is sufficient to meet the specified demand of each product at that point.

The next four blocks of constraints may be considered secondary in the sense that the model would remain a well-posed problem if any or all of them were removed. However, they each play an important role and have been added to provide additional realism to the model. The first of these constraints is our so-called operational reserve requirement. This set of constraints imposes a restriction on assembly shipments such that no more than 85 percent of the raw milk available at any supply point can be shipped to a fluid plant. It reflects the reality that fluid plants do not operate seven days per week yet farmers must market their milk daily. The constraint is not applied in Mexico because much of the packaged milk in Mexico is the result of reconstitution.

The next two sets of constraints impose restrictions on the use of SNF at soft products and cheese plants. They are applied only in the case of Canada and the U.S., and are designed to ensure that the model produces outcomes that reflect common management practices. The first requires that at least 50 percent of the SNF used at cheese plants must come from raw milk shipped directly to the cheese plant. The second prevents soft products plants from emulating a stand-alone ice cream plant. In other words, the soft products plants represent a range of product varieties, not just ice cream. It achieves this by requiring that no more than 50 percent of the SNF used to produce

[4]For a comprehensive discussion of the USDSS and its data requirements, refer to Pratt *et al.,* 1997.

[5]Although not employed for this study, the model can be formulated to incorporate scale economies in the processing activity; a desirable feature of analyses for which efficient plant location choices are important.

finished products can enter the plant in the form of ice cream mix.

Finally, there are 860 plant capacity constraints (one for every processing node). While plant capacity could be set to any level at all, for this study it was either set at zero to disallow processing or it was set arbitrarily high to enable processing to occur. The model determines the actual level. At each processing location there are potentially five plant types. The capacity constraint is used to switch on only those plant types that are required to operate at a particular location.

In total, there are 8,257 constraints to the problem, not counting the usual non-negativity constraints, and 771,185 variables. The model is coded in GAMS, the General Algebraic Modeling System, and is run on an IBM RS6000 workstation. The solution algorithms are selected from IBM's Optimization Software Library (OSL). A "typical" run takes approximately two hours of CPU time.[6]

DATA

We now turn to the data required by the model. The preceding discussion has already alluded to the model's data needs; here we focus on the sources and construction. The data compiled for this analysis builds upon the USDSS's 1993 data files. Annual data have been compiled from secondary sources in a manner consistent across all of the regions. Even though Mexico, Canada, and the aggregate rest-of-the-world region are explicitly included in the model, although not at the same level of disaggregation as the U.S., the focus is on the U.S. For each type of data, the collection and construction process is first described as it pertains to the U.S. Whenever necessary, the procedures germane to Canada, Mexico, and the rest-of-the-world are contrasted with those applicable to the U.S.

The first task in compiling the data was to construct a list of cities, or nodes, to represent the locations of economic activity pertaining to supply, processing, and consumption. This study utilizes 565 such nodes; 492 in the U.S., 17 in Canada, 46 in Mexico, 9 to represent points of trade with the rest of the world, and one to represent stockholding in the U.S. Of the 9 trade nodes, 7 represent the major sea ports through which imports to the U.S., Canada, and Mexico occur while the other two represent export transshipment sites, one for the U.S. and one for Canada. Each node may be a production site, a processing site, a consumption site, or some combination of all three. There are 275 supply points, 416 potential processing sites (each of which may potentially be associated with 5 plant types), and 278 consumption centers. The domestic U.S. portion consists of 240 supply points, 359 processing sites, and 234 consumption points.

A key element of the USDSS is transportation costs. Because transportation costs are a function of distance, it is necessary to know the distance in miles from each city to every other city. It is assumed that all transportation occurs along interstate and other major highways. A shortest path algorithm was used to generate the matrix of distances separating every pair of cities. Only the distance between two cities matters to the model; the actual route taken is irrelevant although it will, by construction, be the shortest one possible. Implementation of the shortest path algorithm only requires that a network of distances which connects all cities be constructed. In other words, using the shortest path algorithm avoids the need to manually determine all 159,330 distances (*i.e.*, 565*564/2 = 159,330).

For each of the 275 supply points, a fixed quantity of raw milk and an associated fat and SNF content were specified. The supply of raw milk represents actual 1993 marketings rather than production. Figure 2 illustrates the spatial distribution of the milk supply in North America. While the supply of farm milk from the r.o.w. is not relevant to this analysis because it is not viable to ship such milk to the U.S., each of the seven import nodes are assigned a virtual supply of raw milk; the purpose of which is to make available the components necessary to generate the desired imports. The 240 U.S. supply areas represent the milk marketings from farms in the county or aggregate of counties comprising that particular area. Each of the 3,111 U.S. counties and independent cities in the 48 contiguous states were

[6]By March, 1999, models of this genre were being solved on our NT workstation in less than 90 minutes using GAMS/OSL and in less than 50 minutes using GAMS/CPLEX.

Figure 2. Proportional Representation of Raw Milk Supply

aggregated into one of the 240 supply areas based on the spatial distribution of either milk cows or milk production within each state. A single city was then chosen to represent supply within each area. The U.S. supply data were compiled from USDA milk production statistics, (USDA, 1994). Milk marketing data for Canada were similarly estimated, while those for Mexico were drawn from the work of Nicholson (1996).

The raw milk supply data are summarized in Table 1. Approximately 147.9 billion pounds of milk were marketed in the U.S. in 1993. The composition of U.S. raw milk varies across states and through time although on average it was estimated to be 3.66 percent fat and 8.64 percent SNF in 1993. Relatively plentiful and reliable data were available for determining the fat content of milk in most regions but ascertaining a reliable estimate of the SNF content was not always so easy. In some cases, the best approach was simply to estimate it assuming a certain degree of correlation with the fat content. Canadian milk marketings were estimated to be 17.3 billion pounds in 1993 and were apportioned to one of 14 supply areas based upon knowledge of where the milksheds were located. The composition of farm milk in Canada was assumed to be uniform over the entire country at 3.81 percent fat and 8.90 percent SNF. Estimates of milk marketings in Mexico are notoriously unreliable and variable. Because Nicholson (1996) invested considerable time estimating milk marketings and reconciling the milk component balance in Mexico, the data from his study were used here and are reported in Table 1. Following Nicholson, however, the fat content of raw milk marketings in Mexico was adjusted downward to 2.32 percent as it was not possible to otherwise reconcile the fat balance in Mexico.

Table 1. Summary of Raw Milk Supply Data

	Quantity (billion lbs)	Fat %	SNF %	Number of Nodes
Country				
U.S.	147.89	3.66 (avg.) 3.46 (min.) 3.78 (max.)	8.64 (avg.) 8.55 (min.) 8.69 (max.)	240
Canada	17.34	3.81	8.90	14
Mexico	15.83	3.30	8.60	14
Total	*181.06*			
Import Sector				
U.S.	1.20	7.38	23.78	3
Canada	0.40	2.67	8.18	2
Mexico	10.00	10.37	33.29	2

The seven import nodes were each assigned an arbitrary raw milk supply with an associated composition that allowed the required imports to be "produced" and delivered. Note that the composition of this milk is set such that a given level and mix of imports is able to be supplied. Apart from the importation of manufactured products, the import sector is completely disconnected from the rest of the North American dairy sector. In other words, imports of intermediate and final products were simulated in the model by allowing raw milk to enter a processing node which then delivered the products to the appropriate country. The ports of New York, Houston, and San Francisco were specified to be the entry points for dairy imports into the U.S. Similarly, Vancouver and Montreal were the import nodes in Canada, while in Mexico, the ports of Veracruz and Manzanillo were used. Each of these 7 ports were connected directly to the nearby city so, in essence, imports from outside of the three North American countries are considered to arrive by sea at the respective ports at which point they are transferred to the road transportation system.

Of the 416 potential processing locations, 359 are in the U.S., 17 are in Canada, 33 are in Mexico, and the import sector has 7. However, it is not always the case that all five product classes can be manufactured at every processing location. After determining which classes of product are processed at each site, the capacity of the corresponding plant type at each location was set accordingly. Because the capacity of all active plants was set arbitrarily high, it was left to the model to determine the precise level of activity at each plant. Of the 359 processing sites in the U.S., class I products are able to be produced at 271, class II at 126, cheese at 158, butter at 65, and powder at 55. Due to the level of aggregation present in the representation of the Canadian dairy sector, production of all five product classes is able to occur at each of the 17 Canadian processing nodes. In Mexico, production of class I products can take place at all 33 of the processing nodes, while class II products and cheese are produced at only 17, and butter and powder at 8. The location of all North American aggregate fluid milk processing facilities is shown in Figure 3.

The import nodes also have processing facilities commensurate with the type of imports allowed from the r.o.w. into each North American country. It is important to appreciate that the import sector exists only to supply products from the r.o.w. It was assumed that U.S.-Canada and U.S.-Mexico trade occurs via the road network. Canada-Mexico trade, of which there is a small amount, takes place via sea freight. Therefore, Canadian exports to and Mexican imports from the r.o.w. are adjusted accordingly. Imports from the r.o.w. to the U.S. and Canada are assumed to be strictly final products and are therefore destined for consumption points. However, in Mexico imports are able to enter as either intermediate or final products. Intermediate products are, of course, utilized at processing locations.

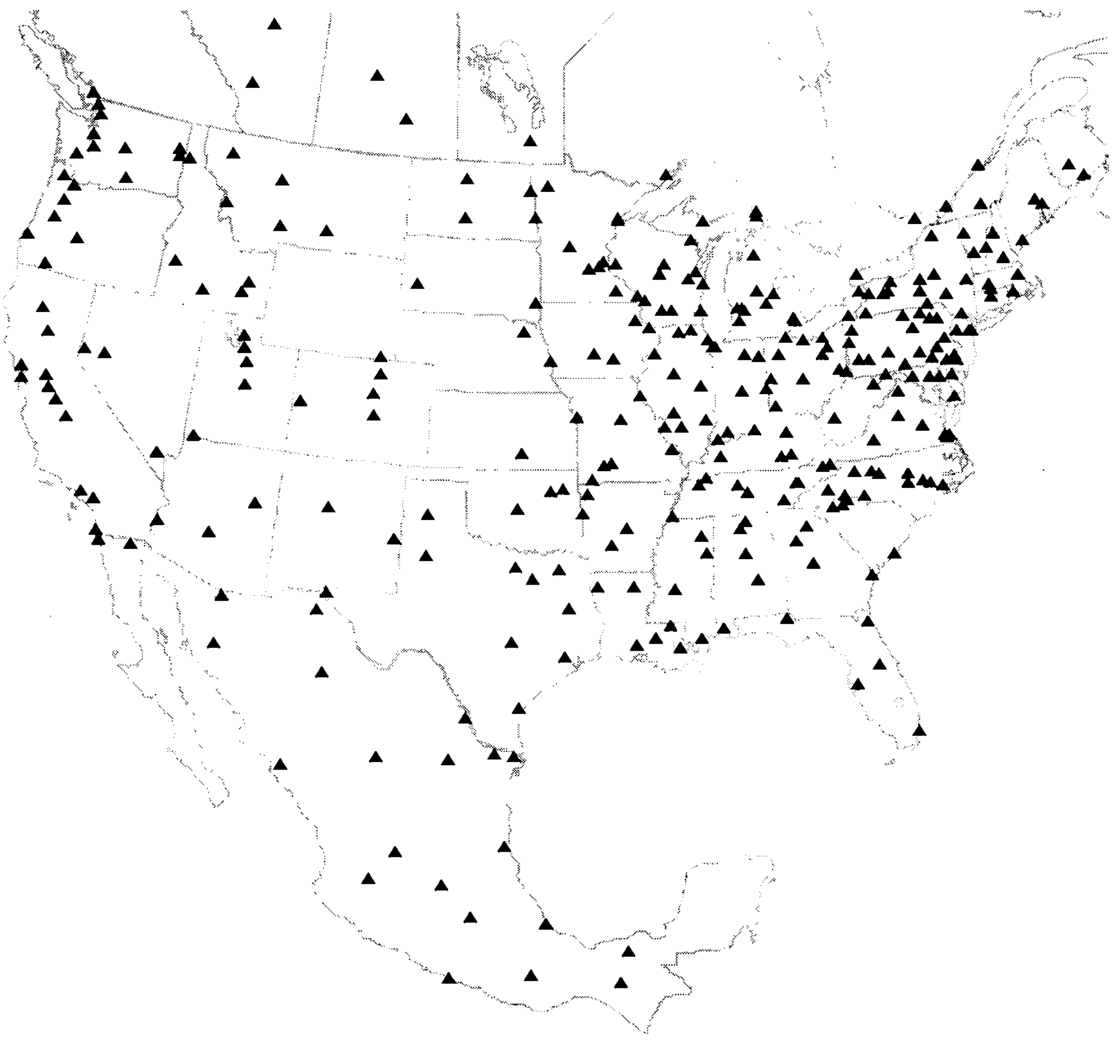


Figure 3. North American Fluid Milk Processing Locations

The Mexican fluid processing sector contains an additional level of complexity not present in Canada or the U.S. Beverage milk in Mexico is frequently manufactured from dairy ingredients rather than fresh raw milk. Most of Mexico's imported NDM and AMF is used for just this purpose. Hence, it does not make sense to allow such fluid processing plants to ship final products to the U.S. Essentially, what we have are two different products yet both are being classified as fluid milk. One way around this problem which avoids the creation of a sixth product category, and the attendant increase in model dimensions, is to duplicate plants. Thus, at 16 of the 17 Mexican fluid milk processing sites, there are actually 2 distinct plants; one able to receive raw milk and interplant transfers but unable to distribute fluid milk to the U.S., and a second which is only able to receive raw milk but which is able to deliver fluid milk to the U.S. as well as to Mexico.

Interplant movements are a unique feature of this model allowing it to more closely resemble the actual structure of the industry. Such product movements have been defined according to the type of plant they come from, the type of plant they go to, and the type of intermediate product. A total of 13 interplant movement types were thus defined. If one considers intermediate products on the basis of composition, there are then literally hundreds of different product types that move between plants on a daily basis. The 13 used here are just a small representative subset and are comprised of 4 cream, 1 skim milk, 2 ice cream mix, 3 NDM, and 3 AMF movement types. The shipment of unused fat in the form of cream from a fluid plant to a butter plant, and the use of NDM to standardize milk used in the manufacture of cheese are just two examples of the kinds of interplant movements able to be simulated by the model. The only case where AMF plays a role is as an interplant movement from the import sector to plants in Mexico.

Moving now to consumption, there are 278 consumption areas in the model; 234 for the U.S., 17 for Canada, and 24 for Mexico. In addition, there is a single node representing U.S. government purchases and changes in stocks, a node representing the destination of U.S. exports, and a similar node for Canadian exports. Mexico does not export, other than to the U.S., and such movements occur via the road network rather than through the simulated export sector. At all but the last three mentioned consumption areas, each of the five product classes are consumed. The data required for each consumption area consists of the quantity of product consumed, as well as its fat and SNF content. Consumption areas in the U.S. were selected on the basis of state and FMMO boundaries and also to reflect the spatial distribution of population within each area. Mexican consumption data comes directly out of Nicholson's (1996) study. Data for Canada were compiled in a fashion analogous to that used for the U.S. and drew from a variety of secondary sources. The data for Canada and Mexico are more spatially aggregated than those for the U.S.

Consumption data were, in general, compiled as follows (see also Pratt *et al.*, 1997). Demand on a *per capita* basis was obtained for each of the products comprising the five product classes included in the model. A weighted average was then computed for each class where the weights were simply the individual product's proportion of the entire class. This weighted average *per capita* demand figure was then multiplied by the population of each consumption area to give the total quantity demanded in each consumption area. *Per capita* demand data for fluid products in the U.S. were obtained from FMMO statistics and were computed for each federal order by dividing total sales of all products in the class by the population in the area covered by the marketing order (USDA, 1994). Thus, *per capita* demand varies geographically. Figure 4 illustrates geographically the total demand for class I products throughout North America.

Per capita consumption of class II products in the U.S. was obtained from the USDA's Nationwide Food Consumption Survey, 1978-79. The figure was then adjusted by an index reflecting regional differences in consumption patterns across the U.S. Consumption for the cheese, butter, and powder classes in the U.S. were estimated by adding imports to production and subtracting exports and changes in stocks. A regional index was used to adjust consumption of the cheese, butter, and powder classes. The regional indices were computed using information from the USDA's food surveys and were designed to account for regional differences in consumption habits.

A complete reporting of all the demand and composition data by consumption area is not attempted as it is simply too extensive. However, *per capita* and total consumption data are summarized in Table 2. As an aside, note that the SNF requirement for cheese must be adjusted upward from the figures reported in Table 2 to account for the milk solids lost to the whey during the cheese making process. Without such an adjustment, an insufficient quantity of milk would be drawn into the cheese processing sector. In the U.S. and Canada, the cheese SNF figures were scaled by 3.1 and in Mexico by 3.5, reflecting lower yields in Mexico due to poorer cheese processing technology. It is important to understand that all product classes reflect weighted averages of a variety of products. Thus, the composition data will not reflect exactly the composition of any particular individual product. Also, the requirements for fat and SNF in Mexico tend to be lower than for the U.S. because a number of non-dairy ingredients are commonly used by Mexican manufacturers.

Incorporating trade between each of the three North American countries and the r.o.w. was not crucial to this analysis as it involved only manufactured products. Such trade could have been accounted for by simply adjusting the demand data. However, explicitly including it allows certain scenarios to be analyzed more easily, and it provides for a more complete reconciling of component supplies and uses. Table 3 summarizes the trade between North America and the rest of the world. Note that these data have been adjusted to exclude intra-North American

Figure 4. Proportional Representation of Class I Demand

trade. In particular, the share of Mexico's imports that originated in the U.S. had to be excluded as such exports enter Mexico via the road transportation system in this model. Imports and exports were averaged over the period 1990-93 so that the effect of holding stocks could be minimized.

A fundamental element of the model is the cost incurred by transporting and marketing milk and milk products. Indeed, the model's objective is to minimize the total of such costs. A large number of factors contribute to the cost of hauling a good from one point to another; fuel, labor, and the cost of the capital are three of the more significant cost items. Gross vehicle weight limits, which, in the U.S., vary by state and range from 80,000 pounds to 164,000 pounds, also play an important role in determining costs. Raw milk assembly, interplant shipment, and final distribution cost functions for the U.S. are listed in Table 4. These functions were taken from Pratt *et al.* (1997).

Note that raw milk assembly is estimated to be a linear function and in the absence of adjustments for gross vehicle weight limits and the cost of labor is estimated to be 40 cents per hundredweight per 100 miles. The cost of shipping cream, skim milk, and ice cream mix between plants is specified to be the same as that for raw milk assembly except that an additional fixed charge of

Table 2. Average Adjusted Per Capita Demand, Aggregate Demand, and Composition, by Country

	Class I	Class II	Cheese	Butter	Powder
U.S.					
Per capita, lbs	220.5	34.9	26.9	5.0	9.5
Total, mil. lbs	55862.2	8850.4	6809.8	1267.3	2415.5
fat %	2.58 (avg.)	7.83	28.49	81.11	3.68
	1.92 (min.)				
	3.26 (max.)				
snf %	8.73	11.07	26.80	1.00	39.05
Canada					
Per capita, lbs	221.9	28.0	22.9	8.0	10.7
Total, mil. lbs	6739.4	849.9	696.5	241.8	323.5
fat %	2.70	7.93	28.88	81.20	3.80
snf %	8.73	11.07	27.48	1.00	48.08
Mexico					
Per capita, lbs	148.5	6.6	6.7	0.9	4.4
Total, mil. lbs	12918.1	575.0	586.9	767.2	379.2
fat %	2.44	3.68	15.62	50.00	14.01
snf %	8.67	18.74	22.99	1.00	33.55

three cents per hundredweight is added. The purpose of this additional charge is to reflect the cost of handling and reloading. Distribution costs are specified as nonlinear functions and are divided into two categories; those that do require refrigerated transportation and those that don't. The interplant shipment of NDM and AMF is assumed to be the same as distributing the dry, condensed, and evaporated class of products plus a fixed charge of six dollars per hundredweight to cover the cost of processing and handling. The cost functions incorporate an adjustment mechanism to account for labor costs and gross vehicle weight limits. Note that in the case of raw milk assembly and the interplant movement of cream, skim milk, and ice cream mix, the applicable gross vehicle weight limit is restricted to 100,000 pounds. This reflects the fact that bulk-tank trucks typically do not exceed 100,000 pounds when fully laden. The cost of labor enters the cost functions in the form of an index of wages. The wage index used is that applicable at the city associated with the trip destination.

Transportation costs in Canada and Mexico were determined to be linear transformations of those applicable in the U.S. Specifically, costs within Canada were deemed to be 20 percent higher than those in the U.S., primarily due to higher fuel, labor, and taxation costs. Based upon a synthesis of Nicholson's (1996) findings, the transportation costs within Mexico were set to be 86 percent of those in the U.S. For the purpose of specifying the Canadian and Mexican costs, the

Table 3. North American Trade With the Rest of the World, Excluding Intra-North American Trade (1990-1993 average)

	Cheese	Butter (million lbs)	Powder
Exports			
U.S.	27.64	245.35	185.84
Canada	22.05		116.84
Imports			
U.S.	320.81	4.92	4.21
Canada		39.68	
Mexico	33.51	59.36	372.33

Table 4. Raw Milk Assembly, Interplant Shipment, and Final Product Distribution Cost Functions for the U.S.

Raw Milk Assembly:

$$\$/100\text{ lb.} = 0.004 * \text{MILES}_{i,j} * \left(\frac{80,000}{\text{RGVW}_{i,j}}\right) * (0.65 + 0.35 * \text{WI}_i)$$

Interplant Shipments:
Cream, Skim Milk, and Ice Cream Mix

$$\$/100\text{ lb.} = 0.03 + 0.004 * \text{MILES}_{i,j} * \left(\frac{80,000}{\text{RGVW}_{i,j}}\right) * (0.65 + 0.35 * \text{WI}_i)$$

NDM and AMF

$$\$/100\text{ lb.} = 6.0 + 0.022 * \text{MILES}_{i,j}^{0.73} * \left(\frac{80,000}{40,000 + 0.5 * \text{GVW}_{i,j}}\right) * (0.52 + 0.48 * \text{WI}_i)$$

Final Product Distribution:
Class I, Class II, Cheese, and Butter

$$\$/100\text{ lb.} = 0.0245 * \text{MILES}_{i,j}^{0.73} * \left(\frac{80,000}{40,000 + 0.5 * \text{GVW}_{i,j}}\right) * (0.52 + 0.48 * \text{WI}_i)$$

Dry, Condensed, and Evaporated Products

$$\$/100\text{ lb.} = 0.022 * \text{MILES}_{i,j}^{0.73} * \left(\frac{80,000}{40,000 + 0.5 * \text{GVW}_{i,j}}\right) * (0.52 + 0.48 * \text{WI}_i)$$

where:

i = the originating location and j = the destination location,
GVW = the smallest Gross Vehicle Weight limit encountered en route from point i to point j,
RGVW = the GVW restricted to no more than 100,000 pounds, and
WI = the wage index.

wage index was set equal to one and the gross vehicle weight limit was set equal to 80,000 pounds.

A further adjustment to all costs was required for shipments, of any type, which cross national borders to reflect the additional costs a hauler incurs when doing business in another country. For example, a hauler must obtain a state-issued license for all states in which he intends to operate. Road-user fees must be paid on state-by-state basis. Additional documentation and time is required when crossing borders. And, in the case of Mexico, the driver must be familiar with the English language. Based upon these and other factors, the following adjustments were made to all cross-border shipments. As with intra-national shipments, all costs were assessed from the point of origin. Shipments to either Canada or Mexico that originate in the U.S. were estimated to be 5 percent more costly than shipments within the U.S. The cost of Canadian shipments to the U.S. remained at 120 percent of the within-U.S. costs under the assumption that the extra costs incurred by a Canadian hauler doing business in the U.S. would be offset by the ability to purchase fuel at a considerably lower cost in the U.S. Mexico to U.S. shipments were estimated to be 95 percent of the within-U.S. costs compared with 86 percent for the within Mexico routes.

Finally, the class I differential applicable at each demand point in the model was also required. Although, in reality, class I differentials are generally associated with assembly movements and the plant of first receipt, they actually vary according to demand or marketing areas, and not by the location of production or processing. Moreover, it is the milk's ultimate end use which

Table 5. Base Zone Class I Differentials and Class I Utilization by Marketing Area

Marketing Area	Federal or State or Unregulated	Differentials ($/cwt) (at 3.5%)	Differentials ($/cwt) (adjusted)	Pricing Zones in Model	% Cl. I Utilization
Carolina	F	3.08	2.42	3	77.7
Central Arizona	F	2.52	2.07	4	48.3
Central Illinois	F	1.61	0.94	1	65.9
Central Pennsylvania	S	2.74	2.17	1	43.0
Chicago Regional	F	1.40	0.88	5	17.8
E. Ohio-W. Pennsylvania	F	2.00	1.27	1	50.1
Eastern Colorado	F	2.73	2.45	3	44.4
Eastern South Dakota	F	1.50	0.73	2	na*
Great Basin	F	1.90	1.26	3	35.4
Greater Kansas City	F	1.92	1.37	1	66.3
Indiana	F	1.90	1.09	3	63.8
Iowa	F	1.55	0.79	3	31.8
Louis.-Lex.-Evansville	F	2.11	1.37	2	72.1
Maine	S	3.24	2.91	1	50.0
Michigan Upper Peninsula	F	1.55	0.78	1	71.1
Middle Atlantic	F	3.03	2.46	5	44.9
Montana	S	2.55	1.94	1	68.7
N. California	S	1.80	1.26	1	27.8*
Nebraska-W. Iowa	F	1.75	1.12	3	35.0
Nevada	S	1.02	0.38	1	89.0
New England	F	3.24	2.91	6	49.4
New Mexico-W. Texas	F	2.35	1.98	3	39.4
New York-New Jersey	F	3.14	3.00	5	41.5
Ohio Valley	F	2.04	1.36	4	55.6
Pacific Northwest	F	1.90	1.25	3	32.9
S. California	S	2.07	1.55	1	27.8*
S. Illinois-E. Missouri	F	1.92	1.56	5	51.4
S.W. Idaho-E. Oregon	F	1.50	1.11	1	10.1
Southeast	F	3.08	2.38	13	74.9
Southeastern Florida	F	4.18	3.76	1	82.8
Southern Michigan	F	1.75	1.07	3	43.5
Southwest Plains	F	2.77	2.41	7	35.9
Tampa Bay	F	3.88	3.18	1	83.8
Tennessee Valley	F	2.77	2.13	4	80.3
Texas	F	3.16	2.64	5	49.2
Unregulated	U	0.00	0.00	1	—
Upper Florida	F	3.58	2.87	2	76.8
Upper Midwest	F	1.20	0.27	3	16.5
Virginia	S	4.03	3.39	1	64.2
W. New York	S	2.30	2.16	1	41.0
Western Colorado	F	2.00	1.79	1	na*

* Eastern South Dakota is pooled with Greater Kansas City.
Western Colorado is pooled with Eastern Colorado.
California is pooled on a statewide basis but has two marketing areas.

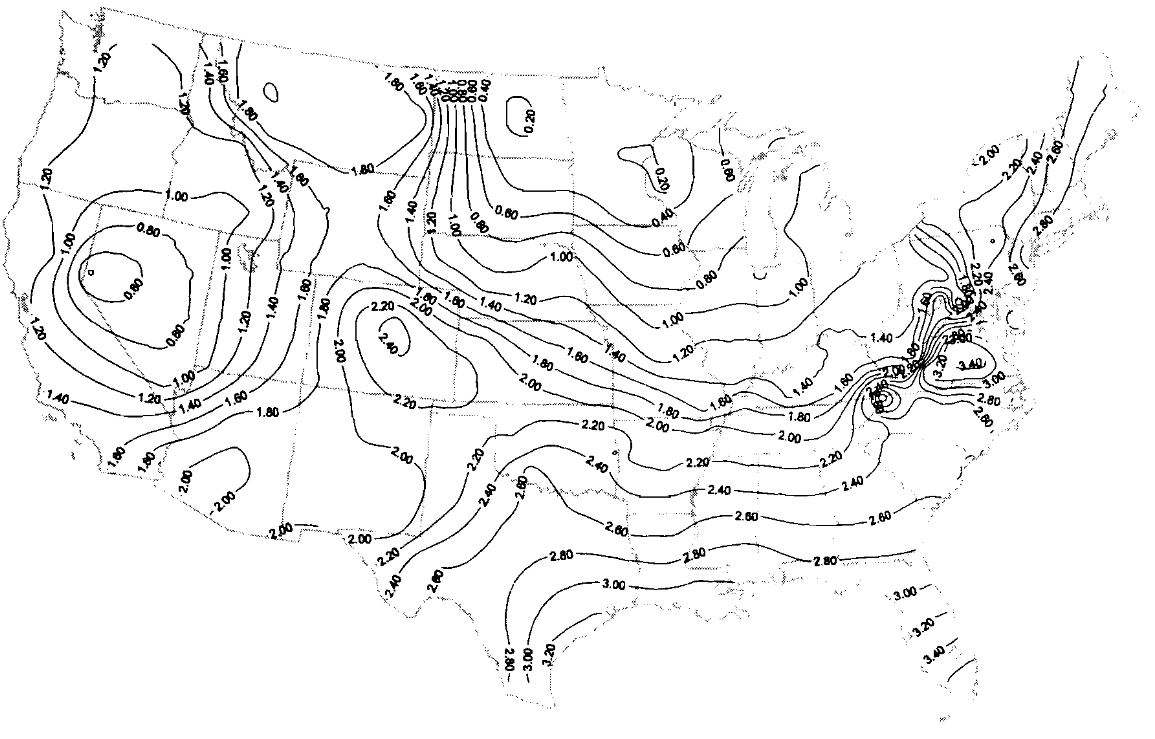


Figure 5. Fat-Adjusted Class I Differential Surface ($/cwt.), 1995

determines the appropriate class. Hence, the differentials were added to the distribution cost functions as an additional fixed amount. Any shipment of class I milk, provided it originated in the U.S., was therefore subject to the differential applicable at the demand point.

All 234 class I demand nodes from the U.S. portion of the model were *a priori* assigned to a pricing zone within one of 41 milk marketing areas. Thirty-two Federal Milk Marketing Orders, eight state marketing areas, and one unregulated area were identified to cover all class I milk sales. Within each marketing area there may be a number of pricing zones where the differential will be different from that applicable at the base zone. In all, 116 pricing zones were identified. Table 5 lists the base zone class I differentials for the 41 marketing areas included in the model. Class I utilization within each marketing area is also noted.

Although class I differentials are reported at the standard 3.5 percent butterfat, it was necessary to adjust them according to the fat content of the fluid milk demanded at the applicable consumption area. Class I differentials were adjusted according to the following formula: $Diff_i = Diff_{3.5} - 5.9*(35 - 10*fat\%_i)/100$, where $Diff_i$ is the adjusted class I differential at node *i* in dollars per hundredweight; 5.9 is the 1994 average butterfat differential in cents per 0.1 percent of butterfat; 35 is the standard 3.5 percent fat test multiplied by 100; and $fat\%_i$ is the fat test of fluid milk demanded at node *i*. Figure 5 illustrates how the fat-adjusted class I differentials vary across the U.S. At each demand node, the fat content of the class I product category is slightly biased upward due to the inclusion of cream in this category when in fact cream should more properly have been included in the class II category. This does not unduly affect the results and is merely a quirk of the demand data originally being grouped on a weight-reduced basis rather than to facilitate the analysis of federal orders.

A couple of final points regarding data should be noted. First, in modifying the USDSS to suit this study, the data were selected to be representative of 1993 primarily because that was the most recent year for which the existing data files had been updated. However, the milk marketing order data are more recent. For instance, the number of federal orders reflects the existence of the newly formed Southeast marketing area which was established in 1995. Also worth clarifying is the choice of 1994 for the class I utilization data. These data were not required by the model *per se*, but were used *ex post facto* when calculating producer receipts as implied by the distribution of class I products. Regardless, 1994 utilization data were used because the 1993 figures were somewhat aberrant. Approximately 6.4 percent of the class III milk in the Chicago Regional and Upper Midwest orders was voluntarily depooled in 1993 due to large price swings. Hence, using the class I quantity and utilization figures to imply actual producer receipts would have been misleading.

KEY SIMULATIONS

Introduction

Three key simulations are described in this section of the report—the base solution, the free trade (or trade liberalization) simulation, and the class I credit simulation. The intent of this section is to sufficiently describe each simulation so that the differences between each of them are clearly understood. Further discussion of the solutions and a more in-depth comparison is reserved for the Results and Discussion section.

The Base Solution

In order to perform any analysis of a new policy or market environment, it is necessary to first establish a base from which to make comparisons. This section describes the base solution used for such comparisons in this study. The base solution is designed to simulate the economic activity and policy settings in the U.S. dairy sector, particularly as it relates to marketing orders. Therefore, in the base scenario, grade A milk is priced under federal or state regulation; imports occur, primarily of cheese subject to quotas; and some exporting, especially of NDM to Mexico, takes place as well.

An overall impression of the base solution can be gained from viewing the thematic maps in Figures 6 and 7. These maps represent, respectively, the flows of raw milk from farms, or supply points, to fluid milk processing locations, and flows of class I products (beverage milk) from plants to consumption areas. The flows are depicted by the lines. The solid triangles represent plants[7] and their size gives a relative indication of the level of activity. Thus, in Figure 6, the triangles denote the destination end of the flows, while in Figure 7, the triangles denote the origin of the flows. The maps representing raw milk assembly show the milk supplies with light gray circles. Those representing packaged milk distribution show the consumption areas with light gray squares. A triangle without a line radiating from it implies the particular processing activity is using local milk supplies and distributing to local demand markets. These conventions will apply to all subsequent thematic maps presented throughout this report.

Immediately noticeable from these maps is that fluid milk processing locations tend to be near the consumption areas and farther away from the raw milk supply areas. The appearance of many more black triangles on gray squares in Figure 7 than there are black triangles on gray circles in Figure 6 attests to this. Indeed, the weighted average length of raw milk shipments to fluid plant locations in the U.S. is 77.5 miles while for packaged milk distribution movements which terminate in the U.S. it is only 11.0 miles. This phenomenon is consistent with both economic theory and other studies (Bressler, 1958; Francis, 1992), and general observation. There are 192 U.S. fluid plant locations receiving a total of almost 57.9 billion pounds of farm milk in the base solution. Some 55.9 billion pounds of packaged milk were distributed from these processing points to the U.S. consumption areas. In addition, these fluid processing plants shipped out cream for use in other types of plants. To avoid cluttering the thematic maps, interplant shipments of intermediate products such as cream are not indicated.

On the basis of actual North American interregional trade, the only permissible cross-border movements in the base scenario were between the U.S. and Mexico. The model ob-

[7]It should be understood that a reference to either plants or plant locations refers to processing activity aggregated to a single point. It does not suggest that there literally ought to be only one actual plant at the particular location.

Figure 6. Raw Milk Flows From Supply Points to Class I Processing Locations, Base Solution

tained an optimal solution without shipping packaged milk across the U.S.-Mexico border. There were, however, some U.S. shipments of raw milk, cream, and final manufactured products to Mexico in the base solution.

Although this model has been constructed with structural simplicity in mind, there remains ample opportunity for misspecification that can lead to results which do not conform to expectations. The base solution, however, is entirely consistent with expectations. Based on the model's output, we estimate there to be about 140 billion pounds of regulated grade A milk received at plants; roughly 113 regulated by federal orders and about 27 under state programs. Adding to this another billion or so pounds of unregulated grade A sales, approximately 2 billion pounds of direct sales by suppliers, and about 6 or 7 billion pounds of grade B milk yields the 149.1 billion pounds of milk actually marketed in 1993.

Trade Liberalization Without Regulation of Foreign Plants

This simulation examines the impact on FMMOs when trade policies are liberalized and fluid milk processors located outside the U.S. are not legally able to be regulated under the terms and provisions of federal orders. This is not to say that the products such processors might ship to the U.S. do not have to meet the necessary

Figure 7. Class I Distribution Flows From Processing Plants to Consumption Areas, Base Solution

sanitary standards or conform to the identity standards of the particular product being shipped. It simply assumes that the administrators of federal orders have no jurisdiction to require plants located outside of the U.S. to abide by the rules of the order in which they sell class I products. In particular, such plants do not have to pay producers the blend price, nor do they have to contribute to the order's producer settlement fund. To the extent that class I differentials more than cover the extra cost of transporting raw milk and/or final fluid milk additional distances, processors in Canada and Mexico have an incentive to ship fluid milk to the U.S., using as an input either local raw milk or raw milk procured in the U.S.

The degree of trade liberalization included in this particular scenario is extensive. In fact, complete free trade among the NAFTA countries in raw milk, intermediate products, and final products, both fluid and manufactured, is permitted. The quantity of imports allowed to enter any of the NAFTA countries from the rest of the world was left at the base case levels. It has already been argued that such trade would not involve fluid products and would therefore have no bearing on the performance of FMMOs. The supply of raw milk displaced by increased imports of manufactured products would, over time, diminish or continue to be utilized in the class III category. Either way, while there could well be competitive implications for the U.S. dairy sector, they are unrelated to the operation and performance of FMMOs so are of no concern to this study. The blend price in any particular order might decrease as a result of increased imports of manufactured products, but this does not in and of itself imply a problem with the functioning of federal orders.

Before proceeding, it may be helpful to review some of the underlying factors upon which this and subsequent solutions are predicated. First, the focus of the analysis is on the potential first round impacts and what they suggest about the incentive to circumvent marketing order regulations under liberalized trade. Indeed, because the model features no simultaneous price response on either the supply or the demand side, it would be incorrect to interpret the results as being the long run equilibrium outcome. If the consequences of trade liberalization for marketing orders were severe, and assuming the U.S. Congress continues to believe that orders are warranted, one would logically expect some kind of policy response to mitigate these affects.

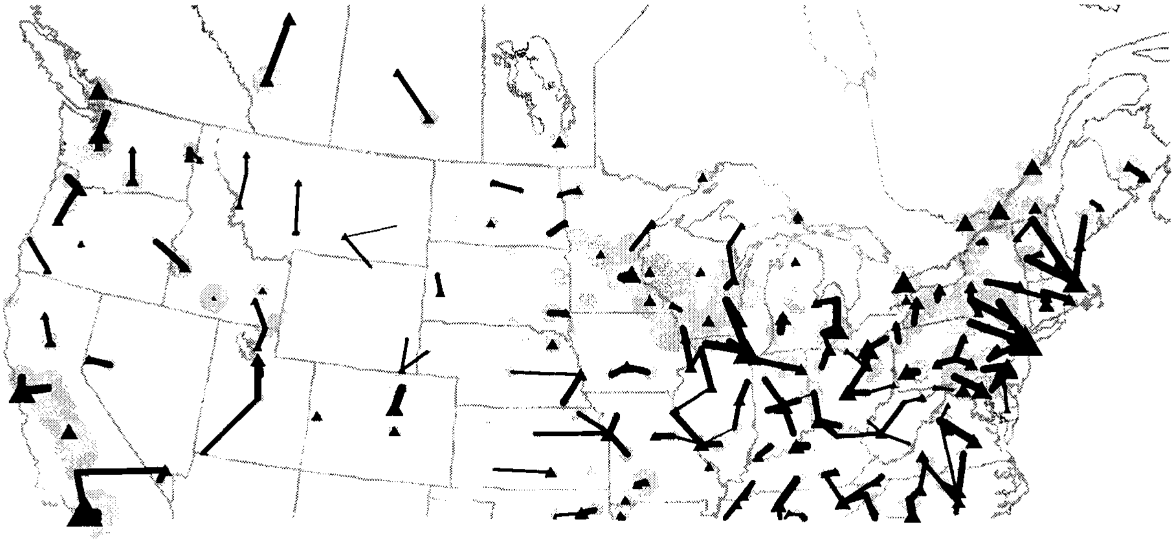
Secondly, although assumed in this study, free trade with Canada is, of course, not the current policy. Nor is there any agreement as yet to even begin phasing in such a policy. However, because many analysts believe that it is just a matter of time before dairy trade with Canada dramatically increases, analyzing this scenario is beneficial. Along the Mexican border, restrictions on dairy trade are already being relaxed under the terms of the NAFTA agreement, and will continue to do so at an accelerating pace. Finally, all uses of milk other than class I are assumed to be priced at the class III price. The implications of such an approximation are minimal because such prices are similar to class III prices anyway, and the quantity of milk they utilize is relatively small.

For large parts of the North American region the outcome of this simulation looks much like the base scenario. However, along both the northern and southern borders, the pattern of raw milk assembly and final product distribution shipments changes dramatically. Figures 8 through 11 provide a contrast between the present trade liberalization scenario and the base scenario. Specifically, these figures compare raw milk assembly and class I distribution movements in the vicinity of both the northern and southern U.S. borders.

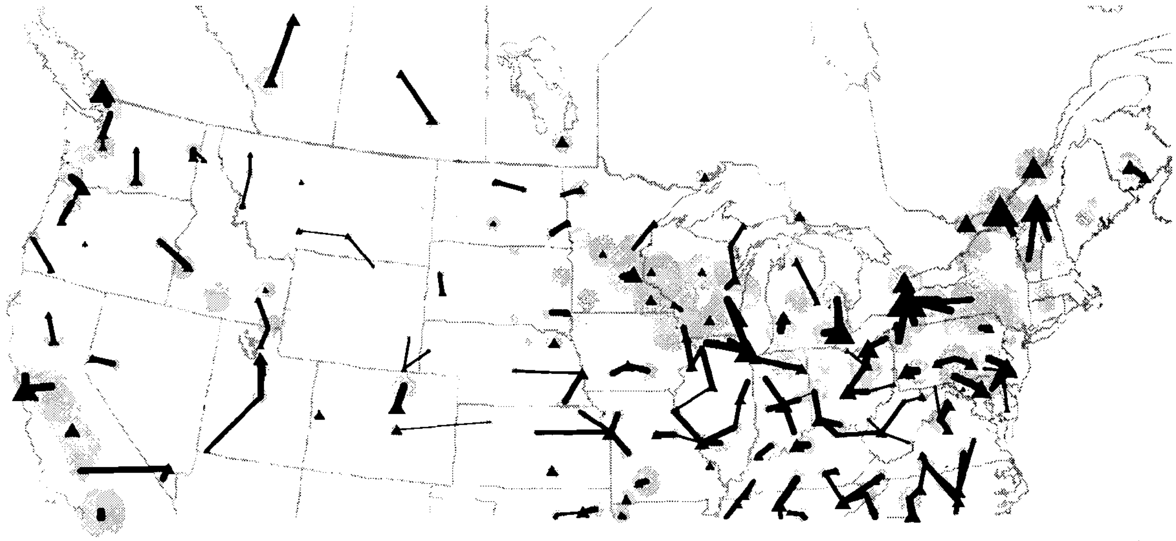
Consistent with expectations, class I differentials provide a substantial arbitrage opportunity, the exploitation of which requires that both raw and packaged milk be hauled longer distances. An indication of this is the weighted average length of raw milk shipments from U.S. supply points to fluid plants which increases by almost 9 miles over the base case. More significant is the increase of 91 miles to 102.1 for the weighted average distance that packaged milk destined for U.S. markets must be transported. This suggests two things; first, supplies of U.S. farm milk are being shipped across the border only if they're located close to the border, and second, Canada and Mexico are diverting significant quantities of their own raw milk supplies to fluid plants for use in the production of packaged milk destined for U.S. markets. Moreover, these shipments of packaged milk are moving a considerable distance into the interior of the U.S. There are 152 locations processing fluid milk in the U.S., down from 192 in the base solution.

Class I Credit

The final of the three principal simulations is referred to as the class I credit scenario. The motivation for this experiment stems from the concerns of regulators in markets near the Mexican border who, already, are proposing policy responses to the difficulties faced by marketing orders when trade is liberalized. In a nutshell, this simulation allows fluid plants in a predefined zone to procure milk at less than the class I price. In fact, such plants would be able to purchase farm milk at the blend price and thereby remain competitive with unregulated plants located across the border. The mechanism by which a scheme such as this allows eligible plants to purchase grade A milk for class I use at less than the class I price would be to award a monthly credit equal to the difference between that month's class I and blend prices. While the benefit of such an arrangement is that the processing activity remains based in the U.S. and the portion of the producer revenue over and above the basic formula price is pooled, the cost manifests itself as a lower price for producers. Clearly there exists flexibility in defining the class I credit zone; a more inclusive zone is better able to prevent arbitraging of the class I differentials but this must be weighed against the resulting diminution of the blend price.



Base



Trade Liberalization

Figure 8. Raw Milk Flows From Supply Points to Class I Processing Locations (Northern U.S.-Canada), Base and Trade Liberalization Solutions.

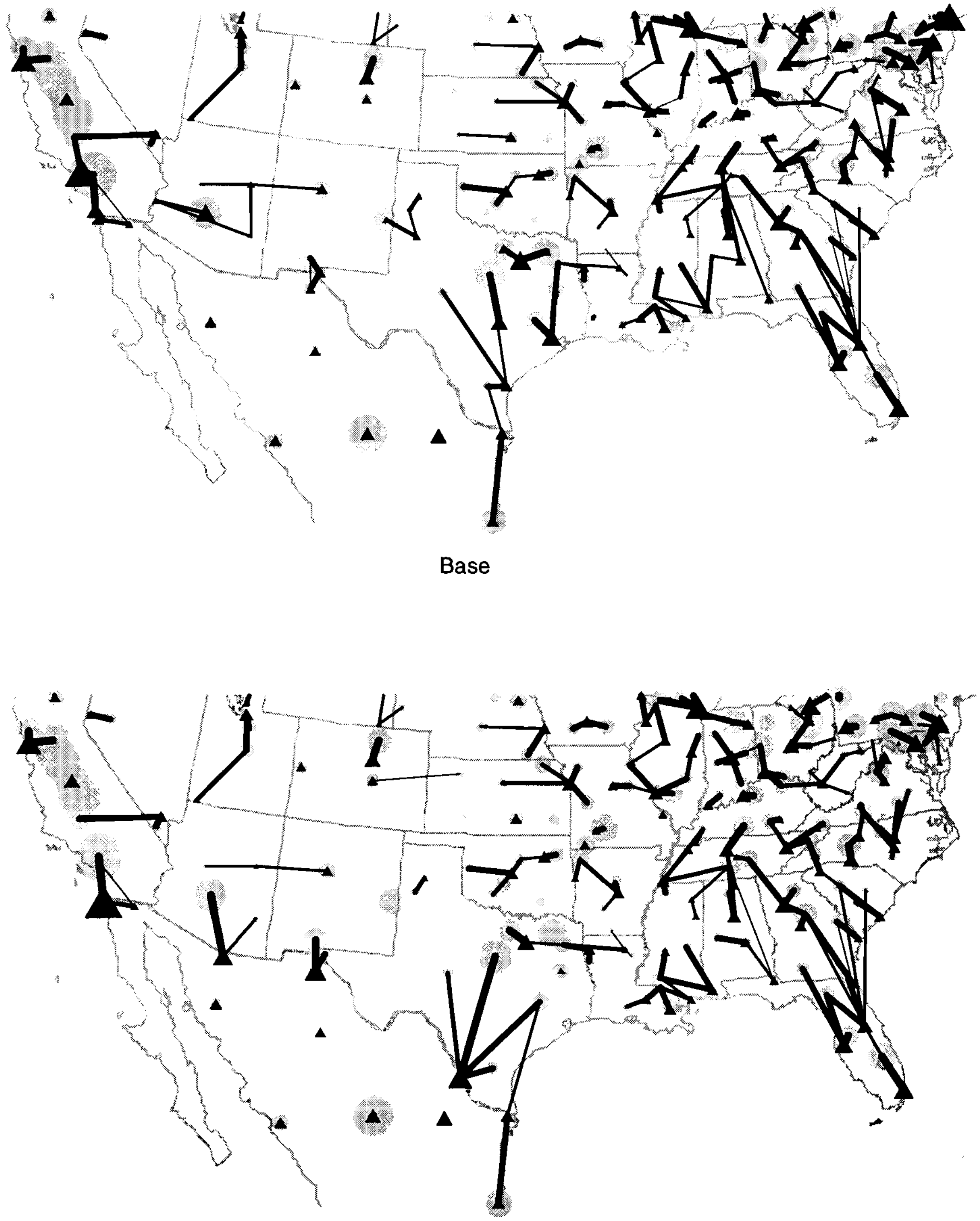


Figure 9. Raw Milk Flows From Supply Points to Class I Processing Locations (Southern U.S.-Mexico), Base and Trade Liberalization Solutions.

Base

Trade Liberalization

Figure 10. Class I Distribution Flows From Processing Plants to Consumption Areas (Northern U.S.-Canada), Base and Trade Liberalization Solutions.

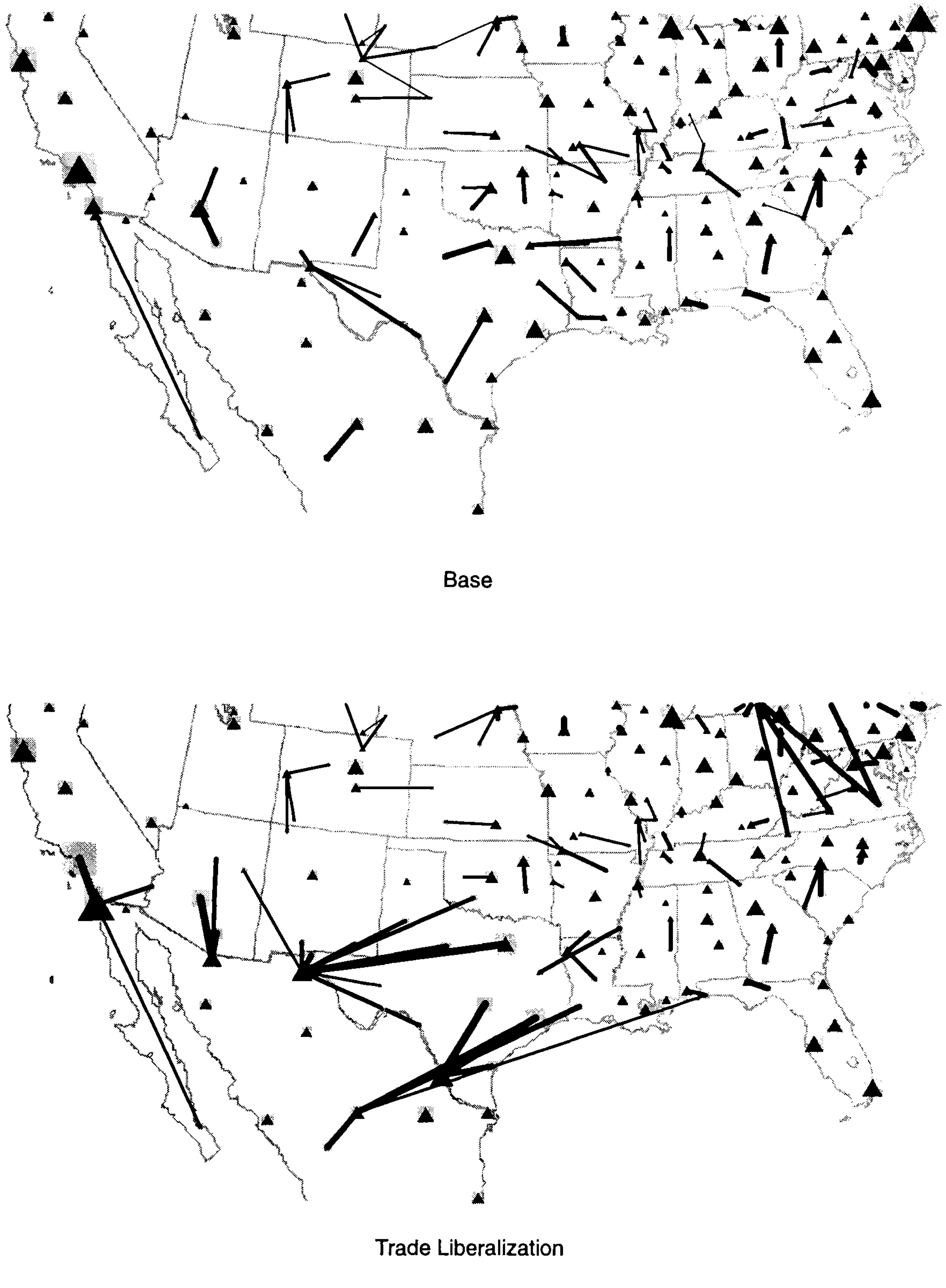


Figure 11. Class I Distribution Flows From Processing Plants to Consumption Areas (Southern U.S.-Mexico), Base and Trade Liberalization Solutions.

Advocates of this type of arrangement envision that the zone of plants eligible to receive the class I credit would be defined geographically. For example, all counties contiguous to the border, or a 50 mile wide district along the border, would encompass all eligible plants. However, it can be seen from Figures 10 and 11 that such a narrow definition would be highly inadequate. Under the free trade scenario, shipments of packaged milk from Canada reach into Tennessee and Virginia while from Mexico they reach as far as Oklahoma and even Florida. Although the model used in this study is highly disaggregated, it does not include every single plant location in the country. Thus, the class I credit simulation was implemented as follows. First, all marketing areas receiving shipments of class I products from outside the U.S. under the previous free trade simulation were identified. The affected pricing zone within that area was then assigned a class I differential of zero and the free trade simulation was run again. In other words, as far as the cost of milk procurement is concerned, U.S.-based fluid plants were placed on an equal footing with Canadian or Mexican processors.

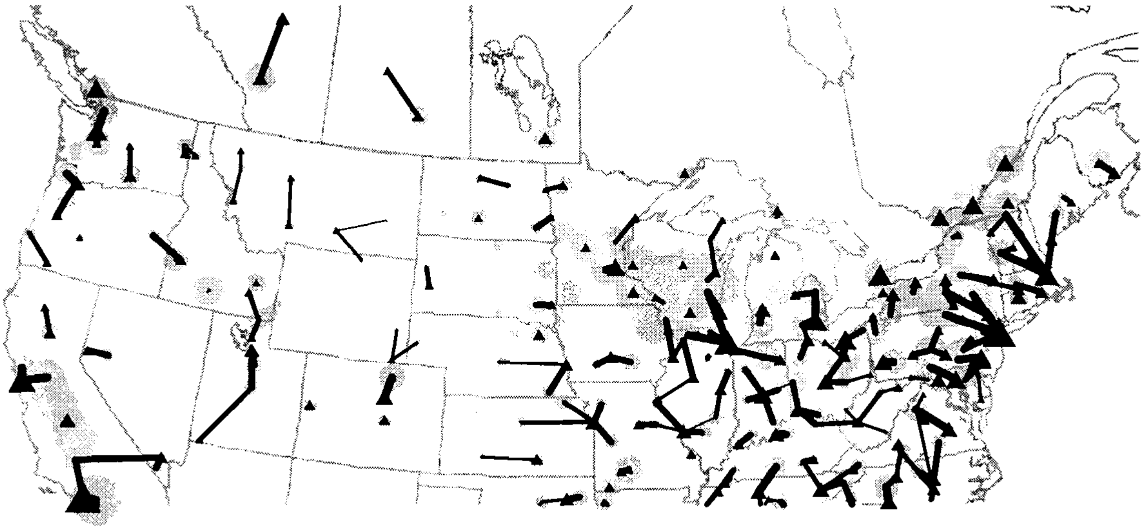
On the first attempt at simulating the class I credit idea, the model was still able to find consumption areas where the class I differential was sufficient to induce plants in Canada and Mexico to engage in arbitraging behavior. In the free trade case, Canadian plants shipped a little under 12,216 million pounds of packaged milk into the U.S. Even though, as was just explained above, each of the consumption areas receiving that milk had its class I differential set equal to zero for the class I credit simulation, Canadian plants were still able to displace almost 1,562 million pounds of packaged milk sales in the U.S. because of class I differentials. Likewise, plants in Mexico shipped a little over 8,028 million pounds of packaged milk into the U.S. under free trade and in the first class I credit simulation were still able to ship 519 million pounds. Given that the intent of the class I credit is to prevent Canadian and Mexican fluid processors from undercutting their U.S. counterparts, it seems obvious that the process employed to simulate the class I credit scenario should be repeated until Canadian and Mexican packaged milk shipments to consumption areas with a non-zero class I differential cease. Table 6 summarizes the six iterations that it took to obtain the class I credit solution.

As expected, the final solution to this scenario looks much like the base case as far as the class I sector is concerned. In the north, not one shipment of raw milk from the U.S. to a fluid plant in Canada occurred. Neither were there any sales of packaged milk from Canadian processors to markets in the U.S. Along the Mexican border, 262.98 million pounds of raw milk were shipped from the U.S. to fluid plants in Mexico while just 56.74 million pounds of packaged milk crossed the border—from Neuvo Laredo, Mexico to Laredo, Texas. In the manufacturing sector, both raw milk and final product shipments occurred in both directions across both the northern and southern U.S. borders. Figures 12 through 15 contrast the fluid assembly and distribution pattern under this scenario with the base case.

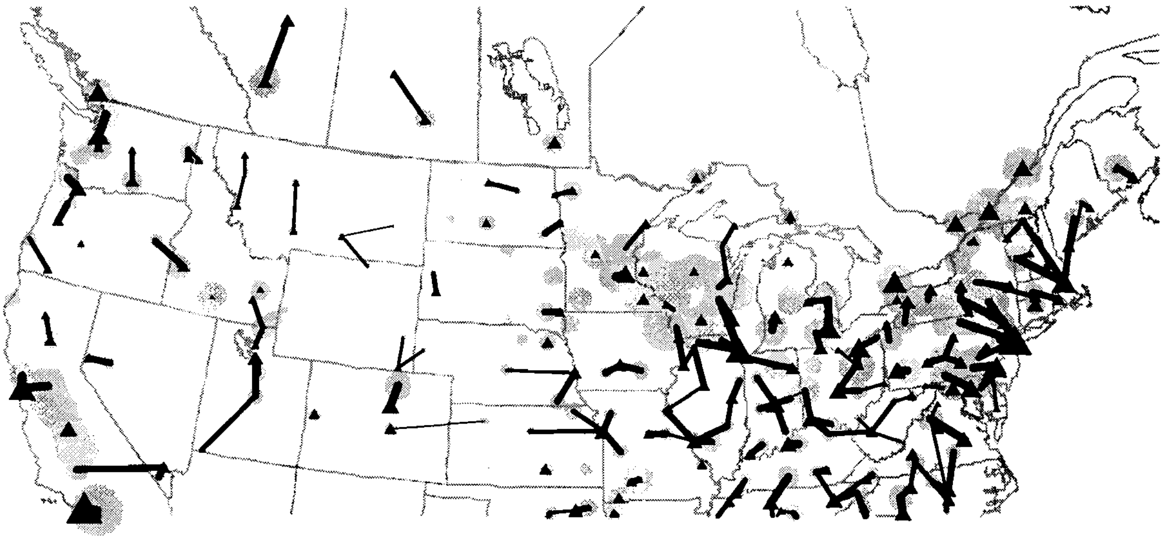
Once again, the average distance that raw milk is assembled and packaged milk is distributed conforms with both expectations and theory when compared with the previous two simulations. Removing trade barriers and offering the credit to preclude the hauling of milk long distances solely to avoid class I differentials has the aggregate effect of allowing fluid processing plants to be

Table 6. Shipments of Packaged Milk to U.S. Consumption Areas with Non-Zero Class I Differentials at Each Step of the Class I Credit Simulation (million pounds)

	Free Trade	Step 1	Step 2	Step 3	Step 4	Step 5	Final Solution
From Canada	12,215.94	1,561.79	451.03	168.58	98.39	24.83	0.00
From Mexico	8,028.25	518.93	0.00	0.00	0.00	0.00	0.00
Total	20,244.19	2,080.72	451.03	168.58	98.39	24.83	0.00



Base



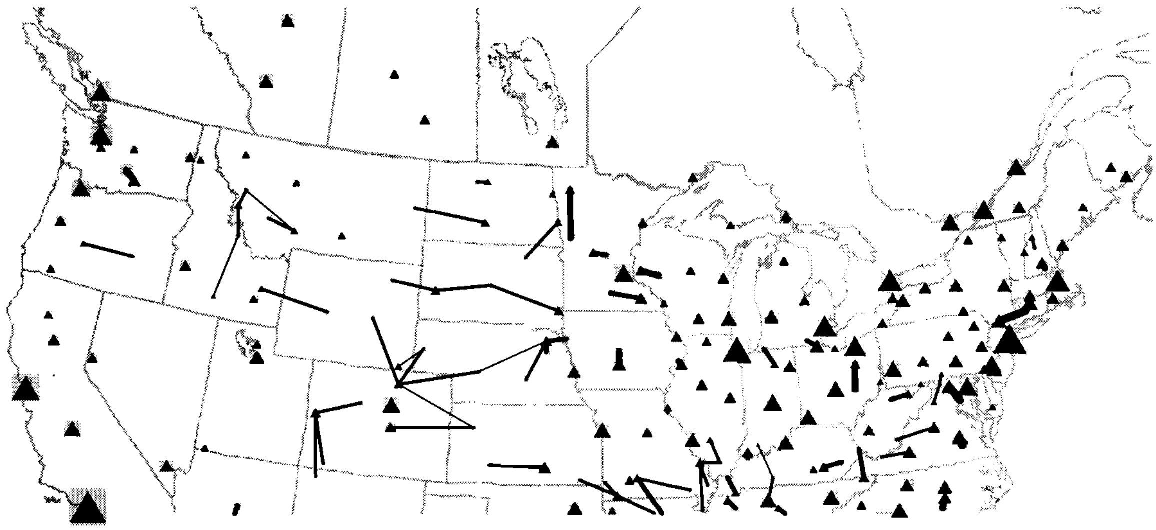
Class I Credit

Figure 12. Raw Milk Flows From Supply Points to Class I Processing Locations (Northern U.S.-Canada), Base and Class I Credit Solutions.

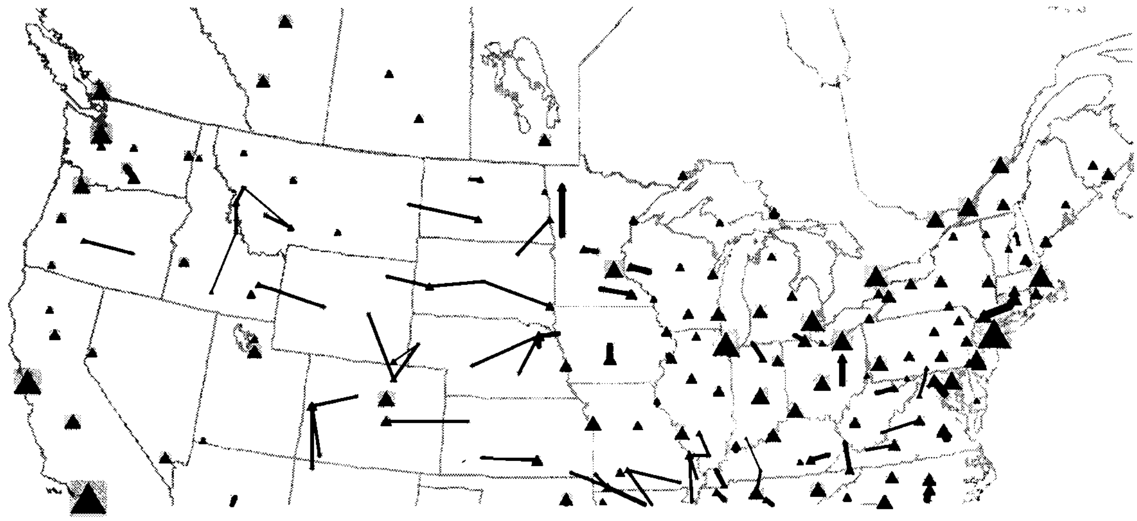
Base

Class I Credit

Figure 13. Raw Milk Flows From Supply Points to Class I Processing Locations (Southern U.S.-Mexico), Base and Class I Credit Solutions.



Base



Class I Credit

Figure 14. Class I Distribution Flows From Processing Plants to Consumption Areas (Northern U.S.-Canada), Base and Class I Credit Solutions.

Base

Class I Credit

Figure 15. Class I Distribution Flows From Processing Plants to Consumption Areas (Southern U.S.-Mexico), Base and Class I Credit Solutions.

located even closer to the markets they serve. Compared with the base case, the weighted average distance that packaged milk is transported to U.S. markets falls slightly from 11.0 to 10.7 miles. Concomitant with this the weighted average haul of bulk milk to U.S. fluid plants also falls slightly from 77.6 to 76.8 miles. Note that in the case of distribution, these distances are considerably less than for the previous free trade scenario where the incentive to avoid class I differentials existed.

SECONDARY SIMULATIONS

Federal Orders Under Liberalized Trade With Regulation of Foreign Plants

Under this scenario, the presumption was made that all the necessary legal mechanisms were in place to allow administrators of federal orders to regulate plants located outside the U.S. in cases where such plants ship class I products to U.S. markets. In essence, the simulation was set up to be identical to the earlier trade liberalization scenario except that now, handlers shipping packaged milk from plants in Canada and Mexico to markets in the U.S. must pay the applicable class price on all raw milk procured for this purpose. In other words, those plants are pooled under the orders in which they sell class I products.

Improbably, this simulation implies that raw milk procured from outside the U.S., as well as that procured from within the U.S., is subject to regulation if the plant in question uses either source of milk to produce packaged milk for sale in regulated U.S. markets. It is not clear whether the administrators of federal orders would be at all concerned about the price at which foreign plants procure raw milk from local producers, even though such milk might be used to produce class I products for U.S. markets. However, there is no convenient procedure in the model to discriminate between the milk from different sources which, once assembled at a plant, can then be used to produce packaged milk for both foreign and U.S. markets. This point illustrates the difficulty that Market Administrators would face under this type of scenario. When a single facility comprising a multi-product plant located outside the U.S. is procuring milk from multiple sources, and that milk is commingled before being used to produce the variety of product types, it would be practically impossible for U.S. auditors to determine whether or not raw milk from the U.S. was used in the production of fluid milk destined for the U.S., or if it were instead used to produce soft products, say, for the foreign market in which the plant operates. Recall too that the rules of origin clauses in the NAFTA treaty do not deem this to be illegal. Those rules only require that the raw materials used in the production of goods being imported into the U.S. under the favorable terms granted to NAFTA member countries be procured from a NAFTA country, rather than from within the specific country doing the exporting.

Despite these conceptual difficulties, the simulation was performed and results were obtained that differed only slightly from the base case. In other words, the ability to regulate foreign plants almost entirely mitigates the impact trade liberalization would have in the absence of such regulatory capability. Across the northern border, there were no shipments of fluid milk from Canadian plants to U.S. markets as there were in the earlier free trade scenario. In the South, there was just one shipment of packaged milk from Mexico to the U.S.—56.74 million pounds from Nuevo Laredo to Laredo, Texas in the Texas federal order. This quantity represents just 1.74 percent of all the class I milk sold within this order.

Given the conceptual difficulty of formulating this simulation, such a quantity would represent a very conservative lower bound under such a scenario. That is, if U.S. auditors of foreign plants could easily discriminate between milk procured from within the U.S. and that procured locally, and, more importantly, the market it was ultimately sold in, then one would expect the amount of packaged milk entering the U.S. would be much greater than that suggested here.

Under this scenario, no U.S. raw milk was assembled at Canadian fluid plants while 262.91 million pounds of U.S. raw milk were shipped to Mexican fluid plants. This amount is more than 200 million pounds greater than the amount of packaged milk that Mexico shipped to the U.S. Clearly, most of it was therefore distributed as fluid milk within Mexico. Because all milk used to produce packaged milk for sale in U.S. markets was regulated, this simulation resulted in some shipments of raw milk from Canadian and Mexican supply areas to fluid plants in the U.S. These shipments, 487.19 million pounds in the north and 136.11 million pounds in the south, occurred solely because of transportation cost savings due to proximity. Some shipments of raw milk also moved across both the Mexican and Canadian borders, and in both directions, to be assembled at manufacturing plants.

Federal Orders Under Liberalized Trade With Import-Substitution in Mexico

One particular idiosyncrasy of the NAFTA treaty is that it permits Mexico to satisfy its own demand for fluid milk through the reconstitution of imported ingredients while using local supplies of raw milk in the production of dairy products for export to the U.S. The existence of federal orders makes this kind of activity even more attractive if the order's pooling obligations can be avoided. This particular scenario takes the earlier simulation of trade liberalization without regulation of foreign plants and exogenously increases Mexican imports. The purpose is to examine the extent to which Mexico has an incentive to substitute imports for local milk supplies and thereby increase fluid milk exports to the U.S. by using its local raw milk supplies for export purposes.

The upper limit on the potential for Mexico to engage in this type of import-substituting activity is the level of Mexico's domestic milk supply. However, in a practical sense, the limit would be much lower as it would obviously not be feasible to transport bulky milk the entire length of Mexico just to export it to the U.S. One could also imagine political objections to this even if the economics made it feasible. Increasing Canadian imports in a similar fashion was not undertaken for two reasons: a) it is difficult to imagine Canadians giving up fresh milk for reconstituted milk to the extent that the Mexicans are used to doing, and b) Canada would be unable to significantly increase imports without a major overhaul of its dairy policy, and this does not appear likely anytime soon.

This simulation revealed that a significant opportunity exists for Mexico to exploit import-substitution as a means of increasing fluid milk exports to the U.S. over and above those already attained under the earlier trade liberalization scenario. Such exports increased by almost 21 percent—from 8,028.25 million pounds in the earlier trade liberalization scenario to 9,673.80 million pounds in the present simulation. Moreover, this was accomplished by drawing 29 percent less raw milk from U.S. supply areas. The cost advantage imparted on Mexico-based processors by having greater local supplies available for export purposes enabled packaged milk shipments to reach as far north as Kansas and east into all parts of Florida. The greatest distance packaged milk was shipped from Mexico into the U.S. was 2,049 miles from Aguascalientes to Miami, Florida. This compares with 1,234 miles from Torreon to Pensacola, Florida in the previous trade liberalization scenario. This study did not examine the impacts of Mexico using import-substitution, as described here, to increase exports of manufactured products, particularly cheese, to the U.S.

Federal Orders, Trade Liberalization, and Reduced Class I Differentials

One of the questions posed at the outset of this report concerned the degree to which the incentive to avoid class I differentials is influenced by the level of those differentials. The simulation undertaken to examine this question involved running the initial trade liberalization scenario thrice over, each time with all differentials scaled by 0.75, 0.50, and 0.25, respectively. These reductions were chosen arbitrarily and do not represent any proposed policy. The purpose is simply to provide an indication of how incentives to flout the intent of marketing orders change with the level of the differential. Of course, if differentials were reduced to zero, then marketing orders would effectively be eliminated. In general, the results from this experiment suggested that the incentive to avoid regulation remains tangible so long as class I differentials are maintained at a level of at least 25-50 percent of their current levels. Table 7 summarizes this simulation.

Considering the actual class I differentials in the affected orders (see Table 5), it is apparent that the level alone does not determine the resulting pattern of assembly and distribution movements. Proximity to both milksheds and major demand markets is also important. Explaining the results in Table 7 is further complicated by the nonlinearity of distribution costs. Recall from the earlier discussion, that the average per unit cost declines as the length of the route increases.

Table 7. Fluid Milk Distributed From Plants in Canada or Mexico Under Trade Liberalization with Reduced Class I Differentials
(million pounds)

Destination Order	Million Pounds of Fluid Milk Distributed by Foreign Plants			
	With Actual Class I Differentials	With Actual Class I Differential Scaled By: 0.75	0.50	0.25
Michigan Upper Peninsula	18.14	18.14		
Middle Atlantic	211.64			
New England	2,984.16	2,477.90	1,901.24	
New York-New Jersey	4,719.74	3,185.68	294.72	
Ohio Valley	268.22			
Pacific Northwest	750.29			
Southern Michigan	1,435.08	1,261.36	1,143.03	
Central Pennsylvania	136.10			
Maine	308.49			
Western New York	595.24	595.24	595.24	366.68
Virginia	742.60			
Montana	46.24	3.42		
Total from Canada	*12,215.94*	*7,850.23*	*3,934.23*	*366.68*
Central Arizona	1,048.78	307.86	241.27	
New Mexico-W. Texas	313.12	301.14	232.07	232.07
Southeast	139.47			
Southwest Plains	81.24			
Texas	2,587.43	587.17	524.31	130.89
Southern California	3,858.20	817.66	817.66	
Total from Mexico	*8,028.25*	*2,013.83*	*1,815.30*	*362.95*
All Milk Distributed in the U.S.	55,862.18	55,862.18	55,862.18	55,862.18
From Canada as % of all milk	21.87	14.05	7.04	0.66
From Mexico as % of all milk	14.37	3.60	3.25	0.65
Weighted average length of distribution haul, miles				
From U.S. to U.S.	11.9	10.2	9.3	9.7
From Canada to U.S.	277.8	254.2	155.0	20.0
From Mexico to U.S.	235.4	129.2	93.1	108.5

Looking first at the northern U.S. border, it can be seen that reducing differentials to 75 percent of their actual level eliminates entirely all packaged milk shipments from Canada to the Middle Atlantic, Ohio Valley, and Pacific Northwest federal orders, and to the Central Pennsylvania and Virginia state orders. The remaining shipments account for a little over 14 percent of all packaged milk distributed into the U.S. compared with the almost 22 percent that Canadian plants shipped to the U.S. in the earlier free trade simulation. The weighted average length of these shipments does not decline by a large amount—from 277.8 to 254.2 miles. This would suggest that it remains viable to avoid the 'reduced' class I differentials by shipping to a number of large markets located a considerable distance from Canada. Indeed, at 75 percent, the markets associated with the cities of Boston, New York, and Newark all receive shipments from Canada. Packaged milk shipments from Canada are roughly halved as the differentials are reduced from 75 to 50 percent of their actual levels. The more distant markets now receive considerably and proportionally less while the markets closer to the border, such as Detroit, western New York, and Boston, continue to receive substantial quantities. At 50 percent, the weighted average length of the shipments from Canada declines markedly to 155 miles. By the time class I differentials have been reduced to 25 percent of their actual levels, shipments from Canada are relatively negligible and are only able to reach the city of Buffalo, New York—a market just 20 miles from the nearest Canadian processing facility.

A slightly different situation is observed along the southern border. Four of the six marketing areas that receive unregulated shipments of packaged milk when differentials are set to their actual levels continue to receive shipments from Mexico after the differentials are reduced to 75 percent of their original level. The proportional decline, however, is much greater than in the north. Specifically, as class I differentials are reduced to 75 percent of their actual level, packaged milk shipments decline by three-quarters in the south while in the north they drop by only one-third. This can be explained by the fact that in the south, a much greater share of the unregulated fluid milk shipped from Mexican plants to the U.S. has its raw milk origins in the U.S. When class I differentials are lowered to 50 percent of their actual level, the decline in fluid milk shipments from the 75 percent case is minimal. However, when they drop to 25 percent, the decrease in shipments of packaged milk from Mexico is as stark as it is in the north—measuring less than 1 percent of all milk distributed to U.S. markets.

The focus of this report now turns to discussing and comparing the results just obtained.

RESULTS AND DISCUSSION

The preceding section indicates that a freer trading environment will cause the performance of quite a number of marketing orders to be adversely affected. While the largest impacts, not surprisingly, occur in areas close to the border, the affects are by no means confined to border areas. In this section, the discussion focuses on the affected areas and explores in greater detail the consequences on an order-by-order basis.

Table 8 compares changes in milk assembled at fluid and manufacturing plants. Under free trade especially, there is a significant reallocation of milk among plant types and across countries. Free trade, combined with class I differentials for U.S. handlers, leads to much less milk being shipped to fluid plants and more to manufacturing plants while in Canada and Mexico the reverse is true. In fact, the U.S. ships an incredible 35.2 percent less milk to its own fluid plants.

Table 8. Raw Milk Assembled at Plants
(% change from base in parentheses)

From	To	Base	Free Trade	Class I Credit
		Million Pounds Assembled at Fluid Plants		
U.S.	U.S.	57,873.77	37,528.85 (-35.15)	57,231.87 (-1.11)
	Canada		6,772.29	
	Mexico	180.29	7,577.64(+4,103.0)	262.98(+45.86)
Canada	U.S.		4.65	
	Canada	6.74	6.74 (0.0)	6.74 (0.0)
Mexico	U.S.		5.38	0.15
	Mexico	12.92	12.92 (0.0)	12.92 (0.0)
Total From U.S.		*55.86*	*45.83 (-18.0)*	*55.72 (-0.3)*
		Million Pounds Assembled at Manufacturing Plants		
U.S.	U.S.	55.86	45.83 (-18.0)	55.72 (-0.3)
	Canada			
	Mexico			
Canada	U.S.		4.65	
	Canada	6.74	6.74 (0.0)	6.74 (0.0)
Mexico	U.S.		5.38	0.15
	Mexico	12.92	12.92 (0.0)	12.92 (0.0)
Total From U.S.		*55.86*	*45.83 (-18.0)*	*55.72 (-0.3)*

The class I credit scenario results in a pattern of assembly movements barely different from that evident in the base scenario.

Concentrating on the free trade results for a moment, it is clear from Table 8 that much of the raw milk diverted away from U.S. fluid plants is sent either to fluid plants in Canada and Mexico, or to manufacturing plants located in the U.S. Perhaps most notable is the contrast between Canada and Mexico with respect to the source of additional milk shipped to the fluid sector. Canada increases deliveries of its own raw milk to fluid plants by a staggering 77.2 percent while Mexico does the same to the tune of less than 8 percent. Milk diverted from fluid plants in the U.S. to fluid plants in Canada and Mexico, as a proportion of that assembled at U.S. fluid plants in the base solution, is roughly equivalent for each country; 11.7 and 13.1 percent respectively. When deliveries to both fluid and manufacturing plants are combined and used as a proxy for the level of activity in the processing sector, the U.S. suffers an overall loss of almost 10 percent. Of course, the increased fluid milk processing capacity required in Mexico and Canada might well be U.S.-owned although that would surely be of little comfort to U.S. producers.

A detailed examination of changes to the pattern of interplant movements becomes mind numbing very quickly so is therefore not attempted. However, the ability of the model to move intermediate products between plants of different types and at different locations should be kept in mind when trying to reconcile changes in the volume of milk assembled at fluid plants with that at manufacturing plants. For instance, Table 8 shows that Mexican manufacturing plants received 110.3 million fewer pounds from Mexican producers under the class I credit scenario than in the base solution. This was offset, however, by additional shipments from the U.S. totaling just 37.8 million. Such a result does not point to an inconsistency, rather it reflects the outcome of simultaneous changes going on at both the intermediate and final product levels.

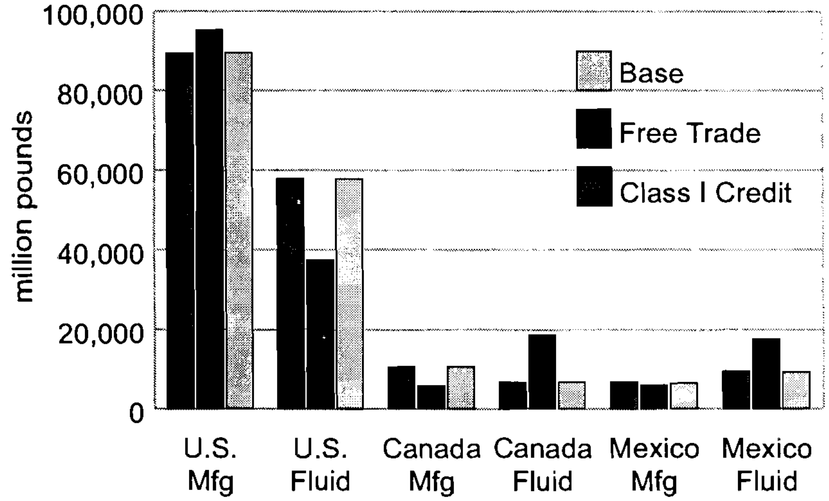
Turning now to the distribution side of the ledger, Table 9 summarizes changes in the distribution of packaged milk. The story here is consistent with what has just been described for raw milk assembly. Notably, under free trade, fluid plants in the U.S. distribute approximately 36 percent less packaged milk than under the base scenario. Note that a small quantity of U.S.-packaged milk, 375 million pounds, is shipped to Canada when border restrictions are removed. Both Canada and Mexico fill the void left by the huge decline in fluid milk processing in the U.S. Under the free trade simulation, Canada supplies almost 22 percent of the U.S. fluid milk requirement while Mexico supplies just over 14 percent. Of the packaged milk that Canada ships to the U.S. under free trade, a much lower proportion is produced from raw milk procured in the U.S. than is the case for Mexico. In fact, approximating the proportion on a simple volume basis, raw milk procured from the U.S. accounted for 94.4 percent of the packaged milk that Mexico distributed to the U.S. while the same proportion in the case of Canada was only 55.4 percent. This disparity has producer price implications in the U.S. which will be discussed shortly.

Table 9. Distribution of Packaged Milk, Million Pounds
(% change from base in parentheses)

From	To	Base	Free Trade		Class I Credit	
U.S.	U.S.	55,862.18	35,617.99	(-36.24)	55,805.44	(-0.10)
	Canada		374.87			
Canada	U.S.		12,215.94			
	Canada	6,739.38	6,364.51	(-5.56)	6,739.38	(0.00)
Mexico	U.S.		8,028.25		56.74	
	Mexico	12,918.07	12,918.07	(0.00)	12,918.07	(0.00)
Total From U.S.		*55,862.18*	*35,992.86*	*(-35.5;7)*	*55,805.44*	*(-0.10)*

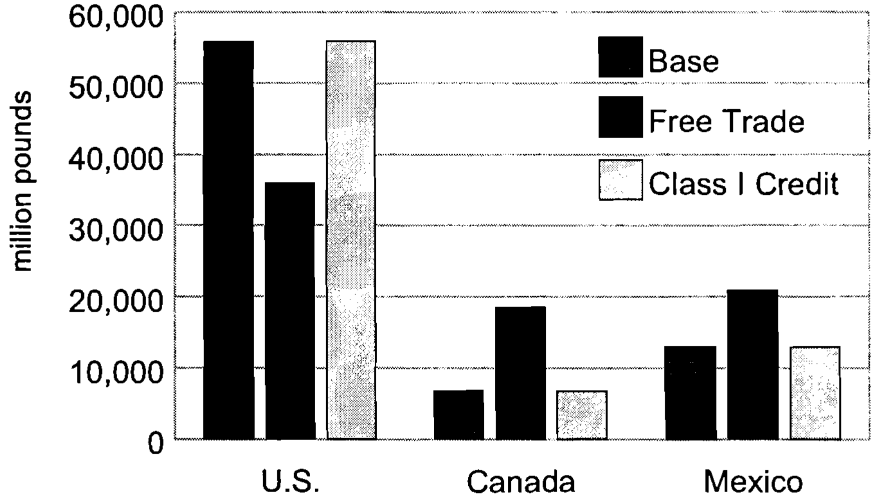
Once again, the class I credit results look very similar to those of the base solution. Only a small amount of packaged milk, 56.7 million pounds, is shipped from Mexico to the U.S. while nothing is received from Canada. That received from Mexico is a direct result of lower marketing costs due to proximity rather than incentives derived from differential pricing under marketing orders. Under the class I credit simulation, U.S. plants close to the border can procure raw milk for class I use at the same price as a plant located across the border.

Figure 16. Raw Milk Assembled at Plants (from all countries)



Figures 16 and 17 depict graphically the information contained in Tables 8 and 9. These figures put the changes resulting from trade liberalization in perspective. Clearly, the changes in the fluid sector of all three countries are significant compared with the base case.

Figure 17. Packaged Milk Distributed by Country (to all countries)



When barriers to trade with Canada and Mexico are removed, the model indicates that both raw and packaged milk will be moved considerable distances solely to avoid class I differentials. This immediately raises concerns about efficiency in the transportation sector. Table 10 summarizes the total cost of assembly, interplant, and final distribution movements into and out of the U.S. for each simulation. While not a direct concern for milk marketing orders, the burden of added transportation costs is borne by processors and producers, so inefficient transportation patterns are of interest.

When looking at Table 10, it is important to bear in mind that transportation costs are a function of both distance and the quantity transported. For example, a decrease in the aggregate cost of a particular item may or may not correspond to less of that item being transported. Also important to note in Table 10 is that assembly costs are categorized as being "from the U.S. to the U.S." and "from the U.S. to U.S./Can./Mex.," while distribution costs are categorized in the reverse order. That is, "from the U.S. to the U.S." and "from U.S./Can./Mex. to the U.S." Such an

Table 10. Aggregate Transportation Costs, Million Dollars
(% change from base in parentheses)

	From-To	Plant Type	Base	Free Trade		Class I Credit	
				Raw Milk Assembly			
A.	U.S.-U.S.	Fluid	166.64	99.54	(-40.26)	164.75	(-1.13)
B.	U.S.-U.S.	Mfg.	100.59	108.84	(+8.20)	95.51	(-5.04)
C.	U.S.-U.S./Can./Mex.	Fluid	167.00	174.62	(+4.56)	166.00	(-0.60)
D.	U.S.-U.S./Can./Mex.	Mfg.	102.26	112.28	(+9.80)	100.01	(-2.21)
				Interplant Transfers			
E.	U.S.-U.S.	All	95.71	90.93	(-5.00)	95.43	(-0.29)
F.	U.S.-U.S./Can./Mex.	All	97.34	98.04	(+0.73)	97.88	(+0.56)
G.	U.S./Can./Mex.-U.S.	All	95.71	92.61	(-3.24)	96.33	(+0.64)
				Distribution of Final Products			
H.	U.S.-U.S.	Fluid	39.85	27.01	(-32.21)	39.12	(-1.81)
I.	U.S.-U.S.	Mfg.	187.85	173.84	(-7.46)	177.66	(-5.43)
J.	U.S.-U.S./Can./Mex.	Fluid	39.85	328.93	(+725.46)	39.15	(-1.74)
K.	U.S.-U.S./Can./Mex.	Mfg.	187.85	175.00	(-6.84)	182.50	(-2.85)
	A+B+E+H+I		*590.64*	*500.16*	*(-15.32)*	*572.48*	*(-3.07)*
	C+D+E+J+K		*592.69*	*881.76*	*(+48.77)*	*583.09*	*(-1.62)*

[1]U.S./Can.Mex.=U.S., Canada, and Mexico.
[2]Mfg. = Manufacturing.

arrangement allows the increased costs that result from the arbitraging of class I differentials under free trade to be easily identified.

Both economic theory and intuition suggest that an environment containing fewer restrictions to trade would lead to lower transportation costs when the objective is to minimize such costs. However, Table 10 reveals that total transportation costs, total C+D+E+J+K, increase by almost 49 percent under free trade when compared to the base case. This increase is directly attributable to the presence of class I differentials. In fact, it could be considered a measure of the incentive to avoid these differentials. A major contributor to this increase is the staggering 725 percent increase in the cost of distributing fluid milk from U.S./Can./Mex. to the U.S. In contrast, raw milk assembly costs for shipments from the U.S. to all of the U.S./Can./Mex. fluid plants increase by only 4.56 percent. Clearly, the incentive to avoid class I differentials manifests itself in the shipping of packaged milk much longer distances rather than assembling raw milk over long distances. Many of the other cost changes noted in Table 10 under the free trade column are consistent with what has already being described. For example, as raw milk gets diverted from U.S. fluid plants to U.S. manufacturing plants, or to Canada or Mexico, the costs change accordingly.

Looking to the class I credit column, we see that except for the cross-border movement of intermediate products, all costs decrease. Overall, transportation costs decline by almost 2 percent under the class I credit simulation, compared with the increase of 49 percent observed under free trade. Offering the class I credit has eliminated the incentive to incur additional transportation costs as a means of avoiding class I differentials.

This, of course, was precisely the intent of the credit. Total transportation costs are now lower than both the base case and the free trade case reflecting the removal of transportation inefficiencies caused by the combination of barriers to trade and the presence of class I differentials in a market where such regulation is easily avoided.

The discussion now turns to the principal findings of this study, that is, the implication for producer prices when trade is liberalized. Table 11 summarizes these findings. In total, nineteen marketing areas are affected; thirteen federal and six state areas. The range of blend price changes under the free trade scenario range from a $1.60/ cwt. decline in the Virginia state order to an *increase* of 12 cents/cwt. in the Eastern Ohio-Western Pennsylvania federal order. For the class I credit simulation, the price changes are less dramatic with the largest decline being 70 cents/ cwt., again, in the Virginia state order. Table 11 contains a lot of information so before proceeding, its construction is explained.

The top half of the first column of Table 11 lists the nineteen federal and state order areas that are affected under free trade. The second column indicates with an 'F' or an 'S' whether the region is a federal or state order. Beneath this is a list of aggregated areas. The final two rows are, respectively, the sum of all current federal order areas and the sum of the entire U.S. The list of aggregated areas is roughly based on the USDA's proposed merged order areas (USDA, 1997), which comprises eleven regional markets, plus the state of California. Each area is an aggregate of the 41current areas listed in Table 5 and is defined as follows. Recall from the earlier discussion that each of the 234 consumption areas included in the model is assigned to one of the marketing areas listed in Table 5.

Appalachian includes the Carolina, Louisville-Lexington-Evansville, and Tennessee Valley federal orders plus 26 unregulated counties from Kentucky and Indiana. Arizona-Las Vegas contains the entire state of Arizona (*i.e.* includes the current Central Arizona federal order area) and the southern tip of Nevada—Clark county. Central includes Central Illinois, Eastern Colorado, Greater Kansas City, Southern Illinois-Eastern Missouri, and Southwest Plains, plus 10 counties from the Nebraska-Western Iowa order and 55 unregulated counties from the states of Colorado, Illinois, Kansas, Missouri, and Nebraska. Florida includes the three Florida orders—Southeastern Florida, Tampa Bay, and Upper Florida. Mideast includes Eastern Ohio-Western Pennsylvania, Indiana, Ohio Valley, Southern Michigan, much of Michigan Upper Peninsula, and 28 currently unregulated counties from the states in the encompassing vicinity. The Northeast region includes the federal marketing orders of Middle Atlantic, New England, and New York-New Jersey, the state orders of Central Pennsylvania and Western New York, and the unregulated areas in the states of New York, New Hampshire, Vermont, Massachusetts, and Pennsylvania. The Pacific Northwest aggregated area is essentially the existing Pacific Northwest federal order area. Likewise, the Southeast area is the current Southeast federal order plus some additional counties from Kentucky. The Southwest area takes in all of the current New Mexico-West Texas federal order and the entire state of Texas. Upper Midwest includes the current federal orders of Chicago Regional, almost all of Nebraska-Western Iowa, Upper Midwest, Eastern South Dakota, and Iowa, plus nine unregulated counties from Iowa, Nebraska, and Wisconsin. Western covers the current orders of Western Colorado, Eastern Oregon-Southwestern Idaho, and Great Basin minus Clark county in Nevada. Finally, California includes the entire state of California.

Using the output from the model, it is a simple task to add up the quantity of class I milk pooled on each order. This is denoted QI in the third column of Table 11. It is assumed that almost all of the milk used for class I uses in U.S. plants is regulated, where regulation implies being subject to class I differentials, or an approximation thereof in the case of state regulation. Using the utilization data from Table 5, it is possible to then use the class I quantity, QI, to infer the quantity of producer deliveries to handlers, or producer deliveries, which is denoted QPR . Note, however, that in the lower half of table 11, the figure for QPR is not inferred in this manner as to do so would require calculating a weighted average utilization for each of the aggregated areas. Rather, actual producer deliveries for each of these areas were calculated using federal order and California state statistical bulletins. Moving now to the five columns in the 'Free Trade' block, things get a little more complex.

Table 11. Summary of Changes in Class I Quantity, Producer Receipts, Milk Exports, and Blend Prices[1]

Order/Region	F/S	BASE Million Pounds QI	BASE Million Pounds QPR	FREE TRADE Million Pounds QI	FREE TRADE Million Pounds QPR	FREE TRADE Million Pounds QX	FREE TRADE % ΔQPR	FREE TRADE $/cwt. ΔBP	CLASS I CREDIT Million Pounds QI	CLASS I CREDIT Million Pounds QI(Cr)	CLASS I CREDIT Million Pounds QPR	CLASS I CREDIT Million Pounds QX	CLASS I CREDIT % ΔQPR	CLASS I CREDIT $/cwt. ΔBP
Affected Areas														
Central Arizona	F	1,075.74	2,227.21	26.96	1,243.28	983.93	-44.2	-0.95	0.00	1,075.74	2,227.21	0.00	0.00	-0.52
E. Ohio-W. Pennsylvania	F	2,028.80	4,049.49	2,028.80	3,393.61	655.89	-16.2	0.12	0.00	2,028.80	3,905.64	143.86	-3.55	-0.31
Michigan Upper Penin.	F	94.87	133.43	76.73	123.65	9.78	-7.3	-0.07	0.00	94.87	123.65	9.78	-7.33	-0.13
Middle Atlantic	F	3,192.40	7,110.02	2,980.76	7,110.02	0.00	0.0	-0.07	43.55	3,148.85	7,110.02	0.00	0.00	-0.60
New England	F	2,984.16	6,040.80	0.00	4,361.94	1,678.87	-27.8	-1.44	0.00	2,984.16	5,803.09	237.72	-3.94	-0.70
New Mexico-W. Texas	F	634.98	1,611.61	321.85	770.96	840.65	-52.2	0.05	0.00	634.98	1,573.87	37.74	-2.34	-0.47
New York-New Jersey	F	4,719.74	11,372.86	0.00	11,112.83	260.03	-2.3	-1.25	0.00	4,719.74	11,355.85	17.01	-0.15	-0.73
Ohio Valley	F	1,873.73	3,370.02	1,605.51	3,370.02	0.00	0.0	-0.11	859.42	1,014.31	3,370.02	0.00	0.00	-0.18
Pacific Northwest	F	2,266.34	6,888.57	1,516.05	5,948.60	939.96	-13.6	-0.09	361.03	1,905.31	6,723.46	165.11	-2.40	-0.23
Southeast	F	4,849.79	6,475.02	4,710.31	6,475.02	0.00	0.0	-0.05	1,564.63	3,285.16	6,475.02	0.00	0.00	-0.30
Southern Michigan	F	2,085.79	4,794.91	650.71	3,499.53	1,295.38	-27.0	-0.27	602.08	1,483.70	4,755.18	39.74	-0.83	-0.18
Southwest Plains	F	1,232.78	3,433.92	1,151.54	3,433.92	0.00	0.0	-0.06	430.83	801.95	3,433.92	0.00	0.00	-0.36
Texas	F	3,258.71	6,623.39	671.28	5,053.16	1,570.22	-23.7	-0.95	0.00	3,201.97	6,564.79	58.60	-0.88	-0.67
Central Pennsylvania	S	288.82	671.68	152.73	671.68	0.00	0.0	-0.44	0.00	288.82	671.68	0.00	0.00	-0.53
Maine	S	308.49	616.99	0.00	594.58	22.41	-3.6	-1.46	0.00	308.49	594.58	22.41	-3.63	-0.70
Montana	S	234.26	340.98	188.01	336.07	4.91	-1.4	-0.25	0.00	234.26	336.07	4.91	-1.44	-0.40
Southern California	S	3,858.20	13,878.41	0.00	9,962.24	3,916.17	-28.2	-0.43	0.00	3,858.20	13,854.32	24.09	-0.17	-0.31
Virginia	S	1,011.04	1,574.83	268.44	1,574.83	0.00	0.0	-1.60	0.00	1,011.04	1,574.83	0.00	0.00	-0.78
Western New York	S	595.24	1,451.81	0.00	0.00	2,494.77	-100.0	-0.89	0.00	595.24	1,352.52	99.28	-6.84	-0.50
Aggregated Areas														
Appalachian		3,347.08	4,973.00	3,347.08	4,973.00	0.00	0.0	0.00	2,046.20	1,300.88	4,973.00	0.00	0.00	-0.18
Arizona-Las Vegas		1,075.74	2,227.21	26.96	1,243.28	983.93	-44.2	-0.95	0.00	1,075.74	2,227.21	0.00	0.00	-0.52
Central		3,878.37	9,114.00	3,797.13	9,114.00	0.00	0.0	-0.02	3,056.62	821.75	9,114.00	0.00	0.00	-0.10
Florida		2,635.20	3,062.00	2,635.20	3,062.00	0.00	0.0	0.00	0.00	2,635.20	3,062.00	0.00	0.00	-0.39
Mideast		7,242.91	12,892.00	5,521.46	10,930.95	1,961.05	-15.2	-0.07	2,621.23	4,621.68	12,698.63	193.37	-1.50	-0.18
Northeast		11,780.36	23,584.68	3,133.49	19,151.02	4,433.66	-18.8	-0.93	43.55	11,736.81	23,230.67	354.01	-1.50	-0.68
Pacific Northwest		2,266.34	6,888.57	1,516.05	5,948.61	939.96	-13.6	-0.09	361.03	1,905.31	6,723.46	165.11	-2.40	-0.23
Southeast		4,849.79	6,475.02	4,710.31	6,475.02	0.00	0.0	-0.05	1,564.63	3,285.16	6,475.02	0.00	0.00	-0.30
Southwest		3,893.68	8,337.00	993.13	5,926.12	2,410.88	-28.9	-0.76	0.00	3,836.94	8,240.66	96.34	-1.16	-0.63
Upper Midwest		5,778.26	28,370.00	5,778.26	28,370.00	0.00	0.0	0.00	5,778.26	0.00	28,370.00	0.00	0.00	0.00
Western		1,106.40	4,231.00	1,106.40	4,231.00	0.00	0.0	0.00	1,106.40	0.00	4,231.00	0.00	0.00	0.00
California		6,145.16	22,104.89	2,286.96	18,188.73	3,916.17	-17.7	-0.22	2,286.96	3,858.20	22,080.80	24.09	-0.11	-0.18
Total		*53,999.28*	*132,259.37*	*34,852.43*	*117,613.73*	*14,645.64*	*-11.1*		*18,864.88*	*35,077.66*	*131,426.46*	*832.92*	*-0.63*	
All FMMOs		46,970.06	112,908.80	32,412.74	104,674.08	8,234.71	-7.3	-0.21	16,577.92	30,335.40	112,199.25	709.54	-0.63	-0.31
All U.S.		55,862.18	135,182.17	35,617.99	120,509.21	14,672.96	-10.9	-0.23	18,994.30	36,811.13	134,321.93	860.23	-0.64	-0.31

[1] See Table 12 for notes and definitions.

Table 12. Notes and Definitions Pertaining to Table 11

Descriptor	Definition
QI	class I quantity.
QPR	quantity of producer receipts.
QX	exports of raw milk where such milk was pooled in the base solution but is no longer pooled on federal or state orders.
ΔQPR	percent change in producer receipts relative to the base case.
ΔBP	change in the blend price relative to the base case.
QI(Cr)	class I milk subject to the class I credit, i.e. it is pooled but is priced at the blend price rather than at the class I price.
Affected Areas	current federal and state order areas that are affected under the free trade scenario.
Aggregated Areas	11 marketing areas as defined by AMS (May, 1997) plus California.
All FMMOs	32 current federal milk marketing orders.
All U.S.	sum of Aggregated Areas, states of Maine, Montana, Nevada, and Virginia, and several unregulated areas, i.e. literally all of the contiguous 48 states.

As before, the column headed QI denotes the class I quantity pooled on each order. By definition, such milk originates in a U.S.-based plant. Focusing for the moment on the 'Affected Areas' rows of the 'Free Trade' columns, it can be clearly seen that for all orders except Eastern Ohio-Western Pennsylvania, the class I quantity declines. All else being equal, this would result in a lower class I utilization and therefore a blend price decline. However, there is now the possibility for raw milk to be shipped out of the U.S., as indicated by the column headed QX. Such milk may or may not be shipped to a fluid plant—it doesn't really matter. What is important is that any milk shipped from U.S. producers to foreign handlers is a) no longer pooled, and b) assumed to have been sold at the prevailing blend price. This, of course, makes perfect sense; a producer would surely not sell to a foreign handler at a lower price than could be obtained by selling to nearby local handlers, that is, the blend price. A consequence of raw milk shipments to foreign handlers is that producer deliveries, QPR, decline. Milk that was pooled as class I under an order in the base case is, in the free trade case, pooled as either class I or III, or is exported to Canada or Mexico. In other words, the quantity of all pooled milk, whether it be class I or not, decreases which is tantamount to saying that for the free trade columns, QPR plus QX is equal to the base case QPR figure. Note that the percent change in producer deliveries *vis-à-vis* the base case is indicated in the column headed ΔQPR.

What all of this means for the blend price under free trade is as follows. If the class I quantity decreases relative to the base case and raw milk exports, QX, are zero, then class I utilization and therefore the blend price will decline. This is indeed the case for most of the 'Affected Areas.' The blend price changes are indicated in the column headed ΔBP. If the class I quantity does not change relative to the base case and raw milk exports are positive, then class I utilization, and ergo the blend price, will increase. This is precisely what happens in the Eastern Ohio-Western Pennsylvania order. But note, while the blend price has increased, the quantity of milk to which it is applicable, as measured by producer deliveries, has become smaller. In cases where the class I quantity decreases *vis-à-vis* the base case and raw milk exports are positive, the direction of the change in the blend price is an empirical question and depends on the relative impact of both class I quantity changes and raw milk exports. It turns out that for all such cases except the New Mexico-West Texas order, the blend price changes are negative. In the New Mexico-West Texas order, the relatively low class I utilization (39.4 percent in the base case) coupled with a 52 percent decline in producer receipts due to raw milk exports under free trade, leads to a small increase in the blend price. In marketing areas where changes in the class I quantity are zero and raw milk exports are also zero, there is no impact on blend prices—such areas are *not* listed in Table 11.

The lower half of Table 11 (the Aggregated Areas, All FMMOs, and All U.S.) reports the above statistics under the premise that pooling takes place on a regional or national basis. The intent here is to examine the impact on blend prices when the cost of trade liberalization is shared over a larger group of producers. Recall from above, the aggregated areas are comprised of more markets than just those listed in Table 11 as being affected by trade liberalization.

Turning now to the class I credit columns, the calculations take on yet another layer of complexity. Once again, QPR plus QX is equal to the base case figure for QPR although as can be seen from the table, the values for raw milk exports, QX, are fewer and smaller than those for the free trade case. The key difference between the class I credit and free trade results is that the class I quantity is now divided into two categories. Some amount of class I milk, that which is presented in the column headed QI, is priced at the regular class I price. However, there is some additional class I milk, amount QI(Cr.), which is eligible to be purchased at what ultimately turns out to be the blend price. That is, it gets priced initially at the class I price but is subsequently awarded the class I credit, an amount equal to the difference between the class I price and the blend. Moreover, and more importantly, both of these categories of milk are pooled so apart from the relatively small quantity of raw milk exports, the quantity of pooled milk barely declines from that in the base case. The pool revenue, however, does decline.

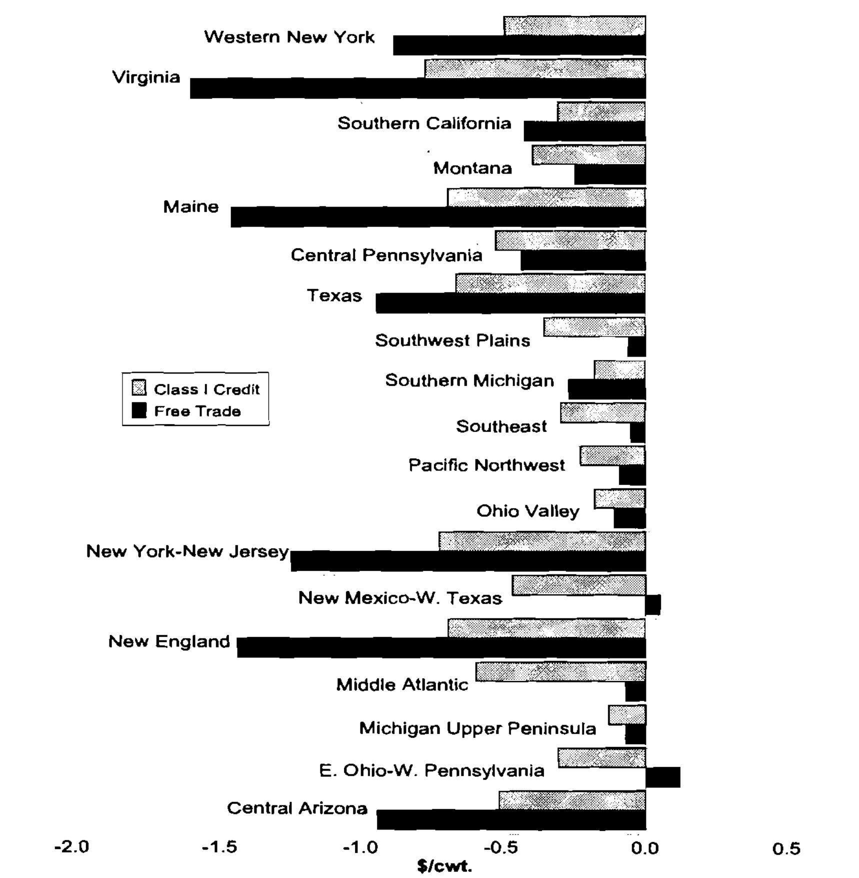
A number of important points can be taken from Table 11. Immediately apparent is that the impact of liberalized (free) trade varies from one order to the next. At one extreme, the New England and New York-New Jersey federal orders, and the state marketing areas of Maine, Southern California, and Western New York are effectively eliminated under the free trade case. In other words, once the class I quantity has dropped to zero there are no differential values left to pool and the order ceases to exist. Interestingly, not one of these areas is the most severely impacted in terms of blend price reductions. If blend price changes are to be the measure of the impact of trade liberalization, then producers in the Virginia state order are the most severely harmed with a blend price decline of $1.60/cwt. Of course, Virginia maintains a very high class I price relative to the surrounding area so has a high base from which to fall. Other particularly hard-hit areas include the federal orders of Central Arizona, New England, New York-New Jersey, and Texas with blend price declines of $0.95, $1.44, $1.25, and $0.95 per hundredweight, respectively. Likewise, the Maine and Western New York state orders experience price declines of $1.46/cwt. and $0.89/cwt., respectively. In contrast, two federal orders, Eastern Ohio-Western Pennsylvania and New Mexico-West Texas, see modest price increases due to relatively large raw milk exports causing class I utilization to increase significantly. Of course, those orders not listed in Table 11 experience no blend price changes at all.

It is useful to reiterate at this point that while milk sold by U.S. producers to plants in either Canada or Mexico is depooled, the particular producers making such sales are not necessarily any worse off, although in the long run they probably would be. For example, looking at the New York-New Jersey order, it can be seen from Table 11 that 260 million pounds of producer milk, which was pooled in the base case, was shipped to Canadian processors under free trade. As has already been explained, it is reasonable to assume that Canadian processors would have to offer at least the blend price to attract this milk. Yet, all other producers in the New York-New Jersey milkshed, who continue to supply milk to regulated plants, suffer a $1.25/cwt. price decline under free trade. This kind of price disparity would surely be a transitory phenomena and eventually, after the price dynamics had worked themselves out, a new equilibrium would be established. As the prevailing blend price declines due to milk being depooled, the price that unregulated handlers must offer in order to elicit a supply also gets lower. Inasmuch as this draws more unregulated handlers into the market, competitive pressures will begin to work against continued price declines until an equilibrium in the market is attained. The possibility for similar outcomes in other areas can be readily observed in Table 11.

In theory, the class I credit simulation should have alleviated the impact on prices seen under the free trade case; indeed, the scheme was designed with that in mind. However, the final column of Table 11 shows that in nine of the nineteen markets affected under free trade, the blend price declined by an even greater amount with the class I credit. The decline was smaller in the remaining ten. Moreover, the last line of Table 11 shows that had pooling been undertaken on a national basis, the class I credit scheme would have resulted in an overall decline of $0.31/ cwt. versus only $0.23/cwt. in the free trade case. Figure 18 provides a striking contrast in the blend price changes under the free trade and class I credit scenarios.

The results of the class I credit simulation require further explanation. Recall from the earlier discussion that the final solution to the class I credit simulation was obtained from an iterative procedure. At the first step of this procedure, U.S. plants were no longer required to pay the class I price for raw milk that was used to serve U.S. markets if, in the free trade case, those markets were served by plants located in Canada or Mexico. However, while significant abatement of the impact of free trade was attained at iteration one, the problem simply transferred itself to locations even further from the U.S. border, that is, locations that were unaffected in the free trade case. It was clearly still economical for plants in Canada and Mexico to arbitrage the remaining class I differentials. So, a second iteration was executed whereby U.S. plants serving these newly affected areas were relieved of their obligation to pay the class I price for raw milk. In fact, as Table 6 attests, the procedure required six iterations to attain the class I credit solution. A consequence of iterations two through six is that plants serving [pricing zones in] markets, which were unaffected in the free trade case, became eligible for the class I credit and the end result was a diminished pool value. Table 13 indicates the extent to which the arbitraging continued beyond those areas affected under free trade.

Figure 18. Blend Price Changes, Affected Orders



The first point to notice from Table 13 is that, beyond the orders affected under free trade, an additional six federal orders were required to price milk according to the class I credit formula in some or all of the pricing zones within those orders. The six are Carolina, Eastern Colorado, Tennessee Valley, and the three Florida orders. Note, however, that while these six orders are not listed in

Table 11, the resulting decrease in the blend price within these orders, which occurs under the class I credit simulation, is reflected in the entries in the lower half of the table, that is, in the aggregated areas and the national aggregations. For example, the blend price is unaffected in all three Florida orders under free trade, yet in the class I credit scenario, the aggregated Florida order suffers a blend price decrease of $0.39/cwt. Similarly, the Appalachian order goes from no change to a decline of $0.18/cwt.

In total, there are 116 pricing zones enumerated in the model, one of which covers the unregulated areas and therefore has a class I differential equal to zero. Consumption points in 37 of these zones received shipments of packaged milk from either Canada or Mexico in the free trade simulation and therefore had their class I differential set equal to zero for the first iteration of the class I credit simulation. Table 13 reveals that an additional twenty pricing zones also had to have their class I differential set equal to zero in order to reach a legitimate solution to the class I credit problem. Therein lies the reason why the class I credit idea largely failed to deliver on its promise of mitigating the producer price impact experienced under free trade.

The class I credit clearly leads to a dramatic decrease in exports of producer milk, from nearly 15,000 million pounds under free trade to just 860 million pounds. The credit also results in practically all of the class I processing activity, as measured by the class I quantity, remaining in the U.S. These factors in turn lead to a greater amount of milk being pooled than under the free trade case. However, the cost of attaining this outcome is borne disproportionately by producers—some don't pay at all (but neither were they harmed under free trade), some are made better off, and some are made worse off. Those in some of the border areas are made considerably worse off. Moreover, in the aggregate, total pool revenue is smaller leading to an overall loss for producers.

The model does not explicitly consider prices although relative prices are not at issue here. What matters is the cost of transportation relative to the level of class I differentials. Nevertheless,

Table 13. Regulatory Status Under the Class I Credit Scenario

Order	F/S	No. Pricing Zones	Blend Price Affected Under Free Trade	No. Pricing Zones Class Pricing Undermined with Free Trade	Cl. I Diff = 0 Under Cl. I Credit
Carolina	F	3	No	0	1
Central Arizona	F	4	Yes	4	4
Eastern Colorado	F	3	No	0	1
E. Ohio-W. Pennsylvania	F	1	Yes	0	1
Michigan Upper Penin.	F	1	Yes	1	1
Middle Atlantic	F	5	Yes	1	4
New England	F	6	Yes	6	6
New Mexico-W. Texas	F	3	Yes	3	3
New York-New Jersey	F	5	Yes	5	5
Ohio Valley	F	4	Yes	1	2
Pacific Northwest	F	3	Yes	1	1
Southeast	F	13	Yes	2	6
Southeastern Florida	F	1	No	0	1
Southern Michigan	F	3	Yes	1	1
Southwest Plains	F	7	Yes	1	4
Tampa Bay	F	1	No	0	1
Tennessee Valley	F	4	No	0	2
Texas	F	5	Yes	5	5
Upper Florida	F	2	No	0	2
Central Pennsylvania	S	1	Yes	1	1
Maine	S	1	Yes	1	1
Montana	S	1	Yes	1	1
Southern California	S	1	Yes	1	1
Virginia	S	1	Yes	1	1
Western New York	S	1	Yes	1	1
Sum		*80*		*37*	*57*

we know that producer prices in Canada are much higher than in the U.S. so it is reasonable to wonder how this might influence the analysis. U.S. producer prices in the border areas near Mexico are very similar to those observed in the north of Mexico. One would expect that higher prices in Canada *vis-à-vis* the U.S. would moderate the adverse affect of trade liberalization on milk marketing orders. With freer trade, prices would tend to equalize across either side of the border. Thus, if Canadian processors were to offer producers a price which exceeded the blend price, then presumably U.S. producers would want to supply Canadian plants which would in turn cause U.S. processors to offer higher prices. In any event, the question is one of general competitiveness rather than a federal order issue.

The question of producer prices, or rather 'appropriate' producer prices, is frequently raised when the discussion turns to farm-level costs of production. Such costs have no bearing on the issues raised and analyzed in this report. While the cost of production may indeed vary regionally, perhaps significantly, milk is allocated on the basis of the price received, and all competing farms receive the same price. Whether or not trade is liberalized has nothing to do with one farmer being more or less profitable than another unless its impacts are felt disproportionately.

Somewhat related to prices is the question of how a supply or demand response might change the analysis. Again, this issue speaks more to the broader question of the competitiveness of the sector than it does to federal orders. It would be reasonable to assume little response on the demand side to any changes in the consumer price of fluid milk as most analysts believe demand for fluid milk to be quite inelastic. However, if producer prices were to decline, as this analysis has suggested would be the case in quite a number of areas, then a corresponding decrease in the quantity of milk supplied would be expected. This would lead to a strengthening of the manufacturing price which, besides reducing the affects of trade liberalization on blend prices in the border areas, could well result in gains for producers outside of the areas directly impacted, particularly those areas with a relatively low class I utilization.

A number of non-economic factors may mitigate the direct impacts of freer trade on marketing orders and should be considered by policy makers in the search for an appropriate response. This analysis has assumed that plants in Mexico can effortlessly satisfy U.S. product identity standards and sanitary requirements. To the extent that this is not the case, the severity of the estimated impacts will be lessened. It has also been assumed that Canada and Mexico will want to exploit any opportunity to flout U.S. milk pricing regulations. In the case of Canada especially, it is conceivable that they would choose not to out of concern about provoking a backlash. Canada has much to protect right now with respect to its dairy policy. Uncertainty about the future of federal dairy policy would also temper responses. For example, under free trade, this analysis has suggested that fluid milk processing in Canada might increase by over 75 percent. The level of investment required to increase capacity by this much would certainly not be undertaken unless decision makers were certain that federal involvement in dairy markets would continue. Congress has already made such a commitment by embarking on the reforms outlined in the 1995 farm Bill (Federal Agriculture Improvement and Reform Act of 1996). However, this alone does not guarantee the long term existence of milk marketing orders nor does it ensure that the level of class I differentials will go unchanged.

SUMMARY and CONCLUDING REMARKS

This report, addressing directly the concerns of the 103rd Congress, has analyzed the effect that liberalizing trade would have on the Federal Milk Marketing Order program. The possibility of either raw milk or processed milk products moving freely across U.S. borders provides a simple means for fluid milk processors to avoid paying the class I price for the milk they use. Such behavior leads to diminished class I utilization and a decline in producer prices.

The model and the data used to conduct this research have been extensively described earlier in this report. The model is formulated as a single-time period, multi-component transshipment model and is solved within a linear programming framework. Three market levels; production, processing, and consumption, are modeled as are the processing and consumption of a number of intermediate and final products. The model has been designed to be spatially detailed and includes 275 points representing the supply of raw milk, 416 potential locations for processing, and 278 consumption points. Given estimates of raw milk supply, dairy product consumption, and the cost of assembling raw milk, shipping intermediate products between plants, and distributing final products, the model seeks to minimize the total of these costs while determining an efficient pattern of processing locations and milk and milk product movements.

Turning now to the analysis, a base solution was first generated to provide a point of reference for comparing the outcomes of the subsequent simulations. The first experiment addressed the central question of the impact on marketing orders when both raw milk and dairy products are able to move freely across national borders. While increased U.S. imports of manufactured products may well have adverse price implications for U.S. milk producers, it was argued that such imports are of no consequence to the operation and performance of marketing orders so were not considered. The key assumption underlying this simulation was that the USDA has no legal authority to regulate plants located outside the U.S. This proposition has not been tested legally, but it seems fairly clear that U.S. price regulation could only be imposed on Mexican or Canadian plants if there were explicit cooperation from those two countries.

The analysis revealed that to the extent that liberalizing trade with Canada and Mexico places pressure on the ability to regulate the purchase price of grade A milk, U.S. dairy farmers could be significantly to severely harmed. Not surprisingly, the impacts were generally greater in border areas. In all, 36 percent less fluid milk was distributed from U.S. plants when compared with the base case—this was replaced with shipments from Canada and Mexico. Reduced fluid milk processing activity in the U.S. resulted in the loss of 40 aggregated fluid milk processing locations from the affected areas. The U.S. did, however, increase processing activity at class II and manufacturing plants by more than 6 percent but all of this milk was procured at the lower manufacturing price making U.S. producers worse off. Changes in class I utilization due to freer trade ranged from an *increase* of 20 percent in the Eastern Ohio-Western Pennsylvania order to a decrease of 100 percent (*i.e.* there was no class I use under free trade) in the New England and New York-New Jersey federal orders and the Maine, Southern California, and Western New York state marketing areas.

The resulting changes in producer blend prices were in the range of +12 to -27 cents per hundredweight in the least affected areas while the worst hit areas saw declines ranging from $0.43 to $1.60 per hundredweight. Producer price declines of this magnitude would be a severe hardship for all producers. Based on past experience, even 10 cents/cwt., while not sounding too dramatic, would cause hardship for some producers and the declines of forty cents or greater are certainly more than enough to cause extreme difficulty for many producers. A supply response, either in seeking alternative markets or exiting the industry, could be expected.

Following the introduction of freer trade, fluid plants located near the U.S. border in Canada and Mexico are clearly much better off as they benefit immensely in terms of increased activity. It is difficult to contemplate the U.S. blindly allowing this to occur and if it did, one could imagine farmers in highly impacted areas simply voting their orders out of existence so as to eliminate the arbitrage opportunity. This would result in less income but it would have the effect of protecting domestic markets. In fact, the outcome would be similar to the class I credit option.

A second simulation considered how a so-called class I credit would lessen the impact of freer trade on producer prices. In general, it didn't. While the class I credit effectively removed the arbitrage incentive created by class I differentials, there was a cost associated with doing so. Producer prices still declined in the affected areas and in many cases by more than under the free trade simulation. Milk and milk product movements, as well as the location and level of processing activity, were very similar under this scenario to that of the base case.

The third scenario examined the ramifications if foreign plants were able to be regulated under the terms and provisions of U.S. marketing orders. Understandably, such a situation results in practically no effect on marketing orders, *per se*, as marketing costs rather than class I differentials become the determinant of where milk is procured from and distributed to. It is difficult to imagine

Canada or Mexico allowing U.S. price regulation to be imposed on Mexican or Canadian plants. Such action would require the adoption of U.S. pricing mechanisms and explicit cooperation from those two countries.

A fourth simulation explored the likelihood of Mexico using imported dairy ingredients to satisfy more of its own fluid milk requirements thereby increasing local supplies of raw milk for export to the U.S. as packaged fluid milk. Under this scenario, Mexican imports from the rest of the world were allowed to increase dramatically and Mexican processors were not subject to U.S. price regulation. The simulation revealed that a considerable opportunity exists for Mexico to exploit import-substitution as a means of increasing packaged milk exports over and above those already attained under the foregoing trade liberalization scenario. In fact, such exports rose by almost 21 percent above the free trade level.

A final experiment concerned the level of class I differentials and how it influences the incentive for processors to avoid regulation. Here it was found that even with differentials at 25–50 percent of current levels, the incentive to avoid regulation remained significant—particularly if the plant was close to the border and thus not too far from the U.S. markets being served. In other words, and this point is quite obvious, transportation costs will exceed class I differentials more quickly when differentials are smaller and/or the length of the haul gets larger. Reducing differentials had a greater impact in the South and Southwest relative to the Northeast simply because the plants in Mexico are farther from major U.S. markets.

As is the case with any economic analysis, care must be exercised when interpreting the results. Many simplifying assumptions underpin the modeling effort so it is necessary to temper the inferences one draws accordingly. Some of the data required by the model, composition and cost data for instance, are not readily available and might well be called into question. It was found, for example, that the pattern of assembly, interplant, and distribution movements that resulted from any particular simulation was fairly sensitive to the composition parameters. At the intermediate product level especially, there is simply no way to model every product type and specification actually observed. Beyond the question of what specific composition to actually specify, there is a conceptual issue to consider as well. The composition of products leaving a plant are as much a function of the composition of the inputs as they are some documented product specifications. In a linear programming framework, it is not possible to model such nonlinear relationships. These areas would provide useful avenues for further research.

This research was motivated by the desire of the United States Congress to have timely and reliable information as it considers how to best serve the needs of the dairy industry while at the same time designing policy that is consistent with international treaties and obligations. Quite apart from that, this research has made a contribution by bringing together two strands of inquiry that are usually considered separately, that is, trade liberalization and milk marketing orders.

It has been shown that the Federal Milk Marketing Order program will be severely hampered as a result of trade liberalization. Moreover, the adverse affects will be concentrated in the Northeast and the Southwest. Both state and federal orders in these regions will be impacted. As milk is diverted from these areas to fluid processing plants in Canada and Mexico, the disorderly conditions that federal orders sought to, and indeed did, alleviate begin to reappear. For example, plants that locate beyond the scope of milk market regulators and draw milk from regulated areas will surely not continue to procure that milk at the times when variability in demand dictate that it's not required. Consequently, that milk will be left to the manufacturing sector to dispose of and at a much lower price.

The issue for policy makers is clear although the best response is not so obvious. Certainly, there will be no turning back of the trade reform clock which would conveniently make the issue go away. Merging of orders to create larger pools, or even national pooling, would share the burden around but would not address the underlying problem. Some difficult choices must be made soon as the implementation of NAFTA is well advanced and further liberalization seems inevitable. Congress has determined as recently as April of 1996 that it is not prepared yet to dismantle milk marketing orders. It is imperative, therefore, that measures be undertaken which would allow them to continue performing the function for which they were created.

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