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FARM LEVEL IMPACT OF ADOPTING MULTIPLE COMPONENT PRICING IN THE APPALACHIAN FMMO AND EVALUATING THE USMCA CANADIAN CREAM TRQ: A GSIM APPROACH

Luke Gregory Cummings
University of Kentucky, lgcu224@uky.edu
Author ORCID Identifier:
https://orcid.org/0000-0002-8113-5075
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FARM LEVEL IMPACT OF ADOPTING MULTIPLE COMPONENT PRICING IN THE APPALACHIAN FMMO AND EVALUATING THE USMCA CANADIAN CREAM TRQ: A GSIM APPROACH

THESIS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in the College of Agriculture, Food and Environment at the University of Kentucky

By

Luke Gregory Cummings

Lexington, Kentucky

Co-Directors: Dr. Yuqing Zheng, Associate Professor of Agricultural Economics & Dr. Kenneth Burdine, Associate Professor of Agricultural Economics

Lexington, Kentucky

2021

https://orcid.org/0000-0002-8113-5075

ABSTRACT OF THESIS

FARM LEVEL IMPACT OF ADOPTING MULTIPLE COMPONENT PRICING IN THE APPALACHIAN FMMO AND EVALUATING THE USMCA CANADIAN CREAM TRQ: A GSIM APPROACH

This thesis is composed of two essays regarding the dairy industry of North America. The first essay aims to evaluate the adoption of an MCP pricing system in the Appalachian FMMO. Producers in Georgia, Kentucky, Tennessee, and North Carolina have formally voiced concern about adopting MCP due to concerns over reduced milk value. Using cow-level production data from Kentucky, the effect on farm level prices can be estimated. It is determined Jersey cow herd's milk value under MCP appreciates 9% in Kentucky, while the impact on Holstein herds is dependent on many factors. The second essay evaluates the potential impact of the expanded tariff rate quota for cream in Canada from the implementation of the United States-Mexico-Canada trade agreement. Utilizing a global simulation model for trade using Armington elasticities, the impact of this expanded access can be estimated for both American and Canadian consumers and producers. Canadian imports of American cream are estimated to increase 316% over the first year of the USMCA. This paper includes a review of Canada's dairy industry and trade relations as relating to the dairy industry.

KEYWORDS: Dairy Policy, Multiple Component Pricing, GSIM, Milk Pricing, Tariff Rate Quota

Luke Gregory Cummings

4/26/2021

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By

Luke Gregory Cummings

Yuqing Zheng
Co-Director of Thesis

Kenneth Burdine
Co-Director of Thesis

Tyler Mark
Director of Graduate Studies

4/26/2021

DEDICATION

To dairy farmers on both sides of the 49^{th} Parallel.

AKNOWLEDGMENTS

First I would like to thank Dr. Yuqing Zheng for his input over my time at the University of Kentucky. I could not have asked for a better advisor, through his guidance I have been understand more completely many aspects of this field and this thesis would not be possible without his knowledge. I would also like to thank Dr. Kenny Burdine for his inputs to this project. I also thank Dr. Tyler Mark for his support and insights throughout my time at U.K., as a professor and director he has embodied the academic ideal.

Thank you to all the faculty and staff at University of Kentucky including Janene Toelle, Rita Parsons, Chuck Corby-Lee, Karen Pulliam, Dr. Carl Dillon, Dr. Nicholas Pates, Dr. Jill Stowe, Dr. Barry Barnett, Dr. Sayed Saghaian, and Dr. Steven Buck who have educated and helped me through my time in the commonwealth. The experience I had at U.K. was invaluable, and in spite of a global pandemic, the greatest academic experience of my life.

I would like to thank my friends, family, and Lauren for their support. I would not be here today without their encouragement and assistance. Finally, I thank my grandfather. He is the reason I am in this field.

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Chapter 1. Introduction

The United States and Canada are global heavyweights in the dairy industry. The similarities between the two countries include the following. Herds in both countries are predominately composed of Holstein cows. In Canada, 93% of the national dairy herd is Holstein (CDIC 2019). In the United States, 91% of the national herd is Holstein (Powell et al. 2008). The number of dairy producers in both countries has declined over the years. From 1992 to 2017, the number of dairy producers in the United States has declined from 155,339 to 54,599; a decline of 65% (MacDonald et al. 2020). The number of dairy producers in Canada has declined from 29,358 in 1992, to 11,033 in 2017; a decline of 63% (CDIC D056). There are likely many causes in common for the decline in both countries, but this is beyond the scope of this paper. This paper evaluates the impact of specific policies in their respective regions.

The dairy industry in both countries are regulated by many policies and institutions. Both countries have adopted policies with the goals of protecting producers. The effectiveness of these policies depends on the metric of measurement. In the United States, the primary instrument is from FMMOs (Federal Milk Marketing Orders). Established in 1937, FMMOs set a base price for producers and regulate how the milk market operates (Christensen 1978). In Canada, supply management is the primary instrument of dairy policy. Both policies establish minimum prices for dairy producers, albeit with significantly different implementation and end results.

The first essay Farm Level Impact of Adopting Multiple Component Pricing in the Appalachian FMMO evaluates the potential impact of a change to the system used to derive producer minimum price. To change the system regulating dairy producer price in the United States requires the approval of the majority of producers regulated by the FMMO. Currently, the system of pricing used in the Appalachian FMMO to value producer milk gauges skim and butterfat. Several producer and industry groups support a proposal to switch to multiple component pricing. This essay will consider the impact on producers in Kentucky particularly and evaluate the potential implications for producer price, milk flows, and Class I differentials using regression and scenario analysis.

The second essay evaluates international trade in cream for Canada. The United States-Mexico-Canada trade agreement is historic in its expanded access to Canadian markets for U.S. dairy products. The expansion of the cream TRQ allows for new research involving fluid dairy products. This essay summarizes the Canadian dairy industry and the mechanisms of supply management. At the core of this essay the impact of the expanded TRQ for cream is assessed. Using a modified GSIM model, the potential effects of the USMCA on the international cream market are evaluated.

Due to the complexity of the dairy industry, these essays only serve as a cursory overview of the issues facing the industry. Useful insights can be drawn nonetheless with results from these essays serving as a starting point for more comprehensive analysis for both the Appalachian FMMO and Canadian dairy industries. Results from both these essays suggest the importance of further analysis.

Chapter 2. Farm Level Impact of Adopting MCP in the Appalachian FMMO

2.1 Abstract

This paper aims to evaluate the adoption of an MCP pricing system in the Appalachian FMMO. Producers in Georgia, Kentucky, Tennessee, and North Carolina have been opponents of adopting MCP in part due to concerns over reduced milk value. Using cow-level production data from Kentucky, the effect on farm level prices can be estimated. Prior studies have suggested all FMMOs using MCP to value milk will create a more efficient milk market. This paper will summarize the state of the Appalachian FMMO and evaluate the impact of MCP on Kentucky producers using cow level data.

2.2 Introduction

The dairy industry in Kentucky has been undergoing a period of declining producers (see Figure 2.1). Mostly encompassed by the Appalachian FMMO (Federal Milk Marketing Order), the region has seen a declining milk industry evidenced by milk pooled by Appalachian producers (see Figure 2.2) and a marked decline of producers in the industry. This is despite the state's growing population (see Figure 2.3). Processors in the region have to rely on milk shipped in from neighboring states and FMMOs to meet production demand. Proposals to fundamentally change how the price producers receive have been discussed for the region in light of these issues.

Over the last ten years Kentucky has seen its population increase by 3%. Coupled with a national trend of increased consumption of dairy products (see Figure 2.4), producers in the region would be expected to remain in the industry. The current state of the

Kentucky dairy industry with the Appalachian FMMO is not consistent with this. Since 2010 there has been a 40% drop in the number of producers in the region. Milk production has been relatively stable over the same period due to operations getting larger and producing more milk on average.

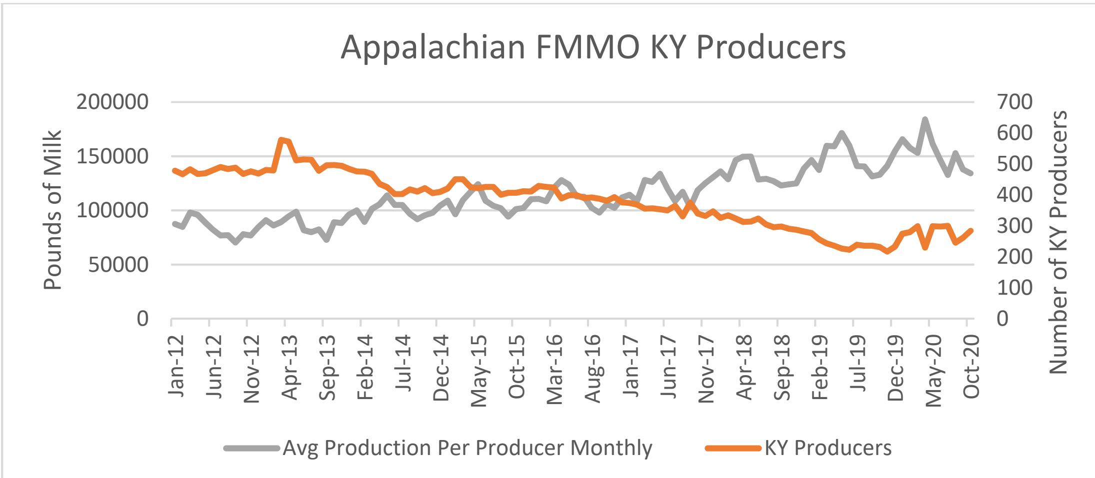

Figure 2.1 KY Appalachian FMMO Producer Average Monthly Production and Monthly KY Producers in Appalachian FMMO (Data: Order 5 Market Administrator)

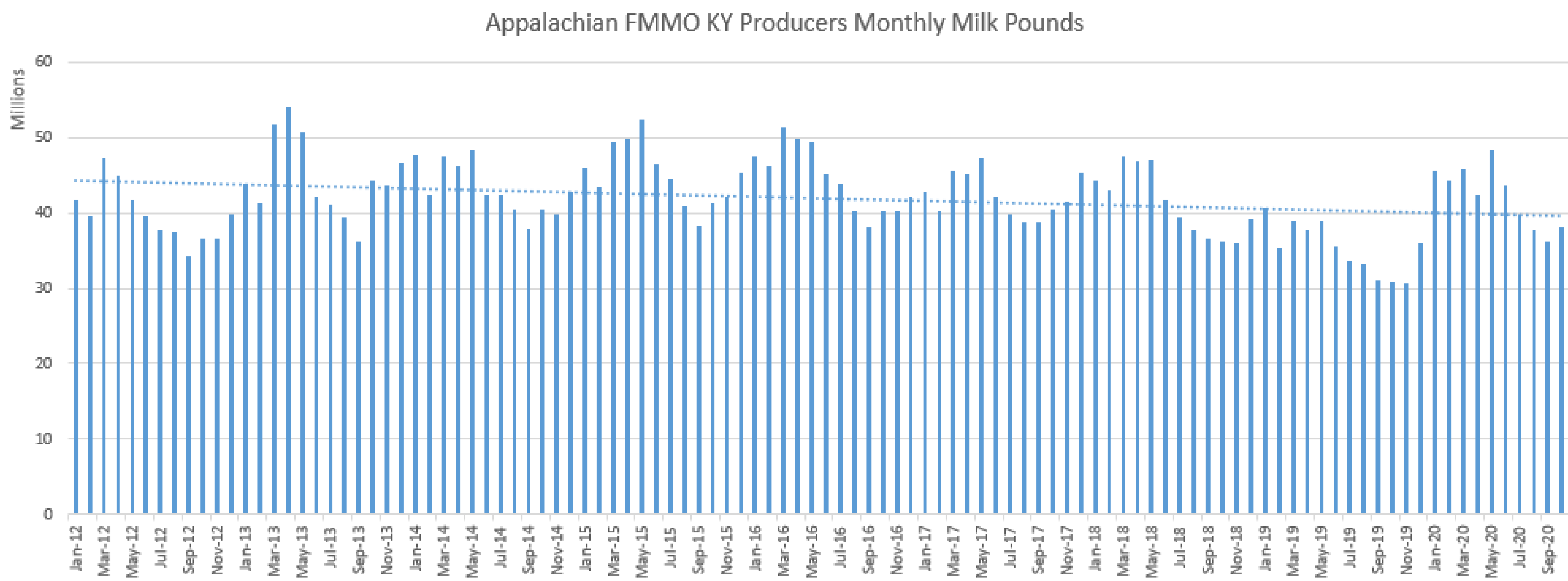

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Figure 2.2 Monthly KY Appalachian Milk Production in Pounds

(Data: Order 5 Market Administrator)

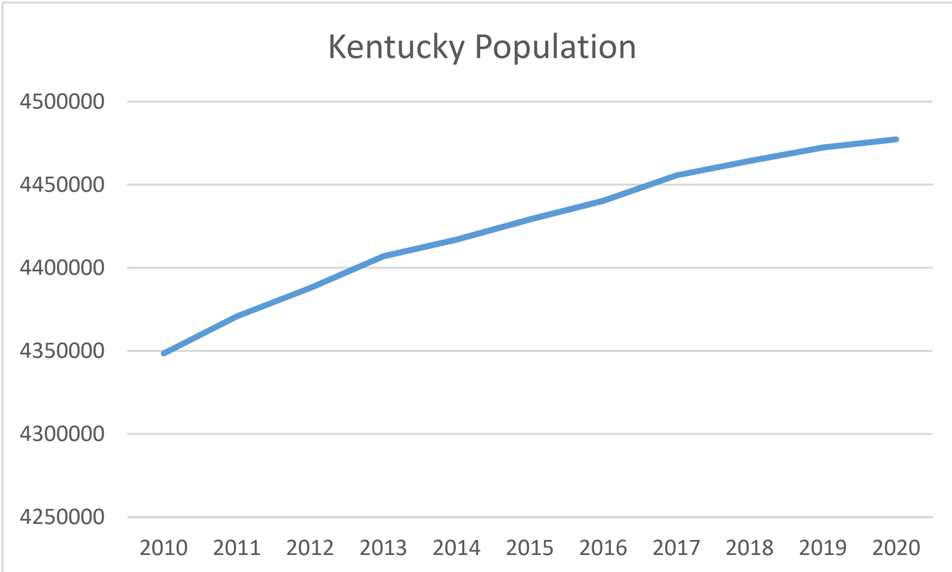

Figure 2.3 Kentucky Yearly Population (Data: US Census)

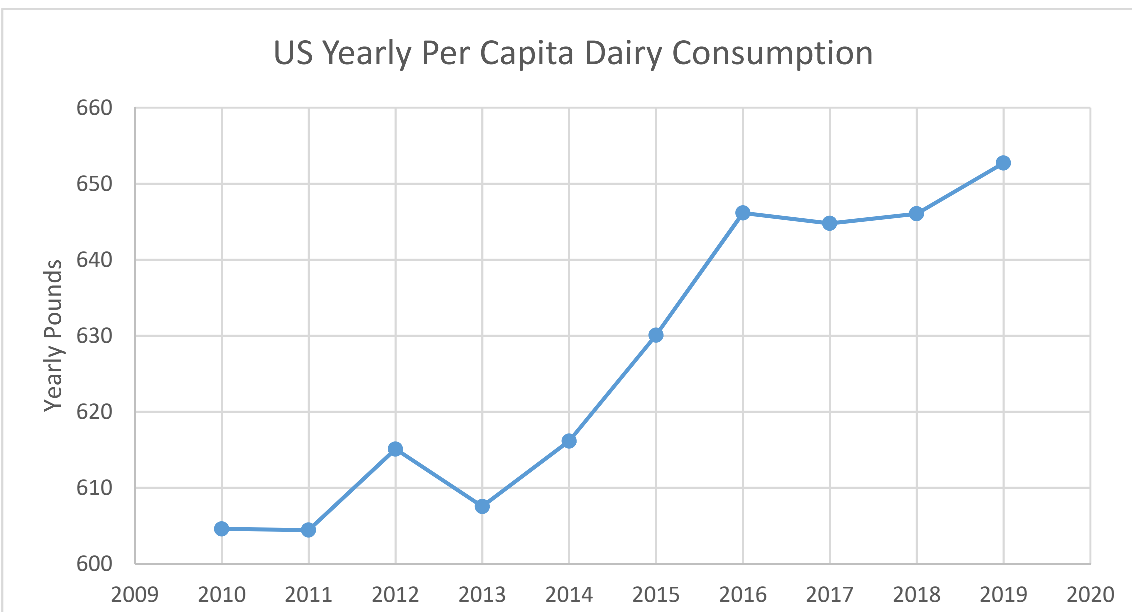

Figure 2.4 Per Capita Consumption of Dairy on a Milk Fat Milk Equivalent Basis (Data: USDA)

Milk production in Kentucky is mostly derived from the southern portion of the state. Production varies by county. Adair County, the most productive county in the state, produces as much as 7,151,785 pounds in October 2020. Caldwell County has the lowest recorded production numbers at 21,631 pounds of milk in the same month. There may be counties with lower production numbers, but producer statistics can only be made public with three or more producers per county due to privacy protections. Figure 2.5 demonstrates the productivity of counties in Kentucky that pool their milk in the Appalachian FMMO, as determined by the Appalachian FMMO market administrator. In Figure 2.5 the Appalachian FMMO is the middle portion of the state denoted by the maroon boundary. Many of the Appalachian FMMO's most productive counties lay outside of the FMMO boundary, in the Southeast FMMO region of Kentucky.

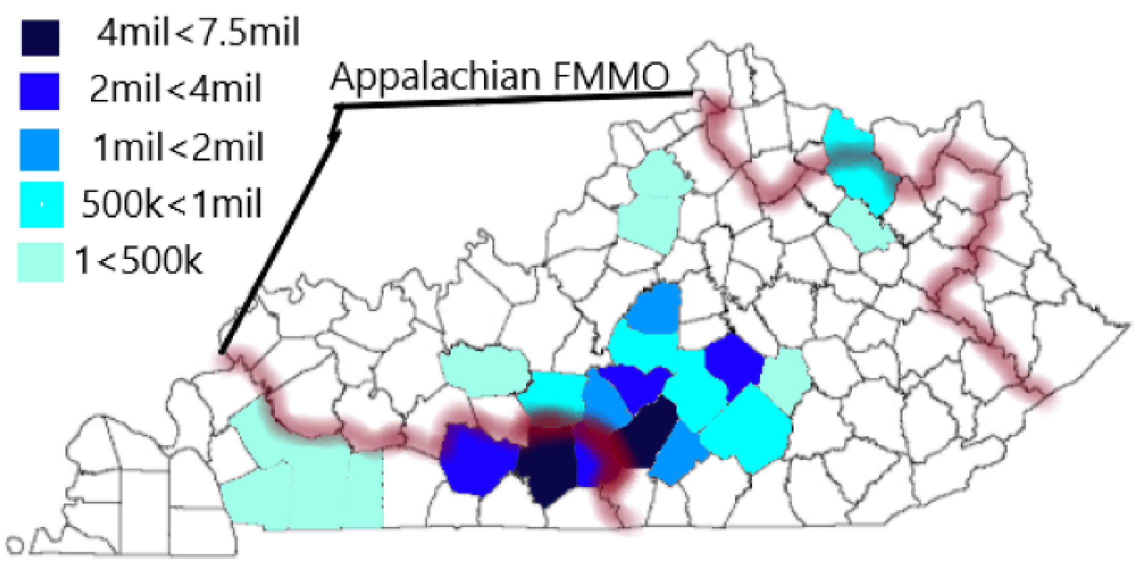

Figure 2.5 Appalachian FMMO Kentucky October 2020 Monthly County Milk Production in Pounds (Data: Order 5 Market Administrator)

2.3 Multiple Component Price Proposal

In April of 2018, a petition for a hearing was filed to the United States Department of Agriculture (USDA) on the subject of adopting Multiple Component Pricing (MCP) in the Appalachian and Southeast FMMOs. Filed by the NAJ (National All-Jersey), a trade organization with two goals per their mission statement: "To increase the value of and demand for Jersey milk; and To promote equity in milk pricing" (NAJ Website). The proposal stated several benefits MCP would bring the two orders. Not having MCP in the orders had the following effects according to Erick Metzger, General Manager of National All-Jersey Inc. "the absence of multiple component pricing for the Southeast and Appalachian markets creates and perpetuates marketing inefficiency, lack of uniformity for manufacturing milk prices, inequitable marketing or procurement costs to handlers, and understated revenue to producers. (USDA Hearing Request)"

The proposal was not met without controversy. The Tennessee Dairy Producers Association opposed the MCP proposal because setting a minimum price for protein would detract from Class I premiums. Stan Butt, director of the Tennessee Dairy Producers Association states, "When FMMO pooling standards are designed to encourage service to a Class I Market, why deliver milk when one can collect the Class I dollars with protein?" They concede some producers with Jersey and high component herds may benefit but state "Opposition to the proposal submitted by NAJ to changing the current pricing structure in FMMOs 5&7 is based on the proposition that the majority of producers in both orders will be negatively affected."

2.4 Federal Milk Marketing Orders

FMMOs are quasi-governmental institutions that regulate the majority of the milk supply in the country. Established in 1937 under the Agricultural Marketing Act, these orders were established with several goals in mind.

FMMOs were implemented due to the following. The milk market of the 1930s was seen as chaotic. Since milk is perishable and seasonal in its supply, it was thought producers were in a weak bargaining position relative to handlers (processing plants). FMMOs brought stability to milk regulated by an order through the following. Minimum prices for milk paid to producers for milk pooled within an FMMO are linked to market prices for dairy commodities. A uniform price is paid to producers for milk of the same quality. Finally, rules regulating the FMMO can only be changed by a broad consensus of producers, handlers, and consumers to allow all affected parties a voice in policy (Christensen 1978). It should be noted only Class I processors are required by law to participate in FMMOs (the classified milk system will be discussed later).

The number of FMMOs has varied over the years, but with the dissolution of the Western Order in 2004, it has remained at 10. Figure 2.6 below demonstrates the current geographical bounds of FMMOs in the United States.

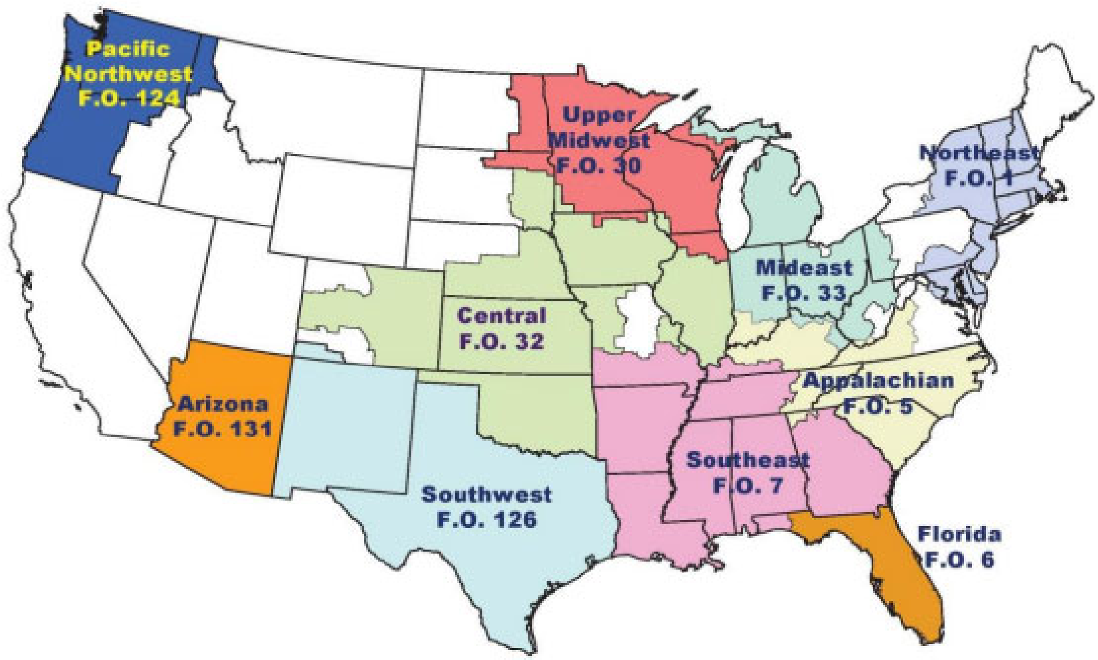

Figure 2.6 Map of Federal Milk Marketing Orders. (USDA AMS)

The two FMMOs which regulate most Kentucky dairy producers are the Appalachian and Southeast. Historically, the FMMOs have been in a milk deficit with producers from surrounding FMMOs supplying milk to processors in the Appalachian and Southeast orders (see Figure 2.7). An FMMO is in a deficit when producers within the geographic bounds of the order cannot supply enough milk for processors regulated by the order. A growing population and a declining number of producers have been cited as factors. (Federal Register 2014)

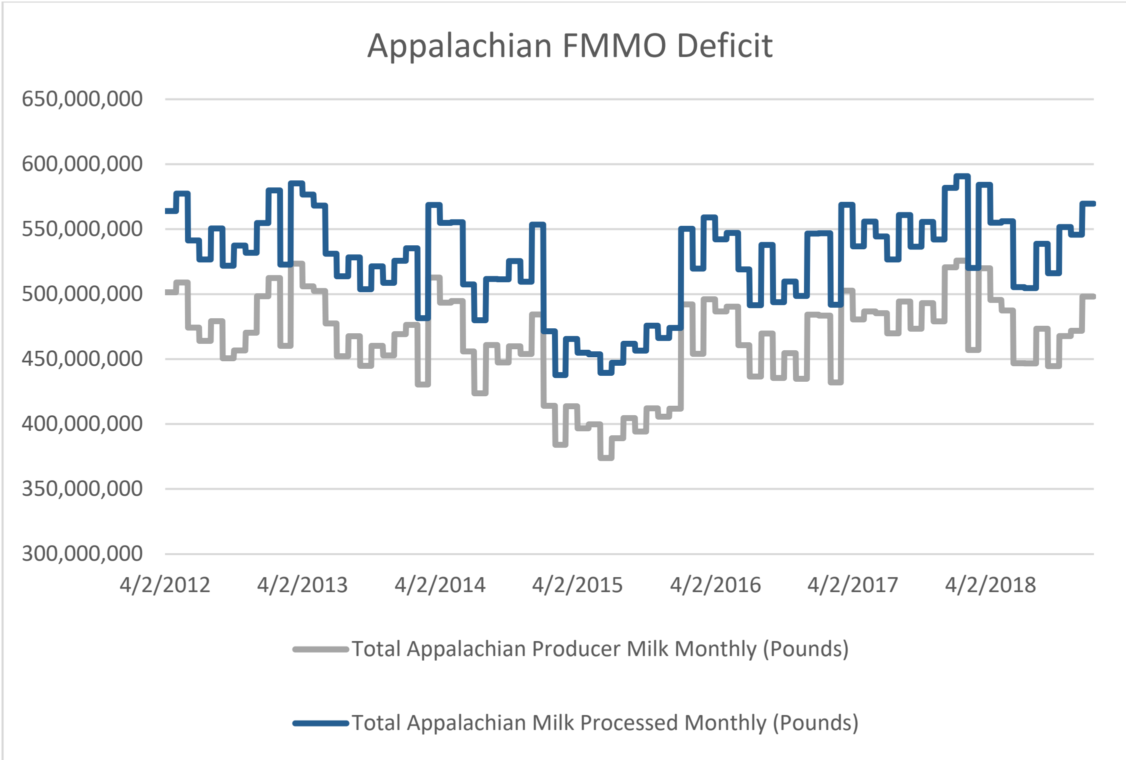

Figure 2.7 Appalachian FMMO Producer Pounds and Total Milk Processed 2012-2018

This deficit has led to policies specific to the Appalachian and Southeast FMMO. To facilitate the transport of milk to processors in the region the Transportation Credit Balancing Fund was instituted. Processors in the Appalachian and Southeast orders pay $0.15 and $0.30 respectively per hundredweight processed into the fund. These payments are not made during "flush" months (March, April, May and June), months associated with higher milk production in the region. During non-flush months the fund is paid out to subsidize the cost of transporting milk into the order (Herndon 2019).

Another policy instituted to cope with the milk deficit in these FMMOs is diversion limits. These limits prevent milk pooled in the FMMO from being diverted to plants outside the FMMO. Since the Southeast and Appalachian orders have persistent milk deficits, diversion limits are set lower than most FMMOs in the United States. The diversion limits in the Appalachian and Southeast FMMOs range from 25-35%

depending on the month. FMMOs with surpluses have higher diversion limits. The Upper Midwest FMMO has its diversion limits at 90% for example. If milk is diverted to a processor outside the FMMO producers receive the same price as if it were processed in their FMMO provided it is within the diversion limit (Herndon 2019).

Finally, delivery day requirements govern if a producer has the ability to pool their milk in a FMMO. The Appalachian and Southeast FMMO both have a delivery day requirement of one day. This means producers have to ship at least one day's production to a processor within the FMMO to have their milk pooled in the order (Townsend 2017). The one day delivery requirement makes it easy for milk out of the Southeast and Appalachian FMMOs to pool in the orders. Kentucky is near several FMMOs which also utilize one day delivery requirements, which due to differences in milk pricing may exacerbate the milk shortage within the Southeast and Appalachian FMMOs.

The difference in methods for pricing milk may lead to milk being valued in one FMMO more than another. John Newton has noted empirical evidence of milk flowing out of Kentucky to the Mideast FMMO, despite the deficit present in the Appalachian and Southeast FMMOs. It is proposed that if the orders used the same pricing system milk would have an incentive to remain in the Appalachian and Southeast FMMOs (Newton 2014).

2.5 Multiple Component Price Versus Skim Fat Price

Among the FMMOs two different systems for pricing producer milk prevail. The first is the skim/fat system. This pricing scheme is used in four of the FMMOs: Appalachian, Southeast, Florida, and Arizona. (CRS Report 2017). Milk priced under this system is valued based on the amount of butterfat present in the milk. The formula for the Skim Fat Price (SFP) is detailed in Equation 1.

$$\text{(1)} \quad \textit{SFP Per CWT} = (\textit{Butterfat Price} * \textit{Lbs Butterfat per CWT}) + \textit{Skim Price CWT}(1\text{-}\%\textit{Butterfat})$$

Where *SFP Per CWT* is the price for milk under skim fat pricing per one hundred pounds. *Butterfat Price* is the announced price for butterfat. *Lbs Butterfat per CWT* is the number of pounds of butterfat per hundredweight. *Skim Price CWT* is the announced price for a hundredweight of skim milk, how this is determined will be covered later. *%Butterfat* is the percent butterfat present in the milk. This formula lays out two factors for pricing milk. Pricing systems similar to this have been used for decades. Several issues have been noted with SFP.

SFP may not reward the most economically valuable milk. Due to pricing milk based on butterfat, the components in skim milk are not individually valued. Under a skim fat pricing regimen the component values in the skim portion are assumed as follows. Protein percentage at 3.1%, other solids at 5.9%, and a somatic cell count (SCC) assumed 350,000 per milliliter (Newton 2014). Due to various factors ranging from genetics to diet, the component percentages and water content of skim milk vary from producer to producer (Bailey 2005, Smith 1978). This leads to a uniform price being paid out for skim milk with varying economic viability at the processor level. These factors, among other, were why a multiple component pricing system was implemented in many FMMOs.

Multiple component pricing was introduced to solve several issues facing the dairy industry in the 1990s. Government support programs had led to extensive stockpiles of dairy commodities. (Marchant 1992). A change in milk consumption patterns made the old butterfat pricing system distort market forces. Consumption of whole milk per capita in the United States decreased from 191.3 pounds in 1972, to 78.73 pounds in 1993. Couple this with an increase in skim milk consumption per capita of 51.6 pounds in 1972 to 130.6 pounds in 1993 (USDA 1994). These trends led to butterfat content no longer being the most accurate gauge of milk value. In 1960 the price per hundredweight for milk averaged $3.13 with butterfat accounting for 77% of the milk's value, skim milk for the remaining 23%. In 1993 milk averaged at $11.80 a hundredweight with skim milk accounting for 77% of producer's price, 23% for butterfat. (Jesse 1994). These changes in milk use may lead to skim milk being undervalued in the price received by many producers in SFP FMMOs (FO 5 & 7 Component Pricing Impact Estimate, SE and Appalachian Order Administrator).

Pricing milk components in skim milk separately gives market incentives to producers for high component milk. Currently six of the ten FMMOs utilize a form of multiple component pricing. This allows the price of milk components received by producers to more accurately reflect how they are marketed at the retail level. The form of MCP used by most FMMOs to determine the milk price received by producers is detailed in Equation 2.

$$(2) \quad MCP\ per\ CWT = (Protein\ Price * Protein\ Lbs\ Per\ CWT) + (Butterfat\ Price * Butterfat\ Lbs\ Per\ CWT) + (Other\ Solids\ Price * Other\ Solids\ Lbs\ Per\ CWT) + PPD + SCC\ Adjustment(350-SCC)$$

The price for protein, butterfat, and other solids are in pounds and announced monthly by the USDA Agricultural Marketing Service (AMS) (USDA Announcement of Class and Component Prices). The PPD (Producer Price Differential) is generated from milk price received at the processor level from classified pricing. The SCC Adjustment is used in the Central, Mideast, Upper Midwest, and Southwest FMMO. This formula will be used to represent the MCP in Kentucky, consistent with the formula submitted by the NAJ in 2018 to the USDA proposing the Appalachian and Southeast FMMOs adopt MCP (USDA AMS, Dairy Programs)

2.6 How Component Prices Are Calculated

In both SFP and MCP FMMOs, producer's minimum price is linked to the end use of milk in the market. The dairy commodities used to determine producer milk prices are: butter, nonfat dry milk, cheddar cheese, and dry whey (USDA AMS). The National Dairy Sales Product Report (NDSPR) determines the price for these commodities through a market survey. Prices for each commodity used is the sales adjusted weighted average of the two weeks most recent to the Announcement of Advanced Prices and Pricing Factors report. Butter price is determined from 25 kilogram and 68 pound boxes of AA grade butter. The price of cheddar cheese is from 38% moisture adjusted 500 pound barrels of cheddar and 40 pound blocks of cheddar. Dry whey price is the price received for dry whey meeting USDA Extra Grade standards from bag, tote, and tanker sales. Finally, the price for nonfat dry milk is bag, tote and tanker sales meeting USDA Extra Grade or US Public Health Service Grade A standards.

Using the commodity prices, the minimum prices for milk components is established. Protein price is determined from cheddar cheese and butterfat. First the protein value in cheese must be calculated (see Equation 3). Cheese price in pounds as tabulated by the NDSPR then has a make allowance of \$0.2003 subtracted. This is then converted to Protein Value in Cheese by multiplying it with the yield factor of 1.383 (USDA Announcement of Class and Component Prices).

(3) (*Price of Cheese - Make Allowance*) * *1.383 = Protein Value in Cheese*

The butterfat value in cheese must be determined next (see Equation 4). This is the same process as finding the protein value in cheese except the yield factor is 1.572.

(4) (*Price of Cheese - Make Allowance*) * *1.572 = Butterfat Value in Cheese*

Finally the butterfat value in butter is determined. This is simply the price of butterfat times 0.9 (USDA Announcement of Class and Component Prices). The price of protein can then be determined. Protein price is the protein value in cheese plus the butterfat value in cheese minus the butterfat value in butter, then multiplied by the yield factor to produce the protein price per pound (see Equation 5).

(5) *Protein Value in Cheese* + (*Butterfat Value in Cheese - Butterfat Value in Butter*) * *1.17 = Protein Price Lb*

This results in the protein price used in MCP FMMOs for producer milk.

The price of butterfat is determined through the price of butter. The Advanced Butterfat Pricing Factor is shown in Equation 6.

(6) *Butterfat Price Lb = (Butter Price Lb - Make Allowance) * 1.211*

The butter price is the aforementioned price from the NDSPR weighted average with the make allowance at \$0.1715 and the yield factor at 1.211. Butterfat price is used in MCP FMMOs to determine producer milk butterfat value. SFP FMMOs use the weighted average butterfat price as derived by classified pricing. Classified pricing will be discussed in the next section.

Other solids price is the price of dry whey (as determined by the NDSPR) minus a make allowance of \$0.1991. This is then multiplied by the yield factor of 1.03 to produce the price per pound for other solids (see Equation 7).

(7) (*Dry Whey Price Lbs - Make Allowance*) * *1.03 = Other Solids Price Lbs*

This price for other solids is then used in MCP FMMOs to value producer milk.

The SCC (Somatic Cell Count) Adjustment takes the measure of the amount of somatic cells in a milliliter of producer milk. An elevated count can indicate an infection, so the limit for SCC is 750,000 per milliliter (Nolan 2020). The adjustment is based on 350,000, where milk with an SCC below gains value and milk with an SCC greater loses value. The value of the adjustment is determined by the price of cheddar cheese (see Equation 8).

(8) *SCC Adjustment Rate = Cheese Price * 0.0005* (USDA, Price Formulas)

The prices of components in MCP FMMOs have been examined. To evaluate how the price of skim milk received by producers in SFP FMMOs is generated and the Producer Price Differential, an understanding of Classified Pricing is necessary. Figure 2.8 shows the relationship of protein price to Appalachian skim milk price. It should be noted how protein price is more volatile, consistent with its intent to link producer price to end wholesale product price.

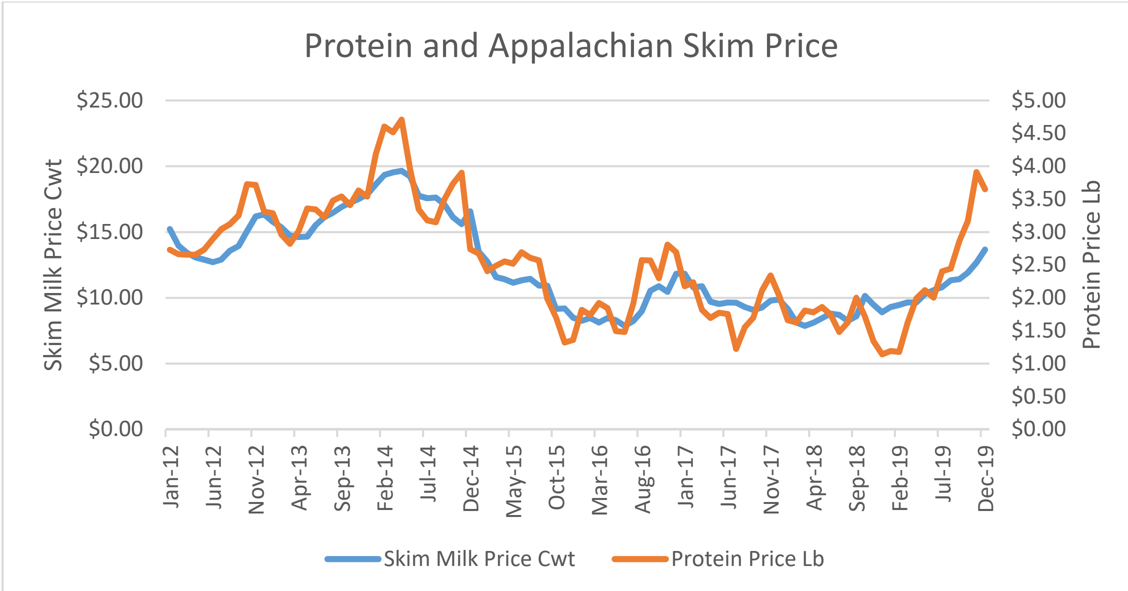

Figure 2.8 Protein Price per Pound and Appalachian Skim Milk Price per Hundredweight

2.7 Classified Pricing

A central tenet of FMMOs is milk of the same quality receives the same price. If a producer's milk is used for industrial uses, it will receive the same price as if it were used for fluid milk purposes, provided the pooling location and component values are the same. This blend price is accomplished through milk pooling. All the producer milk in a FMMO is pooled and then utilized in one of four classes, with each class assigned a different end use. The classes are in order of perishability as follows:

Class I - fluid milk, drinking milk and other dairy beverages e.g. eggnog

Class II - soft dairy products e.g. yogurt and ice cream

Class III - Hard cheeses and whey

Class IV - Butter and dry milk powder

(Farm Bureau 2019)

Each of these classes receives a price based on the price dairy products receive in the market discussed earlier except Class IV milk. Class IV price is derived from the butterfat price and the price of nonfat solids. The butterfat price has been derived earlier. The price for nonfat solids is the price for nonfat dry milk minus a make allowance of $0.1678; this term is then multiplied by the yield factor of 0.99 (see Equation 9).

(9) *Nonfat Solids Price Lb = (Nonfat Dry Milk Price Lb-Make Allowance) * 0.99*

The resulting term is the price for nonfat solids. Nonfat solids price per pound multiplied by 9 yields the Class IV skim milk price per hundredweight. . The price of Class IV skim and butterfat are then used to determine the Class IV price per hundredweight, shown in Equation 10 (USDA *Calculating Class IV Price*).

(10) *Class IV Price Cwt= (Class IV Skim Price Cwt * 0.965)+ (Butterfat Price Lb * 3.5)*

Class III milk is the benchmark of industrial milk. Class III price is based on the price of milk components discussed earlier. The price for Class III skim is detailed in Equation 11.

(11) (*Protein Price * 3.1*) + (*Other Solids Price * 5.9*) = *Class III Skim Milk Price Cwt*

This formula is reflected in the assumed characteristics of skim milk in a SFP FMMO where each hundredweight of skim is assumed to have 3.1 pounds of protein and 5.9 pounds of other solids (Newton 2014). The price of Class III milk is then as follows (see Equation 12), (USDA *Calculating Class III Price*).

(12) (*Class III Skim Price Cwt * 0.965*)+(*Butterfat Price Lbs * 3.5*)=*Class III Price Cwt*

The price for Class II milk is derived in a similar manner. The Class II Skim Milk price per hundredweight is the Class IV Skim Milk Pricing Factor plus a \$0.70 differential. The price for Class II butterfat is the aforementioned butterfat price plus a \$0.007 differential. The Class II price per hundredweight is then derived in Equation 13 (USDA *Calculating Class II Price*).

(13) (*Class II Skim Price Cwt * 0.965*) + (Class II *Butterfat Price Lbs * 3.5*)=*Class II Price Cwt*

How the price of Class I milk is derived recently changed. The data for this project was priced under the old Class I price formula. Under the old formula for the Class I skim milk the price was higher of Class III or Class IV skim milk plus the applicable Class I differential. Class I butterfat was priced using the butterfat price plus the applicable Class I differential divided by 100. In May of 2019 the formula for Class I milk had modifications from the 2018 Farm Bill implemented. (Farm Bureau 2019) Currently the price of Class I milk is calculated as follows. The base price of Class I skim is determined from the average of Advanced Class III or Class IV Skim Milk Pricing Factor, plus a premium of 74 cents a hundredweight (see Equation 14).

(14) *(Base Class 1 Skim Milk Price Cwt * 0.965) + (Butterfat Price Lb* 3.5) = Base Class I Hundredweight Price*

The Class I differential is then applied in the same way as the old system to produce the Class I price. Over the two formulas for Class I milk, the way Class I differentials are derived remained constant. The Class I differential exists to act as an incentive for milk to flow to areas with high fluid milk consumption e.g. cities. The Class I differential is based on the county a milk processor is located in; hence the price received by a producer could vary based on the processor milk is shipped to within the FMMO (Jesse and Cropp 2008).

With Classified Pricing covered, the final components of the pricing formula can be determined. The final part of multiple component pricing is the Producer Price Differential (PPD). The intent is to share with the producers the true value netted by milk at the handler level. The approximate value of the PPD is outlined below (see Equation 15).

(15) *Weighted Average Price of Class I, II, IV - Price of Class III = PPD*

Since the price for Class III milk is based on components, the PPD reflects the value of fluid milk at the handler level and directs the proceeds back to producers. (Jesse and Cropp 2008) Similarly, the price received for skim milk in SFP FMMOs is a weighted average of the skim price received over all classes. A summary of how the MCP and SFP prices are derived is shown on the next page.

Multiple Component Price

MCP Per Hundredweight = Protein Percentage * Protein Price Lb + Fat Percentage * Fat Price Lb + Other Solids Percentage * Other Solids Price Lb + Somatic Cell Adjustment * (350 – (Somatic Cell Count (thousands)) + Producer Price Differential

Protein Price Lb = ((Cheese Price Lb – 0.2003) * 1.383) + ((Cheese Price Lb-0.2003) * 1.572) – ((Butter Price Lb * 0.9) * 1.17)

Fat Price Lb = (Butter Price Lb – 0.1715) * 1.211

Other Solids Price Lb= (Dry Whey Price Lb – 0.1991) * 1.03

Somatic Cell Adjustment = Cheese Price Lb * 0.0005

PPD = (Weighted Average Price Per CWT of Class I, II, IV - Price Per CWT of Class III) – Location Adjustment

Classified Pricing

Class I Price Per CWT = (((Advanced Class III Skim Price per CWT + Advanced Class IV Skim Milk Price per CWT)/2) +0.74 + (Applicable Class I Differential * 0.965) * 0.965 + 3.5*(Fat Price Lb + (Applicable Class I Differential/100)

Class II Price Per CWT = ((Advanced Class IV Skim Price per CWT + 0.70) * 0.965) + ((Fat Price Lb + 0.007) * 3.5)

Class III Price Per CWT = (((Protein Price Lb * 3.1) + (Other Solids Price Lb * 5.9)) * 0.965) + (Fat Price Lb * 3.5)

Class IV Price Per CWT = ((((Nonfat Dry Milk Price Lb – 0.1678) * 0.99) * 9) * 0.965) + (Fat Price Lb * 3.5)

Skim Fat Price

SFP Per Hundredweight = Skim Price Per CWT * Skim % + Butterfat Price Per Lb * Pounds Fat Per CWT

Skim Price Per CWT = Class I Skim Price Per CWT * Class I Skim Utilization % + Class II Skim Price Per CWT + Class II Skim Utilization % + Class III Skim Price Per CWT * Class III Skim Utilization % + Class IV Skim Price Per CWT * Class IV Skim Utilization %

Butterfat Price Per Lb = Class I Butterfat Price Per Lb * Class I Butterfat Utilization % + Class II Butterfat Price Per Lb * Class II Butterfat Utilization % + Class III Butterfat Price Per Lb * Class III Butterfat Utilization % + Class IV Butterfat Price Per Lb * Class IV Butterfat Utilization %

2.8 Data and Review

2.8.1 Literature Review

Milk pricing in the United States is a complex topic. In Washington D.C. there is a saying, "Three people understand milk pricing and two of them are lying." The reasons for adopting a multiple component pricing system have been a topic of research for decades. It has been suggested multiple component pricing would promote more equitable prices for producers while also making marketing conditions more stable.

Smith and Snyder (1978) research the impact of adopting a pricing system that prices protein instead of skim milk. The main findings were under all multiple component scenarios herds composed of Holsteins would fare worse on average compared to the old butterfat price with an average decrease in value of 0.3%. In contrast, a herd of Jerseys would see milk values increase by an average of 5%. Bailey et al. (2005) seek to determine if Holstein herds actually fare worse under Pennsylvania's multiple component pricing system. By including feed costs they determine Holsteins generate more income for producers due to a lower feed cost relative to milk production. A herd of Jerseys produces milk more economically valuable per hundredweight but a herd of Holsteins has more components in absolute terms at a lower feed cost. The impact of herd size was also considered with larger herds potentially negating any gains from higher component levels. According to Van Tassel et al. 1999, genetics accounts for 55% of milk variation with management decisions accounting for the remaining 45%.

The impact of herd size has been noted in affecting the component levels in milk. Since herds in Kentucky have been trending towards getting larger as the years go, this is of particular interest. Freije (2016) wrote in a paper commissioned by the Upper Midwest FMMO using farm level data that noted different production characteristics in milk were associated with operation size. Small producers (23,411 pounds a month) had typically had higher butterfat tests and protein levels along with a higher somatic cell count when compared to larger producers. Larger producers (1,862,290 pounds a month) were found to have higher other solids levels when compared to small producers. The temperature has been found to impact milk production negatively. Using sprinklers as a heat abatement strategy leads to 15.9% greater production in Kentucky cows in the summer (Gunn 2019), suggesting investment in cooling technologies can be used to boost milk yields. Additionally, heat stress has been noted to reduce fat content in milk, but heat can be negated with proper watering strategies (Linn 1988).

To evaluate how multiple component pricing may affect the Southeastern United States, Newton (2014) simulated a multiple component pricing system for each of the listed FMMOs. The average impact on adopting multiple component pricing in the Appalachian FMMO was $0.05 per hundredweight for producers, while the average for the Southeast FMMO was $0.08. Using data from Bailey (2005) characteristics for Jersey herds were estimated with Jersey milk gaining $1.73 value per hundredweight under multiple component pricing in the Appalachian FMMO and $1.77 in the Southeast FMMO.

The literature suggests Jersey herds benefit with appreciated milk value under MCP with the proposition for Holsteins dependent on component levels, which may be associated with management decisions. The concerns of Holstein producers losing milk value under MCP is not a new phenomenon. Smith and Snyder (1978) estimate four of the five breeds would see their milk values appreciate under MCP, with Holsteins being the exception. An average price reduction of 0.3% was predicted for Holstein milk under MCP by Smith and Snyder. The authors note a reduction of this size should not greatly concern Holstein operations. Given Holsteins are still the overwhelming majority of dairy cows, even in FMMOs which have adopted MCP, the assessment seems to hold.

The prior literature primarily examines the pool level impact of adopting MCP. This approach suggests the overall value of milk pooled increases, due to milk in Classes II, III, and IV having components valued with the MCP formula. At the producer level, the impact has not been analyzed extensively. There are many challenges to evaluating how a potential switch may impact producers.

Firstly MCP changes the milk attributes producers receive a price for. Due to the current SFP paradigm minimal incentives exist for producers in Kentucky and other states operating in an SFP FMMO. The Appalachian FMMO does not track protein and somatic cell count components since these components do not currently contribute to any price tabulation. Any study seeking to assess farm level impact of MCP would need farm level data, including components used in MCP FMMOs. Additionally the impact of MCP on Class I differentials should be considered. Switching to MCP may impact the amount of compensation a producer receives for location adjustments. This study seeks to contribute to the MCP debate by considering these two additional factors.

2.8.2 Data

The data ranges from April of 2012 to December 2018 due to availability from the Dairy Herd Improvement Association. Each observation represents a dairy herd in Kentucky with associated production quantities for the herd from that day. There are in total 6,522 observations for 322 herds. Nolan (2020) compiled the dataset as it relates to DHIA data.

Variable	Description	Unit	Mean	Std. Dev.	Min	Max	Obs	Source
CWTDIFF	Estimated MCP minus uniform SFP, reflecting test day components	$/cwt	0.23	0.37	-1	2.19	N=6,512 n=322 T=81	DHIA USDA
COWS	Number of cows in herd on test day (in regression divided by 100)	Cows	118.3	218.5	20	4070	6,512	DHIA
FAT-PERCENT	Percentage of fat in herd milk on test day	%	3.63	0.21	3.1	4.2	6,512	DHIA
PROTEIN-PERCENT	Percentage of protein in herd milk on test day	%	3.05	0.09	2.82	3.28	6,512	DHIA
MILK	Average daily milk production per cow	Lbs	68.2	12.3	22.3	114	6,512	DHIA
HERDSCC	Somatic cell count on test day by herd		174.5	60.4	55.2	604	6,512	DHIA
TEMPER-ATURE	Daily average temperature in Somerset KY	°C	14.42	9.15	-15	31.2	6,512	NOAA

Table 2.1 Descriptive Statistics for Econometric Model

CWTDIFF will be the dependent variable for the econometric analysis of this paper. Given the objective of evaluating changes in producer welfare, the variable allows for a measure of potential price change. Within the dataset, this variable results from subtracting the SFP per hundredweight from the MCP per hundredweight, as reflected by component data for each observation. The SFP is derived from the uniform skim price and uniform butterfat price as derived for the base zone of the Appalachian FMMO, Mecklenburg North Carolina. Similarly, the MCP is derived from the estimated PPD for the Appalachian FMMO, as determined for Mecklenburg North Carolina. No marketing information is available from the DHIA, so adjusting Class I differentials to reflect the location producer milk is processed is not possible. The impact of Class I differentials on CWTDIFF will be reviewed separately in this paper.

FATPERCENT measures the percentage of fat present in the milk on test day. This variable affects the MCP and SFP differently due to how fat price is derived, as mentioned earlier. It was generated by dividing the total pounds of fat from the herd milk pool on test day by the total pounds of herd milk collected on test day. For ease of analysis the resulting term is then multiplied by 100, so that three percent would now be 3 in the model rather than 0.03. The same procedure is repeated for PROTEINPERCENT. Literature confirms the importance of PROTEINPERCENT since it is the most valuable skim component. Other solids was not gathered by DHIA and are assumed to have a value of 5.8%. It should be noted other solids do not fluctuate like fat and protein in response to environmental and management decisions. HERDSCC is the amount of somatic cells present on test day in the pooled herd milk. HERDSCC is included due to its impact on producer price in MCP and can serve as a proxy for good management since elevated HERDSCC can indicate poor cow health. Consistent with dairy industry conventions it is divided by one thousand, so that 350,000 is reflected in the data as 350.

COWS is simply the number of cows, defined as mature female cattle, contributing to the milk sample. Herd size can impact cow health and may also be associated with investment enhancing herd performance, due to larger operating budgets. TEMPERATURE is the daily average temperature in Celsius in Somerset, Kentucky, from the NOAA station. The impact of temperature on dairy operations is noted in the literature. Somerset was the most central location available, given the most prevalent counties contributing to the dataset where consistent daily observations were available over the period of DHIA data. Finally, MILK is simply the average milk production for a cow in a given herd, as determined by dividing total test day herd milk productions by the number of cows in the herd. MILK is included to account for the potential impact of genetic and management choices favoring high volume production rather than high component production, due to the current SFP paradigm only pricing skim rather than skim components.

The data for the price of components and skim and butterfat came from the USDA. The USDA AMS has monthly records for the price of: protein, other solids, fat, and somatic cell adjustment for multiple component FMMOs. Additionally the price of skim milk and butterfat is available for SFP FMMOs. The prices for components coupled with the estimated PPD from the order administrators is then used to generate a producer price using multiple component pricing in a SFP FMMO. The analysis conducted focuses on the Appalachian FMMO. Milk produced in a county within the bounds of the Appalachian FMMO will be assumed to have been marketed within the FMMO.

The component levels for Holsteins in Kentucky within the Appalachian FMMO do not vary considerably on average on a monthly basis. The sample has some discrepancies when compared to a study commissioned by the Appalachian FMMO to evaluate component levels (see Figure 2.9). The difference in means is at most 0.8% protein. The cow-level data sample suggests a lower protein percentage than found by the Appalachian FMMO for Kentucky milk. If the Appalachian FMMO survey is accurate, it indicates on average, producers may benefit even more on average than this study may suggest.

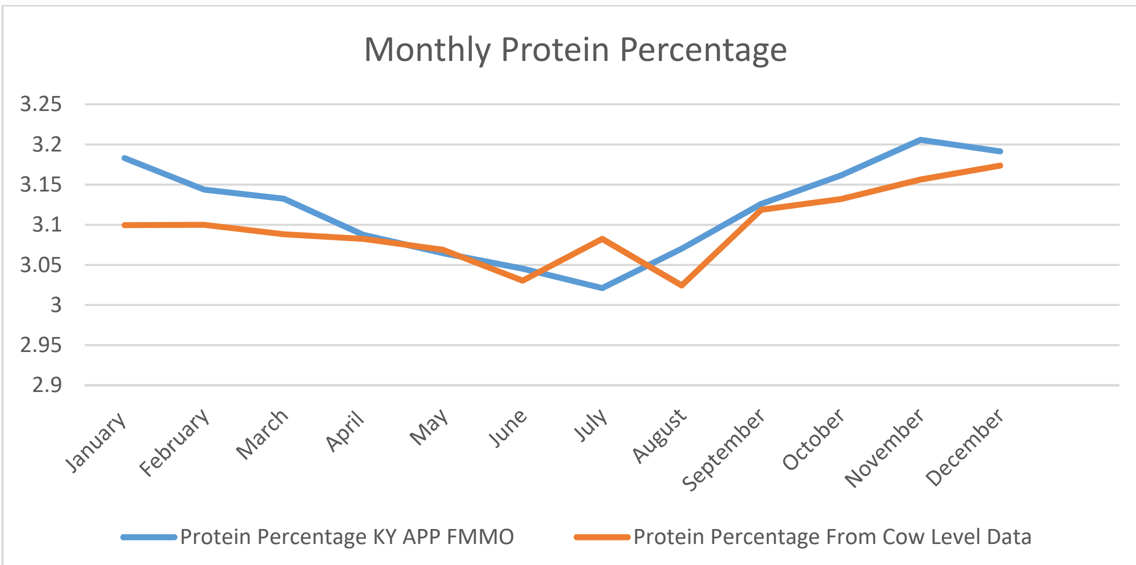

Figure 2.9 Comparing Appalachian Market Administrator Protein Estimates For Kentucky in 2017 to Herd Level Test Day Averages (Data: Order 5 Administrator, DHIA)

Using the test day data, descriptive statistics can be assigned to cows based on production qualities. Table 2.2 is the average of protein components in the test day data for Holstein milk from 2012 to 2018. Using the distribution generated from this exercise, the impact of adopting MCP for Kentucky producers within the Appalachian FMMO can be evaluated based on component levels.

	Obs	Mean	Std. Dev	Min	Max
January	243	3.10	0.34	2.3	4.2
February	244	3.10	0.31	2.4	4.3
March	271	3.09	0.31	2.3	4.4
April	329	3.08	0.30	2.3	4.4
May	289	3.07	0.34	2.3	4.1
June	309	3.03	0.29	2.3	3.8
July	249	3.08	0.33	2.5	4.3
August	291	3.02	0.31	2.2	4.1
September	311	3.12	0.36	2.00	4.3
October	296	3.13	0.34	2.3	4.1
November	209	3.16	0.37	2.3	4.3
December	262	3.17	0.33	2.4	4.7

Table 2.2 Protein Percentage in Holstein Milk from Test Day Data (DHIA)

Figure 2.10 shows the average DIFFCWT by month when considering protein percentage levels. Even Holsteins with protein levels one standard deviation from the sample mean benefit on average in all months but July. Across all months and years, the average increase in price per hundredweight was \$0.195 with a standard deviation of \$0.3694, meaning 32% percent of Holstein cows with below-average protein levels would have their milk depreciate under MCP. This is assuming base level PPD and Class I differential, the impact of location will be reviewed later.

Holsteins with average protein percentages would experience an average of \$0.2888 higher returns per hundredweight under MCP. The standard deviation associated with this is 0.3548 with 19% of Holsteins with normal protein percentages experiencing depreciation of milk value under MCP. The majority of Holstein producers would benefit under an MCP FMMO with minority negatively impacted likely able to adjust in the short run with management changes and the long run utilizing genetic changes favoring component production.

Herd size produced a noticeable trend with regard to milk value under MCP. Among Holstein herds smaller operations (less than 57 cows) realized the largest gains under MCP followed by mid-sized operations (57-163) and finally large operations (more than 163). Small Holstein operations saw milk value increase by an average of $0.32 per cwt, with 18% experiencing reduced returns under MCP. Midsize operations had a price increase of $0.28 for milk per cwt and also 18% of producers experienced a decline in milk value. Finally large producers netted $0.20 more per cwt, with 28% having milk prices depreciate. Table 2.3 shows milk components by herd size. Larger herds seem to have the best management techniques with regards to a SFP system. Large herds have the highest average production per cow and the lowest average protein percentage.

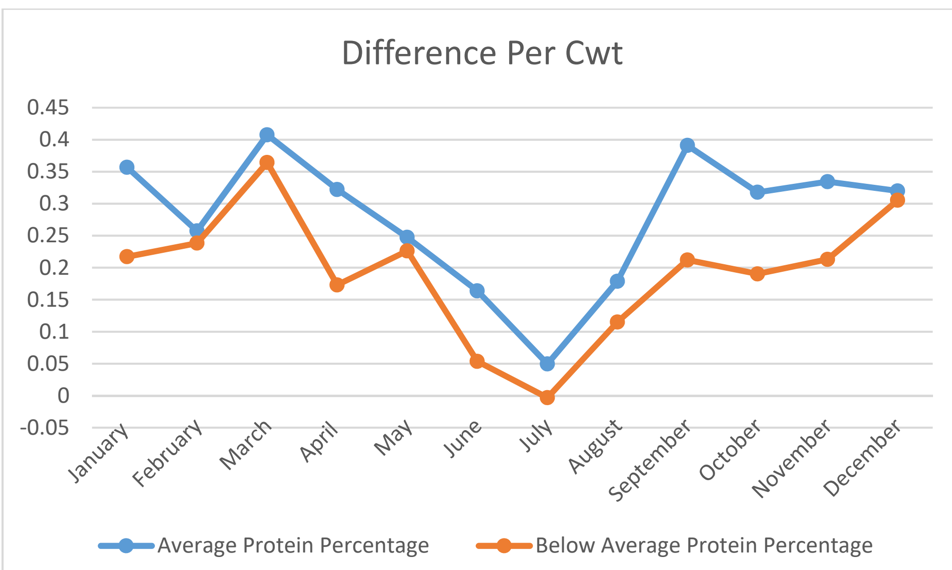

Figure 2.10 Difference between MCP and SFP per Hundredweight based on protein component levels.

Herd Size	Fat Percent	Protein Percent	Other Solids Percent	SCC	Daily Milk Production Pounds Per Cow
1-56	3.68	3.11	5.8	176	64.03
57-163	3.67	3.10	5.8	174	68.52
164-∞	3.66	3.08	5.8	168	79.06

Table 2.3 Production Averages for Holstein Herds by Operation Size

2.8.3 Methodology

Like many econometric projects, data is a constraining factor. The data used takes the form of an unbalanced panel. Confronted with this there are several econometric models to be considered. Firstly is the Pooled Ordinary Least Squares (OLS) model. In this model panel structure is ignored and an OLS model is generated. This structure cannot account for individual-level effects and can easily lead to misspecified models with omitted variable bias. The pooled OLS model is shown below (see Equation 16).

$$(16) \qquad Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \mu_{it}$$

This model assumes the intercept value and slope coefficient are constant across individuals, or in this case herds- represented by subscript *i*. Subscript *t* time as represented by months. This could lead to a model where the relationship between CWTDIFF and the explanatory variables is distorted when evaluated against the actual relationship. For these reasons, a panel regression may be a more appropriate model.

One such possible model is the random-effects estimator. The random effects estimator allows for the inclusion panel effects in the model by including an additional term. The model is outlined in Equation 17.

$$(17) \qquad Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + a_i + \mu_{it}$$

This additional term a_i represents the unobserved effect in the model. In the pooled OLS model this term is included in the error term μ_{it}. When using a random effects estimator, it is assumed a_i is uncorrelated with any explanatory variables. This can be problematic as noted by Wooldridge (2012), "In many applications, the whole reason for using panel data is to allow the unobserved effect to be correlated with the explanatory variables." Given the nature of the model, omitted variable bias is a concern, meaning the assumption $\mathrm{Cov}(x_{it}, a_i)=0$ may not hold.

Using a fixed-effects estimator can allow for a model to more accurately account for unobserved effects. The nature of the panel must be noted prior to considering this model. To use fixed effects on an unbalanced panel it is necessary to assume the reason for missing observations of individual herds are not correlated with the term $\mu_{it.}$ It is not known why herds drop out of the DHIA program. It is possible herds with lower butterfat remain in the data set longer than other herds due to producers wanting to gauge the impact of management decisions on milk components.

The fixed effect model is written out the same way as the prior random effects model. Term a_i will capture any explanatory variable that is constant over time, meaning a herd's breed cannot be included. An important assumption for fixed-effect models is the expected value of μ_{it} for any t when accounting for explanatory variables and a_i is zero, as demonstrated in Equation 18 (Wooldridge 2012).

$$(18) \quad \mathrm{E}(\mu_{it} | X_i, a_i) = 0$$

The fixed-effects model used in this study is outlined in Equation 19. A dummy variable for time is added in monthly increments ranging from April 2012 to December 2018.

This allows the model intercept to adjust in the face of seasonality and potential time trends.

$$(19) \qquad CWTDIFF_{i,t} = \beta_0 + \beta_1 COWS_{it} + \beta_2 FATPERCENT_{it} + \beta_3 PROTEINPERCENT_{it} + \beta_4 MILK_{it} + \beta_5 HERDSCC_{it} ++ \beta_6 TEMPERATURE_t + \beta_7 dApril2012_t + \ldots + \beta_8 dDecember2018_t \; + a_i + u_{it}$$

2.8.4 Regression Results

To determine what the most appropriate model is given the data, the following was done. As stated by prior literature, the impact of MCP varies by breed with Holsteins typically benefitting less than others. Due to herd breeds not varying, any breed impact would be washed out in fixed effects. A Chow test conducted on whether there is a structural break between Holstein and non-Holstein herds based off protein percentage causes the null hypothesis that the parameters do not vary to be rejected. Due to only 430 observations in the non-Holstein sample, analysis will focus on the Holstein herds.

The Breusch Pagan Lagrange Multiplier test was run on the model. The null hypothesis failed to be rejected meaning random effects would not be the most efficient model. Additionally, the Hausman test was run. The Hausman test rejected the null hypothesis that the random-effects model is preferred, suggesting fixed effects is the most efficient estimator. To reduce possible heteroskedasticity within the model robust standard errors are used clustered at the county level. Regression results are shown below in Table 2.4.

Holstein VARIABLES corr(u_i, xb)	Pooled OLS CWTDIFF	Fixed Effects CWTDIFF 0.0155	Random Effects CWTDIFF 0 (assumed)
COWS	-0.000564	0.00074	-0.00056
Robust Std Err	(0.000783)	(0.00231)	(0.000783)
FATPERCENT	0.1234***	0.1248***	0.1234***
	(0.009172)	(0.009498)	(0.009172)
PROTEINPERCENT	2.50973***	2.5106***	2.50973***
	(0.0484)	(0.05566)	(0.0484)
MILK	0.00007	0.00047	0.00008
	(0.0002)	(0.00034)	(0.0002)
HERDSCC	-0.00005*	-0.00005*	-0.00005**
	(0.000026)	(0.0015077)	(0.000026)
TEMPERATURE	0.00044**	0.00027	0.00044**
	(0.00021)	(0.00021)	(0.00021)
Constant	-7.8966***	-7.9297***	-7.8966***
	(0.1705)	(0.2019)	(0.1705)
Observations	6,135	6,135	6,078
Groups		303	303
R-squared	0.9592		
Within		0.9588	0.9587
Between		0.9559	0.9587
Overall		0.9589	0.9592
Sigma_u		0.04	0
Sigma_e		0.0764	0.0764
Rho		0.2157	0

Standard errors in parentheses
(Clustered at County Level)
*** p<0.01, ** p<0.05, * p<0.1

Table 2.4 Holstein CWTDIFF Model Results

These results confirm what high component milk benefits under MCP. PROTEINPERCENTAGE shows for each pound of protein per hundredweight of milk, the producer price increases $2.51 according to the fixed-effects model. This is essentially the average price of protein across time in the dataset, which is \$2.53. Similarly, FATPERCENTAGE shows for every pound of fat per hundredweight in producer milk, the price per hundredweight increases \$0.12. HERDSCC has a significant negative relationship with CWTDIFF as is expected, where every 1,000 increase the SCC results in a \$0.00005 decrease in producer price per hundredweight. COWS and TEMPERATURE were not significant under the fixed effects model. All inference on the impact on CWTDIFF assumes is under ceteris paribus assumptions.

2.8.5 Class I Differential Concerns

As mentioned earlier the Tennessee Dairy Producers Association Proposal to the USDA in opposition of adopting MCP in the Southeast and Appalachian Milk Orders is based on concerns over Class I differentials, stating "the majority of producers in both orders will be negatively affected." To evaluate this statement, how the NAJ MCP proposal impacts Class I differentials must be investigated. The area of concern noted in the letter from the Tennessee Dairy Producers Association is "when protein is forced to be paid with Class I differential dollars regardless of where producer milk is delivered." This objection is rooted in concerns over how a MCP milk order pays producers for components such as protein first, then adjusts the price using the PPD to balance the pool.

The PPD used in this study of the Appalachian FMMO was calculated for Mecklenburg, North Carolina; the base zone for pricing in the Appalachian FMMO. The Class I differential for Mecklenburg is \$3.40. To determine the impact of MCP on one producer's Class I differential dollars, a scenario analysis is conducted for March and July 2017, where March is when earlier research shows producers benefit most under MCP and July is where the change is smallest. The applicable Class I differentials are shown in Figure 2.11 for the Appalachian FMMO. Using the herd level data from DHIA, herds will be grouped three ways. The first group will have component levels reflecting herds with below average protein, as determined by averaging protein percentage for that month. Second will be average components for herds that month and finally above average protein herds. Table 2.5 shows DIFFCWT for Holstein milk by Class I differential and component level, component levels for March 2017 are shown by Table 2.6. Tables 2.7 and 2.8 similarly refer to July 2017.

	Class I Differential							
Components	2.3	2.6	2.9	3.2	3.4	3.6	4	4.3
Low	-0.49	-0.4	-0.3	-0.22	-0.16	-0.09	0.02	0.11
Average	-0.34	-0.25	-0.16	-0.07	-0.01	0.05	0.17	0.26
High	-0.18	-0.09	0	0.09	0.15	0.21	0.33	0.42

Table 2.5 Difference Per Hundredweight (MCP – SFP) For Each Class I Differential In the Appalachian FMMO- March 2017.

Components	Protein Percentage	Fat Percentage	Other Solids Percentage	SCC
Low	2.96	3.56	5.8	186.67
Average	3.04	3.58	5.8	178.64
High	3.12	3.61	5.8	170.09

Table 2.6 March 2017 Holstein Component Levels (Data: DHIA)

	Class I Differential							
Components	2.3	2.6	2.9	3.2	3.4	3.6	4	4.3
Low	-0.35	-0.25	-0.15	-0.04	0.02	0.09	0.23	0.33
Average	-0.26	-0.16	-0.06	0.05	0.11	0.18	0.32	0.42
High	-0.16	-0.06	0.05	0.15	0.22	0.29	0.42	0.52

Table 2.7 Difference Per Hundredweight (MCP – SFP) For Each Class I Differential In the Appalachian FMMO- July 2017.

Components	Protein Percentage	Fat Percentage	Other Solids Percentage	SCC
Low	2.942	3.53	5.8	183.27
Average	3.01	3.57	5.8	181.65
High	3.08	3.61	5.8	179.92

Table 2.8 March 2017 Holstein Component Levels (Data: DHIA)

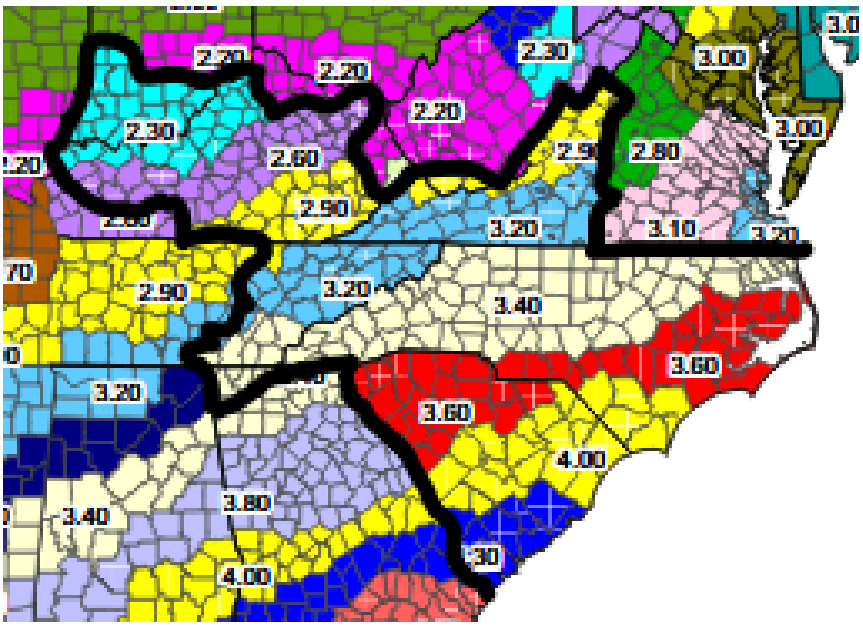

Figure 2.11 Class I Differentials Appalachian FMMO (Federal Milk Marketing Order 30 website, Federal Order Maps)

These preliminary findings suggest areas within the Appalachian FMMO with Class I differentials set below the base zone may experience lower producer milk prices under MCP. Conversely, areas with Class I differentials higher than the base zone will have appreciated producer milk prices. These results are from a static model with utilization reflecting the current SFP paradigm of the Appalachian FMMO. Under an MCP system the increased incentive created by location adjustments may result in more milk flowing to high Class I areas from lower Class I differential areas. This may impact Appalachian producers and processors in areas with lower Class I differentials.

2.8.6 Multiple Component Price Milk Flow

The impact of MCP on milk flows needs to be considered as well. It was noted earlier the Appalachian FMMO has a persistent milk deficit. Despite this deficit status, milk has been observed to flow out of the Appalachian FMMO to MCP FMMOs (Newton 2014). Figure 2.12 shows the extent of Mideast FMMO milkshed in Kentucky for May 2017, with counties in blue having shipped milk to the Mideast FMMO. It is assumed milk flowing out of the Appalachian FMMO is high in components not valued by SFP.

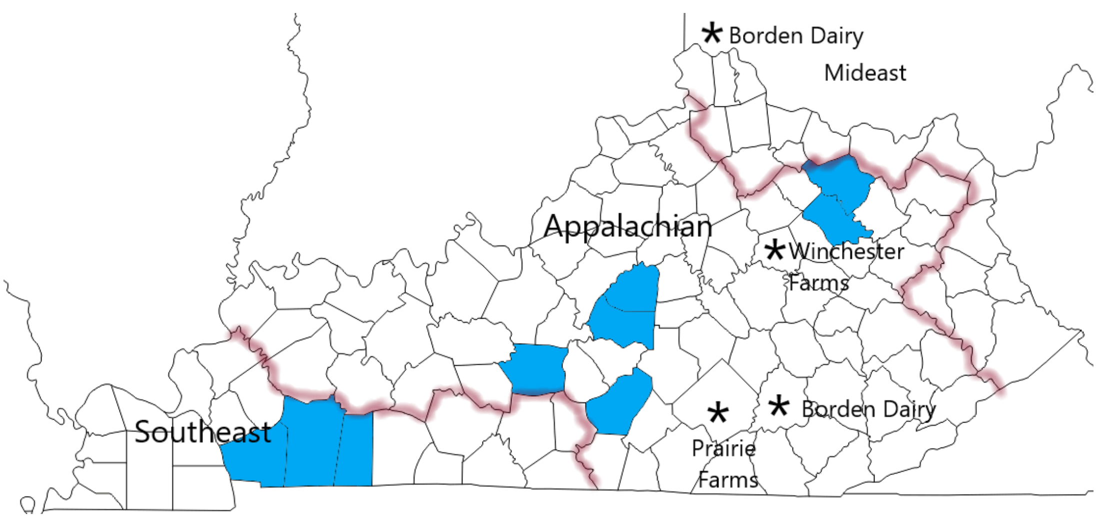

Figure 2.12 Mideast Milkshed in Kentucky May 2017 with Processor Locations

To estimate the impact MCP may have on keeping high component milk within the Appalachian FMMO, a producer in Washington County, Kentucky will serve as an example. Consistent with John Newton's analysis in a 2009 paper evaluating milk transport costs, the county seat will be used as the origin for milk produced. To ship milk to the nearest Appalachian FMMO processor, Winchester Farms, the milk travels 75.4 miles. If the same milk were shipped to the Mideast at the Borden Dairy processor in Cincinnati within the Mideast FMMO, the distance shipped is 108 miles. Assuming an average delivery volume 64,000 pounds, as determined by the Mideast FMMO to be the average producer shipment size from Kentucky (USDA 2011) the cost of shipping can be determined.

To ship the milk within the order to the nearest processor Winchester farms it will cost the producer \$667.67 in hauling charges, assuming a mileage rate factor of \$0.014022. To haul the same milk to Borden Dairy in Cincinnati would cost \$969.20 in hauling charges. Using Jersey component levels of 5.13% fat, 5.8% other solids, 3.87% protein, and an SCC count of 170,000, the producer would rather ship to Borden Dairy in July 2017 to take advantage of MCP in the Mideast FMMO. 64,000 pounds would gross \$13,762.27 SFP at Winchester Farms- accounting for transportation. The same milk shipped to Borden Dairy would gross \$13,915.23. After accounting for transportation in the Appalachian FMMO for the same milk under MCP, the estimated price is \$15,023.16. In the case of Jersey component levels incentive to ship milk outside of Appalachian FMMO would be eliminated.

2.9 Conclusion

The impact of MCP on Kentucky producers is not easily assessed. When Kentucky milk is evaluated at base zone prices, the benefit of MCP seems clear, all but the lowest of component milk appreciates in value. When accounting for Class I differentials, the impact of MCP turns negative for most Holstein producers in Kentucky. Jersey herds in

Kentucky would see their milk appreciate 9% under MCP, despite a $2.60 Class I differential. Additionally, MCP would eliminate incentive for Jersey milk to leave the Appalachian FMMO.

The discrepancy with CWTDIFF between base zone price and location adjusted price suggests the importance of mailbox prices. These prices include adjustments for transportation and Class I differentials. This would allow for a more accurate assessment of the impact MCP may have at the producer level. Adding variables like feed type and feed expenditure would be useful to evaluate the impact of feed regimen on component levels relative to feed cost. This would allow the tabulation of income over feed cost (IOFC)-a standard metric of dairy financial performance- for the two pricing regimens.

The issue of Class I differentials and their impact on MCP adoption within the Southeastern FMMOs certainly merits examination, with the impact varying wildly across the FMMOs. Topics that impact all producers include the Transportation Credit Balancing Fund (TCBF), delivery day requirements, and the size of the FMMO. A common sentiment among producers is out of pool milk should be marketable in the pool on its own merits without a subsidy (the TCBF), especially when that subsidy is indirectly funded by in-pool producers milk checks. Additionally it is thought out of pool milk qualifies too easily within the Southeast and Appalachian FMMO. The Florida FMMO has a delivery day requirement of ten days, compared to the Appalachian and Southeast requirement of one day. The Florida FMMO has not seen the same decline in producer milk pooled as the Appalachian and Southeast FMMO, however how this is related to delivery day requirements is unknown (Townsend 2017). The impact of FMMO consolidation has been suggested to benefit some producers at the expense of others (Godfrey and Stockton 2006). State level pooling requirements have been suggested to prevent out of state milk displacing in state producers, similar to what is seen in the Northeast Interstate Dairy Compact.

Analysis on all these issues should go in conjunction with MCP's impact. A partial equilibrium model may allow for a complete simulation of the milk pool in the Appalachian FMMO. With so many factors contributing to the classified prices and ultimately producer prices, a model accounting for elasticity with respect to milk sources in a pool would generate more accurate results. This analysis would need to generate its own PPD estimates since current PPD estimates are based off class utilization reflecting the current SFP paradigm.

Chapter 3. Evaluating the USMCA Canadian Cream TRQ: A GSIM Approach

3.1 Abstract

The objective of this paper is to evaluate the potential impact of the expanded tariff rate quota for cream in Canada from the implementation of the United States-Mexico-Canada trade agreement. Utilizing a global simulation model for trade using Armington elasticities, the impact of this expanded access can be estimated for both American and Canadian consumers and producers. This paper includes a review of Canada's dairy industry and trade relations as relating to the dairy industry.

3.2 Introduction

Since the implementation of supply management, Canada has maintained extensive import controls on dairy products. Dairy producers in the United States have stated these import controls have prevented market access for U.S. dairy products in Canada. These import controls are a central tenet of Canada's supply management regime. This has resulted in a dairy market with prices consistently higher both at the farm gate and grocery store in Canada when compared to the United States. Canadian dairy groups have stated increased trade with the United States would depress dairy prices and reduce Canadian dairy producer income.

Canada has gradually opened its market more in recent years with several free trade agreements. The 1994 North America Free Trade Agreement (NAFTA) promoted trade between Canada and the United States and Mexico. The 2014 Comprehensive Economic and Trade Agreement (CETA) increased access between Canada and the European Union and the Trans-Pacific Partnership (TPP) created new trade relations for Canada with many nations across the Pacific. These agreements expanded international access to Canadian markets for all dairy products with the exception of the United States, Canada's largest trading partner. The United States-Mexico-Canada Agreement (USMCA) results in expanded market access for U.S. dairy imports to Canada unlike prior trade agreements. This has had varied responses on both sides of the border. Many U.S. publications view the provisions as a win for U.S. dairy, while Canadian producers are concerned this may upend their industry. Using a GSIM partial equilibrium model this paper will evaluate the impact of increased trade access for the cream market in Canada as a result USMCA.

3.2.1 The Canadian Dairy Market

In 2017 Canadian producers produced roughly 9,901,000 metric tons of milk for both industrial and fluid milk purposes. This makes Canada one of the most productive countries in the world with respect to their dairy industry. Canada's production pales in comparison to their southern neighbor and largest trading partner however. The United States produced in 2017 almost produced ten times the amount of Canadian production with 97,734,000 metric tons produced (CDIC DP002B).

The dairy industry of Canada is primarily located in Quebec and Ontario. These provinces are Canada's most populous in addition to having the longest history of dairying as well. The two provinces encompass over 61% of Canada's population (StatCan Population Estimates) and almost 69% of the country's milk production in 2018. In spite of concentration in Quebec and Ontario, dairying has seen growth in all provinces as shown by farm cash receipts (from milk sold off farms after transportation and handling costs plus other fees). Figure 3.1 demonstrates total farm cash receipt growth from dairying in all provinces from 2010 to 2019.

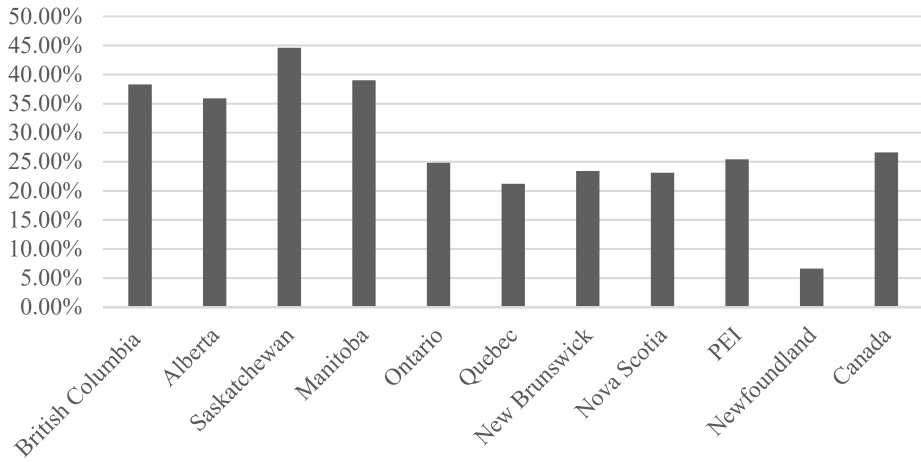

Figure 3.1 Total Cash Receipt Growth From Dairying 2010-2019 Across Provinces (Data: CDIC MI011)

While cash receipts are an indicator of the dairy industry's value, farm level milk production has also increased in Canada. In 2000 Canadian producers had an output of almost seventy-five million hectoliters of milk annually. By 2019 producers in Canada had an output of over ninety-two million hectoliters (see Figure 3.2). This growth in output has occurred with a declining number of producers. From 2000 to 2019 Canadian milk production increased approximately 23% while the number of dairy farms over the same time period decreased from 19,368 to 10,371 (see Figure 3.3). This suggests supply management has not been effective in preserving small farms in Canada since the number of cows and heifers has remained relatively static in the last ten years (see Figure 3.4). The larger farms and assumed economies of scale have not resulted in savings for the Canadian consumer with milk prices rising over the years and Canadians facing higher prices for dairy when compared globally. Canada has seen dairy prices increase at a rate higher than consumer goods compared to the United States where dairy prices have not kept pace with consumer goods (Findlay 2012). The farm gate price received in Canada is on average 63% higher than the average U.S. farm gate price (Informa). This is a result of government policy (supply management) designed to support dairy producers without the use of government funds.

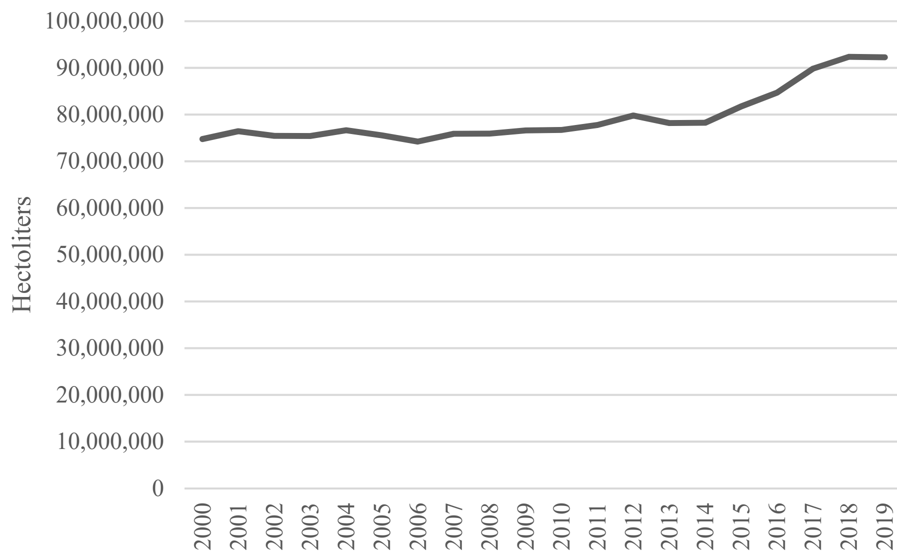

Figure 3.2 Canadian National Milk Production By Year (Data: CDIC – Historical Milk Production)

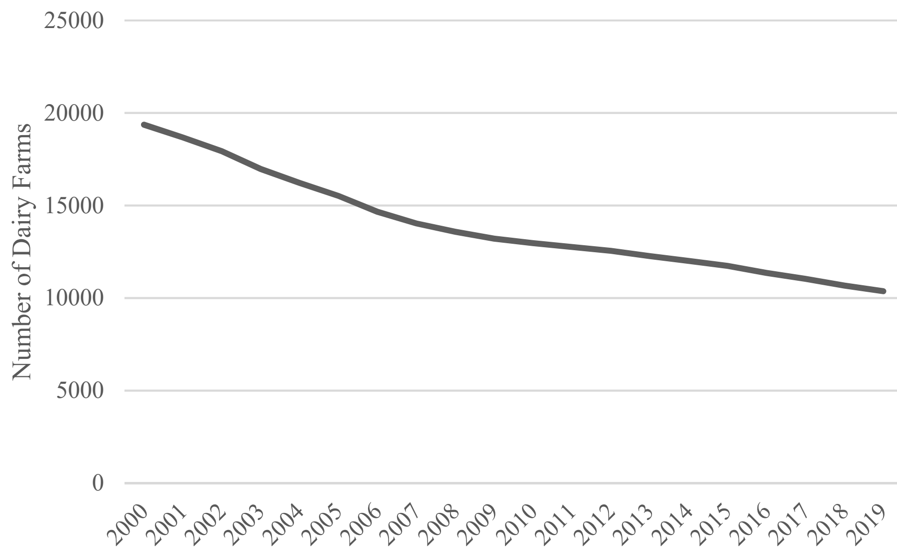

Figure 3.3 Number of Canadian Dairy Farms By Year (Data: CDIC D056)

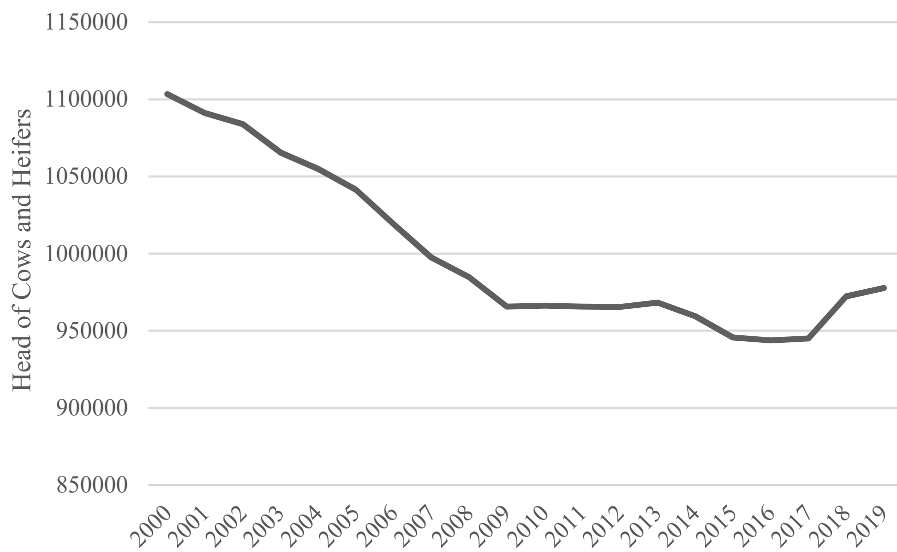

Figure 3.4 Total Dairy Cows and Heifers Canada (Data: CDIC D042)

3.2.2 Supply Management

The history of supply management in Canada dates back to the 1970s. The preceding 1960s were a volatile period for agricultural commodity prices in Canada, largely a result of reduced exports the United Kingdom, which led to a sentiment something had to change. The Vice President of the Canadian Dairy Commission when asked to describe the 1960s in 2003 stated, "Chaos is a great word to describe the 1960s. The market weight between processors and producers was tilted significantly towards processors. Processors were competing vigorously for market position, so much so that producers were often caught in between and became almost 'pawns (Scullion et al). '" The Canadian government decided supply management was the most expedient solution due to priority given to price stability and higher farm gate prices. This led to the development of the Canadian Milk Supply Management Committee (CMSMC).

Supply management for Canadian dairy consists of a three-pronged approach: quotas, minimum prices, and trade restrictions. The CMSMC determines the national production target for industrial milk. The minimum price for fluid milk is determined by the Canadian Dairy Commission. Trade restrictions are present in the form of tariff rate quotas (TRQs) for dairy imports to Canada. These three factors are adjusted based off expected demand for dairy within Canada. These three courses of action are implemented in pursuit of the objectives noted in the authorizing legislation, "The objects of the Commission are to provide efficient producers of milk and cream with the opportunity of obtaining a fair return for their labour and investment and to provide consumers of dairy products with a continuous and adequate supply of dairy products of high quality. (Government of Canada, Justice Laws)"

The price farmers in Canada receive for raw milk shipped to processors is a "blend" price, meaning regardless how the milk is utilized (fluid or industrial) the farmer receives the same price from the provincial marketing board when they sell raw milk, if component levels are the same. In order to sell milk to the provincial marketing board, producers need to hold quota. Producers receive compensation from the provincial marketing board at the "blend" price up to the amount of quota they hold and will receive no price or possibly be fined for production exceeding the amount of their quota which is in terms of kilograms of butterfat per day. A cow typically produces a kilogram of butterfat a day (CDIC D037-1) which is the reasoning behind this approach to quota. The quota is transferable and exchange markets exist for producers looking to sell and buy quota.

Each provincial marketing board is responsible for setting the provincial quota for fluid (beverage) milk and is allocated industrial milk quota from the CMSMC. The CMSMC allocates industrial milk quota, in the industry called market sharing quota (MSQ), to provinces based off of historical production, with Quebec and Ontario receiving the most (see Figure 3.5). The CMSMC uses MSQ to control milk production from a national level (see Figure 3.6). Industrial milk bought by the provincial marketing board is then shipped to processors for manufacture of dairy goods. Approximately forty percent of milk bought from producers by provincial marketing boards goes to fluid (beverage) milk with the remaining being used for industrial purposes.

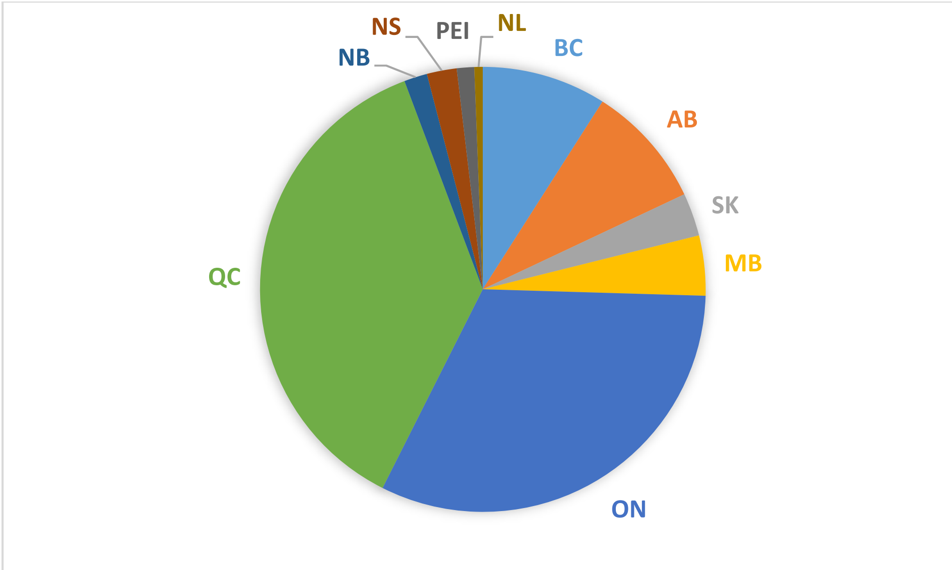

Figure 3.5 2018/19 Dairy Year MSQ Allocation By Province (Data: CDIC. Distribution of total milk quota by province)

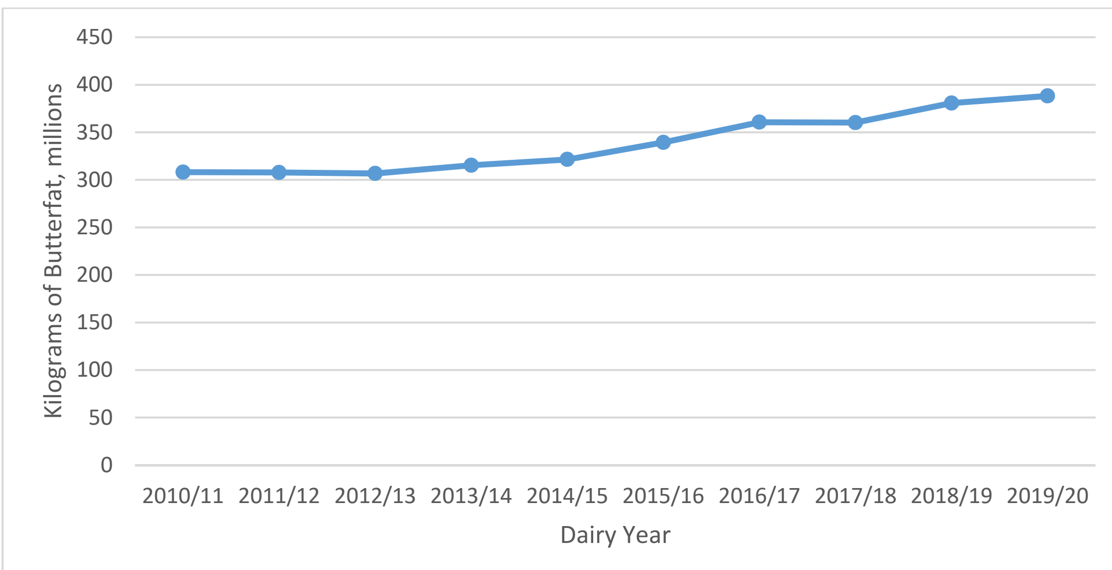

Figure 3.6 MSQ Total By Dairy Year (Data: CDIC. Distribution of total milk quota by province)

The second tenet of supply management in Canada is minimum prices. For producers the minimum prices are in the form of national level minimum prices for the milk components: butterfat, protein, and other solids. These component prices vary by province and are determined from end use prices, such as fluid milk and butter. The price of milk components are typically updated once a year, with adjustment percentages consisting half of changes in production costs and the other half derived from the consumer price index. To support processors the Canadian Dairy Commission sets a support price each year for butter and skim milk powder (CDC Support Prices). The government of Canada maintains a stockpile of butter and skim milk powder as a result of this program.

The final component of supply management is tariff rate quotas (TRQs) for dairy products. Since the implementation of supply management for dairy in 1971, Canada has used TRQs to limit imports of supply managed goods over the objections of their trading partners. The TRQs implemented for dairy have survived multiple trade agreements over the past decades with little modification.

3.2.3 Trade Policy

Canada's trade relationship with regards to dairy goods is dominated by the United States. It is the closest and the largest dairy producer in the world with annual milk production standing at 99.1 million metric tons in 2019 (USDA FAS). As the world's largest economy the U.S. also affords Canada ample market for dairy products. Perhaps constrained by supply management, the Canadian dairy trade balance has been consistently in a deficit state (see Figure 3.7).

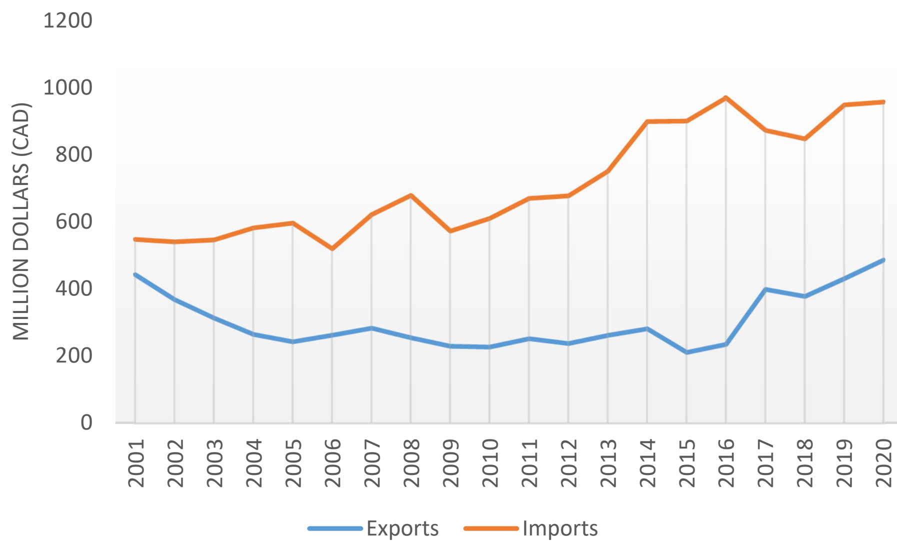

Figure 3.7 Yearly Canadian Dairy Trade (Data: CDIC D023)

Supply management forces the need for trade restrictions to maintain producer prices, as mentioned earlier. These TRQs allow for access to Canadian markets at a low tariff rate until a specified quantity is filled then goods imported are considered "over-access" and have a higher import duty associated with them. The high duty in essence acts as a quota since the rate for out of quota goods is exorbitant (see Table 3.1). Figure 3.8 demonstrates the mechanics of a TRQ. Table 1 shows the current dairy TRQs for any country within the WTO that Canada has most favored nation (MFN) trading relations with. To access the in quota rate, permits must be filed to import. These permits are on a first-come, first-serve basis and once acquired can be renewed indefinitely, provided the amount on the permit is imported every year. If the amount permitted to import is not filled, the permit will be revoked and will be available once again on a first-come, first-serve basis. In the case of binding TRQs, this has led to quotas within the quota in practice, with countries supplying roughly the same amounts year after year, up to the quota limit.

	TRQ Metric Tons	In Quota Tariff (%)	Out of Quota Tariff (%)
Fluid Milk	64,500	7.5	241.3
Cream	394	7.5	292.6
Butter	3,274	7.5	313.6
Cheese	20,412	Varies By Variety	245.6
Yogurt	332	6.5	237.5

Table 3.1 2020 Canadian WTO TRQ Data Dairy Goods (Data: WTO Tariff Quotas)

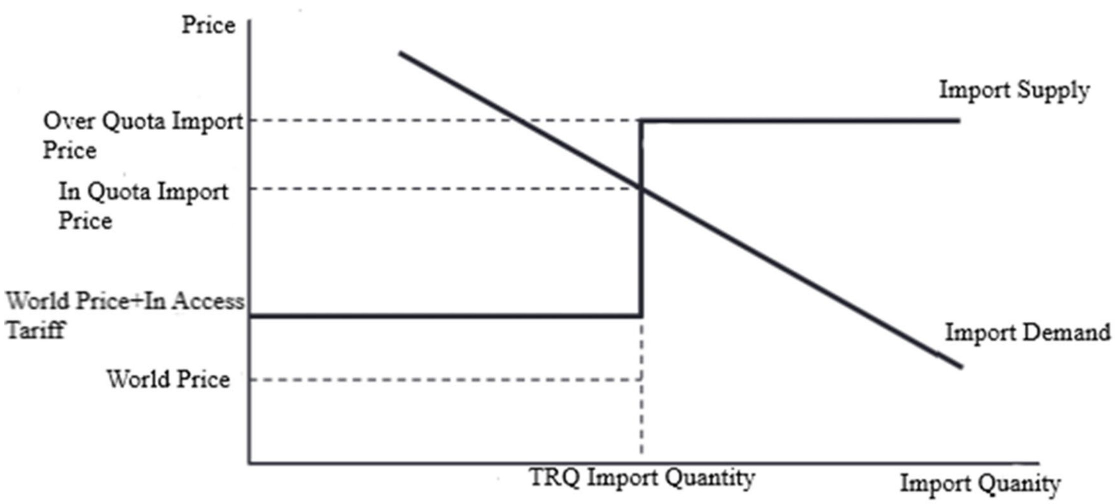

Figure 3.8 Tariff Rate Quota On Imports

The introduction of a TRQ to a market leads to a kinked supply curve for imported goods. The world price is the prevailing price of a good in global markets. This price is then taxed at the lower in access tariff rate for all quantities within the TRQ import quantity. Figure 9 shows a binding TRQ where the TRQ acts as a quota in principle due to the out of access tariff causing goods to be infeasible to import in excess of TRQ quantities. The difference between the in quota import price and the world price including in access tariff represents profits for import permit holders. This study will model the impact of shifting the kink in the supply curve to the right, representing an expansion of the "in access" import quantity.

The USMCA is significant since it redefines the fundamental nature of Canada's trade in fluid milk and cream. Prior to the implementation of the USMCA Canada's trade in fluid milk and cream with the United States was only governed by the aforementioned WTO access commitments. A 1999 WTO panel evaluated Canada's administration of fluid milk and cream TRQs due to allegations brought forward by the United States and New Zealand. This panel notes Canadian processors have never had access to foreign fluid milk, with Canada stating due to the perishable nature of fluid milk it is of limited tradability. The WTO panel states, "In the view of the US claim before this Panel to have wider access to the Canadian market for fluid milk, one can assume that imports of fluid milk are, in principle, technically and commercially viable." The USMCA will allow for the commercial importation of fluid milk while also expanding the quota access for cream for the U.S. exclusively.

July 1, 2020 marked the first day of the implementation of the United States-Mexico-Canada Agreement (U.S. Trade Representative). This concluded years of negotiations between the three countries on the free trade agreement which replaced NAFTA, which had governed trade between the countries since January 1, 1994 (Government of Canada, International). The USMCA created new opportunities for international trade for dairy producers within the United States through expanded access to Canadian markets. Unlike the TRQ quantities shown in Table 3.1, the USMCA grants additional quota to the U.S.

exclusively to Canadian markets. Table 3.2 summarizes the new TRQs as stated by the U.S. Trade Representative.

Dairy Good	Year 1	Year 6	Year 19
Milk	8,333	50,000	56,905
Cream	1,750	10,500	11,950
Skim Powder	1,250	7,500	8,836
Butter	750	4,500	5,121
Cheese	1,042	6,250	7,113
Milk Powders	115	690	785
Yogurt	689	4,135	4,706
Other Dairy	2,738	16,425	13,987
Total	16,667	100,000	109,103

Table 3.2 USMCA TRQs For U.S. Dairy Exports to Canada (Metric Tons) Source: Appendix A of USMCA Trade Agreement, Tariff Rate Quotas of Canada

This study originally was focused on the impact of the milk TRQ within the USMCA. Modelling this impact is beyond the scope of the GSIM model due to the lack of trade relations between Canada and the U.S. for fluid milk commercially, since the current WTO TRQ for fluid milk only encompasses milk for personal use. This study will examine the impact of the expanded cream TRQ due to its long standing as a "binding" TRQ, that is 100% of the TRQ is utilized for whatever purposes seen fit by the import permit holder.

3.3 Literature Review

The literature stating the benefits of trade liberalization is abundant. Ricardian theory of trade suggests more exchange between economies benefits both as a whole due to comparative advantage. This may be true at the aggregate level but supply management was not implemented for the benefit of consumers. The consensus within the prior literature is the dairy industry in Canada extracts rent from Canadian consumers to support producers through the supply management system. Carter and Mérel (2016) assert through marketing boards, producers in Canada are able to assert partial collective monopoly and thus collect a partial rent in the Canadian dairy market. Using a partial equilibrium model they determine supply management may detract from the Canadian economy. In their view Canadian producers hold a comparative advantage with regards to dairy production, suggesting supply management is responsible for preventing a surplus in Canada's dairy trade balance. Similarly Cardwell et al (2015) find evidence of rent extracted from Canadian consumers acting in effect as a regressive tax to support the dairy industry. Using the Exact Affine Stone Index demand model, the authors estimate trade liberalization in milk may save the average Canadian consumer $91 dollars yearly. Discussion on the impact of increased trade in this sector has been evaluated through several methods.

Abbassi et al. (2008) use a spatial equilibrium model to evaluate the impact of dairy trade liberalization while accounting for changes to the national MSQ. This model only accounts for world prices of dairy goods and WTO access commitments. The goods considered are: butter, cheese, skim milk powder and yogurt. The analysis primarily focused on the impact of reducing over access tariffs, rather than expanding quota limits. The scenario of greatest interest to this study - since it closest to expanded quota access of interest in this paper – is the scenario where over access tariffs were reduced by fifty percent. The cut in tariffs causes over access butter and cheese imports to be marketable. In this scenario it was observed the MSQ would need to be reduced 35% in order to keep the same level of rent. Canadian consumer surplus increased 9.4% in the short run in this scenario.

Rude and An (2013) use a simulation model to evaluate similar hypothetical scenarios. The dairy products analyzed are: cheese, butter, skim milk powder, yogurt, and ice cream. Similar to Abbassi et al, the analysis focusses on the impact of reductions to the over access tariffs, with reductions of 40% and 70% evaluated. A 40% reduction in over access tariffs results in a decrease of Canadian consumer price around 2.5% for the mentioned goods. A 70% tariff results in a 4.5% decrease in consumer prices.

Rasmussen (2016) uses a partial equilibrium model to analyze the Trans Pacific Partnership as its dairy provisions relate to Canada. The impact of the TPP with respect to expanded quota access for butter and cheese was found to increase consumer surplus and decrease producer surplus, with the net welfare gain of $81 million CAD for the country as a whole. Cheese prices were estimated to fall by 4.8 % and butter by 0.97%.

No prior studies have evaluated Canada's trade in cream or use a GSIM approach to evaluate trade in dairy goods. Due to the long standing 100% utilization of the cream TRQ, using the GSIM approach to modeling this expansion of the TRQ is aptly suited. Similarly the Armington assumptions on elasticity of substitution within the GSIM model are likely suited to cream consumers. Consumers likely prefer domestically produced goods, to a point. In a country like Canada where polling data suggests 45% of respondents wanted supply management protected in USMCA trade negotiations compared to 31% who want the system abandoned (iPolitics). Given the preference to maintain a system which raises domestic dairy prices, it is reasonable this support continues to the grocery store aisle.

This is the first study to apply the GSIM approach with respect to Canada's dairy trade. Additionally, this study will be the first to model the impact of expanded cream TRQs as a result of the USMCA. The majority of literature has focused on the impact of tariffs, while ignoring scenarios where the quota quantities are adjusted.

3.4 The Model

To estimate the impact of the USMCA on trade in fluid milk between Canada and the United States a GSIM (Global Simulation) model is constructed. This is a partial equilibrium model developed by Francois and Hall (2003). This model assumes products are nationally differentiated, products imported are imperfect substitutes for domestic products. Additionally elasticity of substitution, import demand, and import supply are held to be constant.

To simulate the trade relationships between countries Francois and Hall propose the following. Own-price and cross-price elasticity are based on the assumption that import demand for a given category of goods in Country A imported from Country B are a function of industry prices and expenditure totals for the given category of goods.

$$(20) \qquad N_{(i,v),(r,s)} = \theta_{(i,v),s} (E_m + E_s)$$

$$(21) \qquad N_{(i,v),(r,r)} = \theta_{(i,v),r} E_m - (1 - \theta_{(i,v),r}) E_s$$

Where the term $N_{(i,v),(r,s)}$ in Equation 20 represents cross-price elasticity and the term $N_{(i,v),(r,r)}$ in Equation 21 represents own-price elasticity. Subscript v represents the importing country while subscript r represents the exporting country. Subscript i represents the category of goods being traded. $\theta_{(i,v),s}$ is the expenditure share and E_m and E_s are the composite import demand and elasticity of substitution respectively.

To account for basic supply and demand relationships Francois and Hall (2003) introduce the concept of price as follows. $P_{i,r}*$ is the export price received by exporter r when good i is exported to world markets while $P_{(i,v),r}$ is the price for good i in domestic markets. They link the two prices as shown in Equation 22.

$$(22) \quad P_{(i,v),r} = (1+t_{(i,v),r})P_{i,r}* = T_{(i,v),r}P_{i,r}*$$

T is the impact of a tariff or import tax in country v on goods from country r equal to $1+t$, where t is the tariff rate on imported good i. Supply of good i to world markets is assumed to be a function of world price $P*$ defined as $X_{i,r}$ in Equation 23.

$$(23) \quad X_{i,r} = f(P_{i,r}*)$$

Import demand is a function of industry price and total expenditure on good i as shown in Equation 24.

$$(24) \quad M_{(i,v),r} = f(P_{(i,v),r}, P_{(i,v),s\neq r}, y_{(i,v)})$$

By differentiating Equations 22, 23, and 24 the following can be stated.

$$(25) \quad \hat{P}_{(i,v),r} = \hat{P}_{i,r}* + \hat{T}_{(i,v),r}$$

$$(26) \quad \hat{X}_{i,r} = E_{x(i,r)}\hat{P}_{i,r}*$$

$$(27) \quad \widehat{M}_{(i,v),r} = N_{(i,v),(r,r)}\hat{P}_{(i,v),r} + \sum_{s\neq r} N_{(i,v),(r,s)}\hat{P}_{(i,v),s}$$

The hat (^) represents proportional change as in $\hat{x} = \frac{dx}{x}$. By using Equations 20, 21, and 25 to subsitute into Equation 27 the following equation is generated.

$$(28) \quad \widehat{M}_{i,r} = \sum_{v} N_{(i,v),(r,r)}[P_r*+\hat{T}_{(i,v),r}] + \sum_{v}\sum_{,s\neq r} N_{(i,v),(r,s)}[\hat{P}_s*+\hat{T}_{(i,v),s}]$$

Equation 28 is then set equal to Equation 26 to achieve global equilibrium conditions.

$$(29) \qquad E_{x(i,r)}\hat{P}_{i,r}{*} = \sum_{v} N_{(i,v),(r,r)}[P_r{*}+\hat{T}_{(i,v),r}]+\sum_{v}\sum_{,s\neq \mathrm{r}} N_{(\mathrm{i,v}),(\mathrm{r,s})}[\,\hat{P}_s{*}+\hat{T}_{(i,v),s}]$$

From this it is possible to derive the impact a change in tariff rates may have. An addition to the GSIM model to account for TRQs as proposed by Zheng et al (2017) is used to evaluate the impact expanding fluid milk access for the United States to Canadian markets. A 4x4 GSIM model will be used where Canada and three trading entities relationship in the fluid milk trade is evaluated.

3.5 The Data

Trade data for the simulation is from the United Nations Commodity Trade Statistics Database, more commonly known as UN Comtrade. For the purposes of international trade cream is defined as H.S. codes 0401.40.10 and 0401.50.10, which is cream 6% to 10% fat and greater than 10% fat, respectively. Total imports for Canada exclude cream imported under IREP (Imported for Re-Export Program), since imports under this program are exempted from TRQ measures. Domestic production was included in the model in order to account for dissapearance. To accomplish this a country is treated as its own trading partner with total cream produced minus cream exported used for this measure. The data for Canada is from Statistics Canada "Commercial sales of milk and cream" report, imports were accounted for in analysis. U.S. data is from the USDA report "Selected soft dairy products, domestic use" and E.U. data for 28 member states from a CLAL report. Similarly domestic consumption is adjusted for imports.

The elasticity estimates for this study are seen in Table X. Francois and Hall (2003) estimate the average elestictities for goods as follows: E_m -1.25, E_x 1.5, and E_b 5. Prior literature examining Canadian dairy trade often has used elasticity estimates based off the

U.S. dairy industry, such as Abbassi et al (2008) and Rude and An (2013). Data for elasticity of subsitution is from the U.S. International Trade Commision. Export supply elasticity used is from Gallaway et al (2002). These estimates are for the United States and are applied to Canada and the EU as well for lack of data. Due to the focus of this study being U.S. and Canada trade relations with the majority of Canada's trade in cream being U.S. sourced, any discrepancies with respect the the E.U. and rest of the world likely have a neglible impact. Ghodsi and Stehrer (2016) in their study on import demand elasticities is the source for E_m for each trading entity. Their study estimates the import demand elasticities estimated for over one hundred and sixty countries and more than 5,000 products at the 6-digit level of the Harmonised System for the years ranging from 1996 to 2014. Table 3.3 shows elasticites applied to the GSIM model.

Country	Import Demand (E_m)	Export Supply (E_x)	Substitution (E_b)
Canada	-1.28	1.69	5
U.S.	-2.09	1.69	5
E.U.	-1.38	1.69	5
Rest of World	-1.25	1.69	5

Table 3.3 Armington Elasticities Used in This Study

3.6 Simulation Results

This study is conducted using the most recent complete data for the dairy year 2018-2019. To simulate the impact of the first year USMCA trade deal provisions for cream, the quota for the United States to Canada is expanded. Table 5 demonstrates the estimated impact of this policy. The expansion of the cream TRQ is estimated to increase American exports of cream to Canada by 315% after implementation.

At the core of the simulation is Canada's restrictive TRQ for cream. Canada has a permit required to access the in quota rate for cream. To reflect this each trading entity is assumed to have a binding TRQ with Canada with the amount being a share of the WTO TRQ 394 metric tons. World trade data for cream is shown in Table 3.4. To reflect the USMCA trade concessions, the TRQ for the United States was increased by 1,750 metric tons. At a result of the USMCA, Canada's domestic disappearance (cream produced in Canada for Canadian consumption) is estimated to decrease 2.3% and imports from countries other than the U.S. decrease as well (see Tables 3.5 and 3.6).

The new TRQ for the United States is not fully utilized in this simulation with the quota limit of 1,750 only seeing 62% of access limits filled. The additional TRQ would incentivize the import of 1,036 more metric tons of cream to Canada from the U.S. This suggests under current market conditions the cream TRQ for the U.S. to Canada will remain nonbinding with additional TRQ access not utilized. By 2026 the cream TRQ for the United States will be 10,500 metric tons, suggesting Canadian dairy industry stakeholders do not need to be concerned about additional access brokered for cream assuming 2018-2019 dairy year market activity.

	Destination Country			
Exporting Country	Canada	US	EU	Rest of World
Canada	55,374	0	0	41
US	328	1,425,657	0	4,536
EU	93	179	2,702,350	36,466
Rest of World	47	11,356	75,002	144,049

Table 3.4 Trade Data Dairy Year 2018-2019 Cream Imports and Exports (Metric Tons)

Destination Country				
Exporting Country	Canada	US	EU	Rest of World
Canada	-2.3%	0	0	6.8%
US	316%	0	0	-0.1%
EU	-9.1%	0.1%	0	0
Rest of World	-9.1%	0.1%	0	0

Table 3.5 Changes in Cream Trade After USMCA Implementation

	Domestic Price %	Quantity Produced %	Producer Surplus (2020 USD)	Consumer Surplus (2020 USD)
Canada	-2%	-2.3%	-$3,137,817	$5,914,898
US	0%	0%	$1,149,506	-$1,145,695
EU	0%	0%	-$9,738	$8,891
Rest of World	0%	0%	$2,117	$2,540

Table 3.6 Summary of USMCA Cream Impact

Table 3.6 demonstrates a summary of the impact of the USMCA Cream TRQ. Canadian consumers are the largest beneficiary of this policy change, potentially a result of the rent supply management has extracted from Canadian dairy consumers. Canadian consumer surplus increases almost six million dollars in dairy year 2020-21. Canadian producer objections to the USMCA are justified with producer surplus decreasing by over three million dollars. The total welfare gained for Canadian as a result of the USMCA for cream is 2.8 million dollars. The total welfare impact for the United States is negligible, with the impact on producers and consumers almost cancelling out. This suggests there is almost no dead weight loss in the U.S. cream market, especially when compared to their Canadian counterparts.

The impact on Canadian producers depends on the response of the Canadian government. The reduction in domestic price will indirectly impact the minimum price for milk at the farm gate, as 50% of the milk price adjustment is based off consumer prices (it should be noted currently due to COVID-19 any adjustments to producer milk price in Canada do not reflect consumer markets). The projected reduction in quantity produced for cream may result in more butter production, since at the processor level butter price is supported by the Canadian government.

The period of trade simulated is August 1, 2020 to July 31, 2021. When Canadian government updates USMCA cream TRQ utilization figures for this period, the accuracy of this model can be assessed. The impact of the COVID-19 pandemic was not accounted for, since base data is from the 2018-2019 dairy year. Milk dumping was still occurring on both sides of the Canadian border when the TRQ was implemented due to COVID-19 marketing conditions. The impact this may have is unknown.

3.7 Conclusion

This is the first study to assess Canada's dairy trade using the GSIM model. It confirms statements made about the impact of Canada's supply management regime in the dairy industry, namely it benefits Canadian producers at the expense of Canadian consumers. Similarly, this expanded access benefits American dairy producers, but has a neutral impact due to losses for the American consumer. Since model predicts the new quota for cream is not fully accessed, it suggests the additional concessions in coming years will not be utilized, especially if MSQ is expanded.

A future model using trade data in fluid milk from 2020-2021 could model the effect of changes to the MSQ. Since the MSQ is in essence a TRQ Canada sets on itself, this model could be ideally suited to modeling Canada's trade in industrial milk. In order to fully evaluate how the USMCA will impact the Canadian economy, fluid dairy products need to be considered. The lack of data in this area has prevented prior studies from evaluating this aspect. The coming years are without precedent for the Canadian dairy industry, how this may impact Canadian producers is largely dependent on the Canadian government.

The total impact of the USMCA on Canada won't be known until 2039 when the final TRQ expansion is implemented. Looking to 2026 when 92% of TRQ expansions are implemented, the total amount of additional dairy which can be imported from the U.S. on a milk equivalency basis is estimated to be 183,000 using USDA conversion metrics. When compared to Canada's present day milk production of 101,363,000 metric tons, the additional TRQ access gained from the USMCA is almost 2% of Canadian production. This study estimates the additional cream imported in dairy year 2020-2021 is 1.87% of Canada's total cream production. Given the results of the model for cream, the impact of these TRQs may similarly result in Canadian milk being displaced and losing value at the farm gate.

The USMCA certainly benefits Canadian dairy consumers. The impact this agreement has on Canadian dairy producers is fundamentally dependent upon the government response in Canada. Assuming supply management remains in place, any of the policies listed are possible. MSQ is expanded to increase industrial milk production and reduce industrial milk price, making Canadian milk more attractive to Canadian processors. This policy likely reduces Canadian producer income. Minimum prices are maintained at levels prior to USMCA implementation. This policy would likely need a reduction in the MSQ in order to prevent a surplus of milk at the processor level. Finally, the Canadian government could maintain butter and skim milk prices at the processor level to pre-USMCA levels by adding to their stockpile. This would allow producer minimum prices to be maintained as well with no reduction to MSQ. Of course the Canadian tax payer would fund all this, something supply management was established with the intention of avoiding.

Chapter 4. Summary

The implementation of the policies discussed in these essays, appear to have tangible impacts on producers. The first essay evaluating the potential effect of multiple component price in the Appalachian FMMO concludes Jersey herds would benefit under the new pricing paradigm. Jersey herd milk is estimated to appreciate 9% under an MCP system. Similarly, an MCP system in the Appalachian FMMO may prevent high component milk from flowing outside of the Appalachian FMMO. This is consistent with prior findings within the literature reviewed. When Holstein herds are evaluated, MCP may benefit some herds at the expense of others, with the primary determining factor in this respect being Class I differentials. This essay concludes further examination with better data may yield more commanding results.

The second essay suggests the expanded cream TRQ in Canada for imports from the United States will increase Canada's cream imports. In the first year of implementation of the USMCA, the GSIM model predicts United States' exports of cream to Canada will increase 316%. This increase in imports is predicted to reduce Canada's domestic cream price 2% and domestic cream production 2.3%. The implementation of this expanded TRQ increases Canadian consumer surplus by double the amount Canadian producer surplus decreases. This appears to confirm prior literature suggesting supply management results in deadweight loss at the expense of Canadian dairy consumers.

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Vita

Luke Gregory Cummings

Education

B.S. Economics, The Catholic University of America, May 2018.

Professional Positions

Graduate Research and Teaching Assistant, University of Kentucky Department of Agricultural Economics, August 2019- May 2021

Resident Assistant, The Catholic University of America, August 2016-May 2018

Teaching Assistant, The Catholic University of America, August 2016- May 2018

Senior Staff, Butler's Orchard, May 2014 – August 2019

Greenhouse Technician, University of Maryland, February 2019 – May 2019

Intern, NIH-NIAID, May 2016 - August 2016

Presentations

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