The Effects of Governmental Programs on Dairy Production: An Analysis of the Modern Dairy Industry

By
Angela DeLuca
University of Colorado at Boulder

A thesis submitted to the
University of Colorado at Boulder
in partial fulfillment
of the requirements to receive
Honors designation in
Environmental Studies
May 2017

Thesis Advisors:
Dale Miller, Department of Environmental Studies, Committee Chair
Philip Graves, Department of Economics
Jeffrey Motter, Department of Communication

Abstract

Despite vast research on American dairy policies prior to 2014, few analyses have been published on the new dairy programs within the Agricultural Act of 2014. This study analyzes possible effects of the dairy provisions within the newest Farm Bill on the modern dairy industry as well as possible effects of older policies on the U.S. dairy industry. The objective of this project is to assess how new dairy legislation has altered trends within levels of food waste of fluid milk, excess supply or surplus within the dairy industry, the modern landscape of dairy farming, and farming decisions made by dairy producers in response to federal policies. This study is part of a growing body of research on federal dairy policy and how it influences the dairy sector of U.S. agriculture. It has been found that when less government support is in place there are lower amounts of fluid milk food waste as well as lower surplus levels of manufactured dairy products. In addition, new dairy policy is associated with higher surplus levels of dairy, increases in the proportion of large farms in the U.S., and higher responses from dairy farmers.

Preface

The idea for this project, “The Effects of Governmental Programs on Dairy Production: An Analysis of the Modern Dairy Industry” was inspired by my keen interest in agriculture and U.S. government. Born and raised in Indiana, I have lived in a community based upon agriculture for most of my life. Within the Environmental Studies department at the University of Colorado at Boulder I have found a passion in studying food waste and attempting to find ways to decrease food waste.

My research question was formulated by combining my love for economics and agriculture, along with the directed help of my thesis advisors. This research was challenging, but overall allowed me to understand the relationship between conventional farming and federal government policy. As a vegetarian of twelve years, I have attempted veganism in multiple occasions; however, I have never been able to maintain a vegan diet for more than six months. As an environmental enthusiast, I have always been curious as to how dairy farming affects the environment. I stumbled across an article published by The Wall Street Journal titled “America’s Dairy Farmers Dump 43 Million Gallons of Excess Milk” (Gee, 2016). I found this strikingly intriguing, and wanted to get to the bottom of this issue as it is one that I had never thought of or heard about before. This project was an outlet for me to pursue this topic, and by doing so, I was able to gain insight into an industry and an issue that I did not even know existed beforehand.

Acknowledgements

I would like to thank my thesis committee for their enthusiasm and advice throughout the process of this research project. The completion of this project would not have been possible without your support, guidance, and passion. Thank you for always being available to answer my questions and to provide me with feedback regarding my concerns of this document. I would also like to thank Farm Credit East for giving me access to their annual reports. Without your assistance and help this project would not be where it is today. In addition, thank you to my friends and peers for their endless encouragement, inspiration, and comforting words. Finally, I would like to thank my parents for always inspiring me to stay curious.

Table of Contents

Introduction

This work is a document created to fulfill part of the requirement for graduating with honors distinction from the Environmental Studies program. It is part of a growing body of research on federal dairy policy and how it influences production decisions. As an undergraduate honors thesis project, this report is intended to benefit fellow undergraduate students, dairy producers, dairy manufacturers, and the general public. The purpose of this paper is to analyze the relationship between federal dairy policy, policy changes, and the behavior of the U.S. dairy industry. Specifically, it aims to determine if the new dairy programs (Margin Protection Program and the Dairy Product Donation Program) within the Agricultural Act of 2014 are correlated with a change in four various aspects of the dairy industry: dairy surpluses and excess supply, the landscape of the modern dairy industry, and producer responses to government programs.

The United States dairy industry is historically, one of the most government regulated agricultural industries. Specifically, this document focuses on modern dairy operations and tries to answer the question as to whether certain governmental programs have caused an increase or decrease in dairy food waste and/or the landscape of U.S. dairy farming. The landscape of the dairy industry refers to the makeup of U.S. dairy, meaning the proportion of different sized dairy operations.

In addition, I performed a case study of Northeast dairy farms as a way to study these trends in-depth. I also wanted to examine how producers respond to different policies, so I looked at two different measurements that describe farming decisions made by dairy farmers: herd culling rates and farm exit rates. Herd culling refers to the amount of cows slaughtered by farmers and farm exit rates are used to identify the proportion of farms that shut down production.

Since my various questions can be answered by both qualitative and quantitative data I have decided to perform a secondary quantitative statistical analysis and then study federal policy and policy changes to see if there are any correlations or relationships. This subject was of interest to me because I stumbled upon an article showing dairy farmers dumping milk into holes designed to discard manure, and I found this very interesting. Furthermore, I also wanted to help educate my peers on this issue as I have found that if you are not actually in the dairy industry then there is not a reason to spend time thinking about it. I wanted to better understand the reason for this monumental change that the dairy industry has been experiencing, and hope that my work can help fellow undergraduate students comprehend it as well.

Background

This portion describes the history of the U.S. dairy industry. Specifically, it explains how conventional dairy farming came about within the U.S., the different policies enacted by the federal government on dairy production, and various issues that have arisen regarding U.S. dairy throughout the 20^{th} and 21^{st} centuries.

The Beginning U.S. Dairy Industry

The first evidence of human consumption of cow's milk occurred during the agricultural revolution in 9,000 BCE (Dalal, 2012). During this time period, nomads began to settle in communities and domesticated animals to sustain their food supply. Sheep's milk was the most popular form of fluid milk used for human consumption until the 14^{th} century when the popularity of cow's milk surpassed that of sheep (Dairy Farmers of Canada, n.d.). In the 1600s, Europeans brought dairy cows to North America and the United State's dairy industry began.

Prior to the 1900s, the U.S.'s agricultural system consisted of many small, widespread, unspecialized farms where food was mainly grown for familial consumption. When American cities began to develop in the early 18^{th} century, the dairy industry underwent drastic changes. Families started moving to populated cities, increasing the demand for fluid milk in city areas and decreasing the demand in rural areas. This increase in demand for fluid milk in cities led to an increase in the price of milk. The emergence of railroads allowed goods to be transported and shipped easier and faster, allowing dairymen to access new city markets (Erba & Novakovic, 1995). They soon began to realize that if they were to specialize in fluid milk production they would be able to earn a greater profit. As cities continued to increase in population, milk was shipped over farther distances because the demand for milk in cities continued to increase, creating a need for greater supply. At this time, milk was produced by dairy farmers, transported to cities, and then processed in processing plants in the city. In the late 1870s, refrigerated tankers were invented which allowed for greater volumes of milk to be transported, and for milk to be transported over greater distances (Casavant et al., 2010). The technology of trucks was also being improved at this time, and transported fluid milk from farms to smaller cities.

Before cities, the majority of dairy farmers were “producer distributors,” meaning that they produced and distributed their own products (Erba & Novakovic, 1995). Processing plants in large cities allowed dairy farmers to stop distributing their own goods, and in return they specialized in fluid milk production. The conventional production of dairy products allowed for increased production, inducing an excess supply of dairy goods because supply exceeded demand.

Processing firms began to grow in size, and it was not long until only a few producer distributors were supplying processing plants with adequate milk supply. These large processors and distributors gained market power and bought fluid milk from a large number of small, unorganized producers. On the other hand, dairy producers had little influence in pricing decisions and grew unhappy with their lack of control in the industry. Producers began to organize as collective bargaining units so they would not be subject to the immense power of the processing plants and would be better able to control the supply of milk (U.S. Department of Agriculture [USDA], 2005).

Nonetheless, producers were not able to gain control of dairy price negotiations, and from the late 1800s to 1916, processors determined the milk pricing. Policymakers recognized this conflict and started to devise the first milk-pricing plans. Unfortunately these policymakers ran into several dilemmas. First, the production of milk was not constant (Erba & Novakovic, 1995). Instead, the production of fluid milk varied from year to year (Erba & Novakovic, 1995). Milk consumption trends also varied seasonally but these fluctuations did not correspond positively with the variations in production levels (Erba & Novakovic, 1995). These seasonal fluctuations were difficult to control because milk is a perishable good and cannot be stored to make the supply and demand levels equal. As cities grew so did technology and people started to recognize that fluid milk for human consumption had to be of an adequate sanitary level. This required producers to meet more rigorous sanitary requirements, increasing their production costs (Erba & Novakovic, 1995). At the time there was no economic stimulus to allow for incentives to farmers to upgrade their sanitary equipment so these additional production costs were detrimental to producers.

The First Unofficial Dairy Policies: Pricing Schemes

To combat the disproportionate power between milk producers and milk handlers, pricing systems were emplaced. The first system was called flat pricing system, which allowed for all milk sold to be priced equally, no matter the location of purchase, location of production, or other quality factors. On the other hand, the price received by the producer for their milk varied as it depended on the demand of the milk processor (Manchester, Weimar, Fallert, 1994). Since processor prices were determined by the demand of the processing plants, these processors determined the amount of hired farmers (Machester et al., 1994). In seasons of short supply, dairy processors would hire more farmers but during times of excess supply, processors would fire farmers. This led to a very unstable dairy industry, as dairymen were often victim to the fluctuations of the seasonal demand market. Small processing plants were the main users of this pricing system because they did not have to bargain with cooperatives.

The Excess Plan Pricing System was later established by determining a base level of production, chosen by the amount of deliveries of fluid milk from producers to processors during the short supply months (Manchester et al., 1994). Dairy farmers were paid the fluid milk price for goods produced up to this base level of production; however, any milk produced over the base supply level would receive the manufacturing milk price, which was lower than the fluid milk prices (Cropp & Jesse, 2008). This was the first dairy policy that aimed to decrease the supply of dairy products in the U.S. Other pricing systems were later developed to promote equity between handlers and producers.

World War I brought about many complications to the milk pricing systems. From 1914 to 1918, cooperatives bartered for flat prices for all milk sold (Manchester & Blayney, 2001). The war not only pressured an increase of food supply in the United States to feed soldiers, but also to feed European soldiers. Producers received satisfactory milk prices because manufactured products were in high demand in Europe. At the end of the war, foreign demand for manufactured products declined, leading to the disappearance of the manufactured milk product industry in the United States (McFall, 1925). At this time, processing plants were discontinued across the country. Individual producers and cooperatives could not raise their milk prices because the supply of milk far exceeded the demand. Since the manufactured milk industry declined, distributors that distributed more manufactured products than fluid products began to cut off producers (Erba & Novakovic, 1995). To cooperatives that did not have their own manufacturing and distribution facilities, it was imperative to persuade dealers to buy their entire supply of milk as to not loose profits (Erba & Novakovic, 1995).

Unsatisfied with the direction of this pricing system, cooperatives recommended adopting the classified price system. Milk used for manufactured products were priced accorded to their value which allowed for cooperatives to be better able to bargain for prices of fluid milk (Manchester & Blayney, 2001). A pitfall arose in this system, as there was no way to ensure that milk processers were truthful of their intended use of milk or milk sales. Cooperatives were not able to have control over the industry through this system. In addition, this system was not used countrywide, allowing processors to offer higher prices to individual farmers than cooperatives (Jesse & Cropp, 2008). Also, it allowed for distributors and processors to purchase only or mostly fluid milk, creating even more instability in the market.

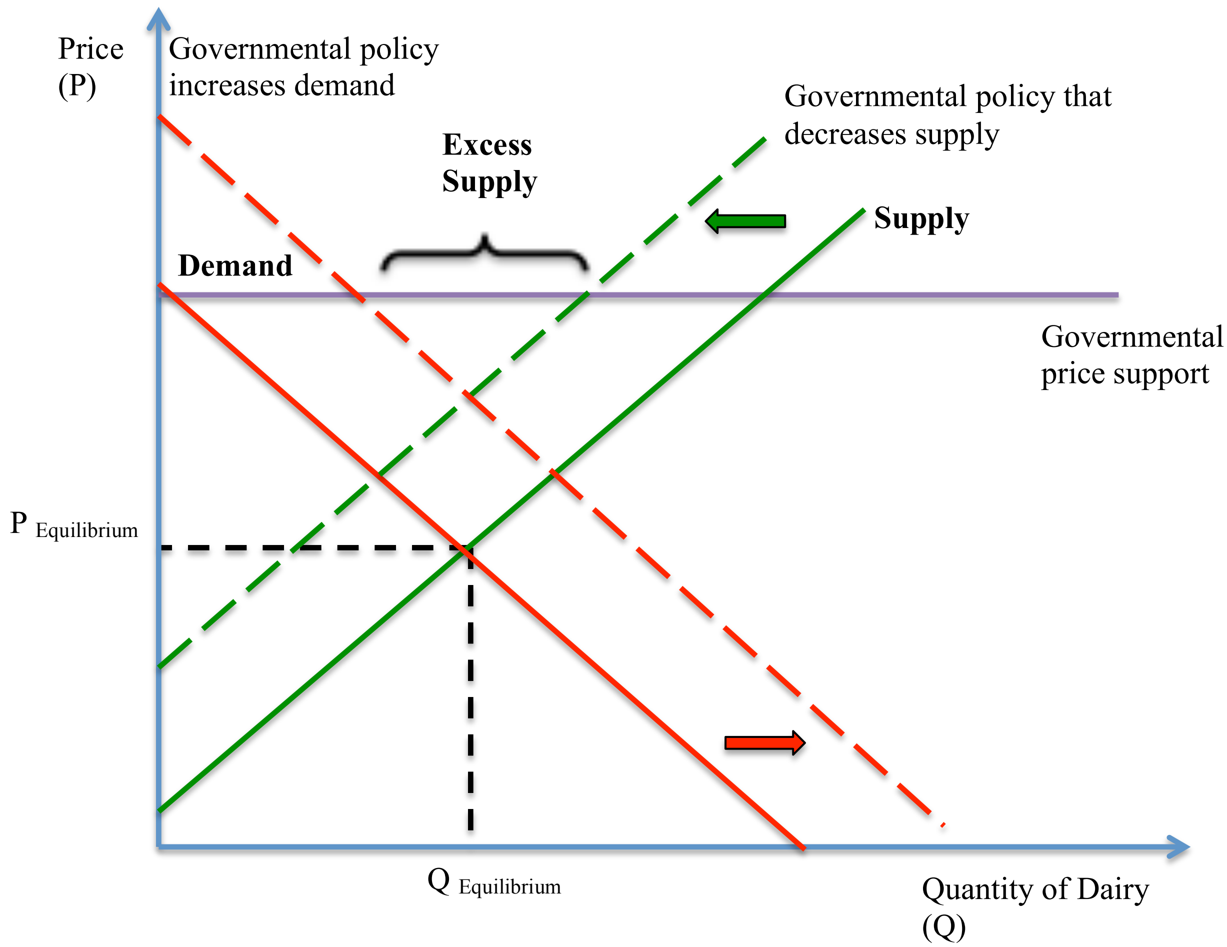
In October of 1929, the stock market crashed and instigated an increase in instability for this market. When the economy declined, consumer confidence also declined because consumers felt insecure about their personal financial situations (The Social Welfare Project, 2011). This caused consumers to save more money and spend less money on purchasing goods, leading to a decline of demanded milk. Individual farmers began to market their milk at prices lower than cooperatives to sell their products during these hard times. Producers and handlers grew unhappy with the instability in the dairy market, as there was not enough demand for the amount of milk supplied. In other words, a surplus of dairy was present. For this market to stabilize, orderly production was needed. Out of options, producers asked local and federal governments for assistance and the first federal dairy policies were born (Erba & Novakovic, 1995).

The Economics Behind a Market Surplus: The Motivation for Dairy Policy

Excess supply of a good creates a market surplus. This means that the quantity supplied of the good is greater than the quantity demanded for the good. In economics, excess supply is determined by a mathematical equation. It is the commodity's demand function minus the commodity's supply function (Debreu, 1974). The excess supply function is as follows: Excess supply = Qs(P) – Qd(P), where Qs = quantity supplied, Qd= quantity demanded, and P= price (Debreu, 1974). When this occurs, some producers are unable to sell their entire supply of goods, provoking them to lower their price of the good to encourage buyers to purchase their products. To compete with these producers, other producers also lower their prices, thus lowering the entire market price for that good (Debreu, 1974). When the price decreases, consumers increase their demand for the good, ultimately moving the market towards an equilibrium price and quantity (Debreu, 1974).

Federal policies are emplaced to make farmers better off than they would be would be with the equilibrium prices they would otherwise face from a market surplus, as governmental price supports increase the market price of a good. Federal policy achieves a higher market price for a good through two different methods: the policy must either increase demand of the good or decrease the supply of the good. This process is displayed in Figure 1.

Figure 1


Price
(P)
Governmental policy
increases demand
Governmental policy that
decreases supply
Excess
Supply
Supply
Demand
Governmental
price support
P Equilibrium
Q Equilibrium
Quantity of Dairy
(Q)

The First Federal Farm Bills and Dairy Policies

In 1933, the first federal Farm Bill was passed. Farm Bills are multi-year laws that are passed every five years. This legislation includes a variety of agriculture and food programs that aim to provide stability within specific markets. Legislation with the title "Agricultural Act" is commonly referred to as Farm Bills. The 1933 Farm Bill, or The 1933 Agricultural Adjustment Act was passed to improve milk prices and farmer incomes (USDA, 1984). There were two main pieces of this policy: price supports and a policy to increase U.S. demand for dairy.

Parity prices were introduced by congress, which allowed prices to be set high enough to allow farmers to sell their products at a price that would provide them with enough income to purchase inputs of production (USDA, 2011). In addition, legislators realized that a lack of import restrictions on dairy products had a negative effect on domestic U.S. dairy demand (Erba & Novakovic, 1995). Domestic dairy prices tend to be higher than the global dairy market prices, so without these restrictions, it was more attractive for consumers to purchase foreign products, ultimately hurting the domestic producers (USDA, National Agricultural Statistics Service [NASS], 2011). In addition, high domestic prices restrict the amount of exports as foreign countries choose to import products from countries with lower prices. A list of restricted dairy imports into the U.S. was published in this Act but was not implemented or enforced until 1951 (Erba & Novakovic, 1995).

Amendments were made to this act in 1935 to implement Federal Milk Marketing Orders (FMMOs). FMMOs set limits on class prices and location prices for handlers (Stephenson, 2010). This Act also authorized the use of government funds to purchase surplus from farmers to distribute to recipients via USDA food programs and conduct research to expand the milk market (USDA, 2013). In other words, FMMOs were a method in which to increase demand by federal purchasing of excess supply products.

Federal courts regulated intrastate milk markets until the 1930s (Erba & Novakovic, 1995). Following this, the federal government gave states the authority to regulate their own milk markets. This was done via state price regulations, restrictions on entry of handler firms into the market, and classified pricing (Erba & Novakovic, 1995). This brought about instability between the states, leading to the enactment of the 1937 Agricultural Marketing Agreement Act (AMAA) (USDA, 1963). The AMAA addressed milk prices over the long-term period and instituted a policy aimed at creating a uniform price (USDA, 1963). A long-term period in economics refers to the amount of time a producer would need to remain flexible in production (Farma, 1998). This act had two policies: one that enforced handlers to follow policies and one that ensures that handlers pay the same minimum price for milk of the same use (Bartlett, 1976). This reduced the fluctuations of market prices between producers and handlers and unfair marketing by distributors. While the AMMA increased the farm price of milk, it also caused an excess supply in various markets because not every market responded to the set minimum prices as anticipated (Farma, 1998).

In 1939 at the start of World War II, excess dairy products were utilized as war supplies. The needs of the war increased, thus increasing demand for dairy production. Shortly after, more dairy products were being demanded than being supplied. The Steagall Amendment was passed in 1941 to set price supports to incentivize farmers to increase production (Lipton & Pollack, n.d.). This amendment required the government to offer financial support to farmers when prices fell below a certain parity level (Lipton & Pollack, 2016).

In 1942, the first extensive price supports were set for manufactured milk products. The Commodity Credit Corporation (CCC) gave incentives to producers to increase yields, and the minimum price established in 1941 was increased (Rojko, 1953). The CCC is a government-operated entity created to provide stability in farm incomes and prices by buying, selling, or making payments within agricultural industries (USDA, Farm Service Agency [FSA],n.d.a). In addition, at this time the competition between manufacturing plants led to a shortage of fluid milk. To mitigate the shortage, a pricing formula that set prices for fluid milk above manufactured milk products by a fixed amount was implemented (Lipton & Pollack, n.d.). Most FMMOs implemented this price support system to encourage producers and cooperatives to produce more fluid products to meet demands.

At the end of WWII, many of the price enhancement systems were discarded. However, The Agricultural Act of 1948 required that price supports be set to a higher level to better reflect historical prices (Lipton & Pollack, 2016). Five months later the Agricultural Act of 1949 was passed, implementing the Milk Price Support Program (MPSP), also known as the Diary Price Support Program (DPSP). This allowed the government to purchase manufactured dairy products from vendors and processors, thus acting as a price support (USDA, FSA, 2011). Specifically, DPSP allows the CCC to purchase manufactured dairy products to be distributed as donations (USDA, 2013). Products purchased by the government or CCC reduces aggregate demand. Similar to the nature of the Act of 1935, the CCC continues to purchase these commodities today while DPSP continued until 2002.

Dairy Policy from 1950 to 1990

The Trade Agreements Extension Act of 1951 enforced import restrictions on products listed in the Act of 1933, which increased domestic demand of dairy (United States Tariff Commission, 1956). During the 1960s, dairy policy began to reflect the interconnectedness of this market as it became apparent that technological improvements such as roads and trucks linked FMMOs in different regions (Erba & Novakovic, 1995). To reflect this, the Minnesota-Wisconsin (M-W) price regime for Class III milk was introduced. Pricing was founded on prices paid for Grade B products by manufacturers in Minnesota and Wisconsin to mirror the value of these products in an unregulated market (Bolotova & Novakovic, 2014). Later, the Basic Formula Price used the M-W price as a base to set prices for other milk classes (Bolovota & Novakovic, 2014). Dairy products with higher intrinsic value such as fluid milk, would receive higher prices than other classes.

In the 1970s, dairy policy concentrated on establishing more support for farmers (Erba & Novakovic, 1995). In 1972, milk supplies and commercial dairy products started to disappear. Prices increased by 30 percent, leading President Nixon to control wages and prices by briefly suspending import quotas and increasing price supports (Erba & Novakovic, 1995). The Agriculture and Consumer Protection Act of 1973 later decreased price supports to the farmers 'dismay (USDA, FSA, 2014). Domestic prices dropped because of the reduced import quotas, causing producers to worry and lobby for more aggressive support (Richardson, Anderson, & Smith, 1999).

During Carter's Presidency in 1976, price supports for dairy were prevalent; however they did not accurately reflect the current demand and supply of this industry. By 1981, federal spending on dairy had risen to $2 billion and the government decided to freeze support prices and eliminate the parity pricing system (Erba & Novakovic, 1995). The Agriculture and Food Act of 1981 set price supports at annually increasing incremental levels, but congress was not satisfied with the little impact this had on the budget (Frederick, 2014). In 1982, the Omnibus Budget Reconciliation Act was legislated and authorized a method for producers to help fund support programs themselves (H.R. 6955, 1982). From 1983 to 1984, $800 million was collected through this policy, but was unpopular with farmers and did little to decrease total milk production (Novakovic, 1982).

The 1983 Dairy Production Stabilization Act was the first effort by the government to control the supply of milk (Erba & Novakovic, 1995). This act featured the Milk Diversion Program which encouraged a reduction in the supply of milk by urging producers to reduce the quantity of milk they market (USDA, 2010). $10/ hundredweight payments were offered to farmers that reduced their marketings by a specified percentage of their historical marketings. Hundredweight is the unit of measurement used for dairy commodities. One hundredweight is equal to 100 pounds. The Milk Diversion Program reduced milk marketings by 5-30 percent, but actually encouraged producers not participating in the program to produce more (Erba & Novakovic, 1995). When the program ended, participating farmers increased their herds to their original numbers, which created a sudden increase in supply (Erba & Novakovic, 1995). The CCC had to increase their purchases of surplus products to uphold the same level of price support (Schwart et al., 1988). This policy included both a method to reduce the supply of dairy as well as decrease in domestic demand through CCC purchases.

The Food Security Act of 1985 (FSA) included two major programs: the Dairy Termination Program (DTP), and the Dairy Export Incentive Program (DEIP) (Womach, 1999). Differentials for Class I products were increased but not at constant levels across all FMMOs (Erba & Novakovic, 1995). The DTP was the second attempt to create a supply control for the dairy industry and aimed to remove twelve billion pounds of milk from the market (Dixon, Berry, & Susanto, 1991). It was a voluntary program where farmers would submit bids for the minimum price per hundredweight for which they would agree to stop farming for the next five years (Glaser, 1986). The DEIP was created to decrease excess supply of dairy by allowing exporters to bid on CCC subsidies (Erba & Novakovic, 1995). DTP was a policy to decrease the supply of dairy whereas DEIP was a policy aimed at reducing trade barriers.

Dairy Policy from 1990 to 2013

In 1990, the Food, Agriculture, Conservation, and Trade Act (FACTA) was passed to address concerns regarding FMMOs and international trade (Weimar & Blayney, 1994). It established a price floor, meaning that milk products could not be priced lower than a specified price (Lynch & Pollack, 1991). Also in this act was the Milk Manufacturing Margin Adjustment provision. This provision prevented states with control of their pricing system from setting manufactured milk prices lower than federal prices (Erba & Novakovic, 1995).

The dairy policies implemented in the 1990s focused less on price supports than policies of earlier years (Erba & Novakovic, 1995). The Federal Agriculture Improvement and Reform Act of 1996 (FAIR) reduced price supports by reducing supports by annual increments until 1999 (USDA, 1996). In addition, this act eliminated payments given to farmers if they agreed to reduce their quantity of milk marketed (USDA, 1996). FMMOs were also consolidated from 33 separate FMMOS to 10-14 FMMOs within the following three years, but still allowed for California to continue mandating their own fluid milk standards (USDA, 1996). The FAIR act ultimately reduced price supports and reduced policies to decrease supply.

The 2002 Farm Security and Rural Investment Act (FAIR) reauthorized DPSP to continue into 2007 through purchases of cheese, butter, and nonfat milk (USDA, FSA, 2011). This supported milk prices. The FAIR act also implemented a loan program for butter, dry milk, and cheese producers to promote better milk product inventory management (USDA, 1996). Finally, the Milk Income Loss Contract Program (MILC) was implemented to support producer incomes through 2005. Dairy producers would be compensated when domestic milk prices fell below a certain level, similar to price supports (USDA, 2006). This program was extended to continue through September 2007 through the Agricultural Reconciliation Act of 2005, although it lowered the level of payments to farmers (Novak, Pease, & Sanders, 2015). The Food, Conservation, and Energy Act of 2008 continued the MILC program until 2014, although payments to farmers were increased again (U.S. Senate Agriculture, Nutrition and Forestry Committee, 2008). In addition, under the 2008 Farm Bill MPSP was reauthorized as DPPSP until 2012; however, it was reauthorized to continue until 2014. Under DPPSP, the Secretary of Agriculture purchased cheese, butter, and nonfat dry milk (USDA, FSA, 2014). In addition to DPPSP, the CCC also purchased dairy products to use in school lunch programs (USDA, FSA, 2014).

In general, the first dairy policies introduced in the early 1900s focused on designing adequate milk pricing systems and establishing FMMOs. From 1940 to 1969, federal policies modified pricing systems, designated support prices, and government purchases of excess products. Policies of the 1970s focused on price supports, with modifications to these policies occurring in the 1980s. The focus of policies in the 1990s was to address concerns of FMMOs and international trade, whereas policies in the early 2000s aimed to reduce price supports.

The 2014 Farm Bill

The Agricultural Act of 2014 was a revolutionary piece of legislation to dairy farmers as it introduced a program never seen before in this industry sector. In 2007, the U.S. monthly all-milk price hit a record high in September as two of the major milk producing countries, New Zealand and Australia were paralyzed by drought (Bollard & Jones, 2007). The demand for American milk products increased as other producers left the market (Shields, 2009). In 2008, farm milk prices reached the second highest level ever recorded; however, the financial crisis of 2009 created major threats to the outcome of this industry (Shields, 2009). Farm milk prices and the margin between the farm milk price and the cost of feed reached the lowest levels seen in twenty-five years (USDA, 2009). The dairy margin is the “difference between the all milk price and the average feed cost” (National Milk Producers Federation [NMPF], 2014). Many farmers and policymakers saw these decreases as indications that current policies did not provide a sufficient safety net for farmers.

The Margin Protection Program Provision

To allow for more flexibility and support for farmers, the Margin Protection Program (MPP) was introduced as a dairy provision in the 2014 Farm Bill. MPP allows producers to decide on the level of government support they would like to receive when producer margins fall below a certain level (USDA, FSA, n.d.b). Dairy farmers choose a margin coverage level, and when a dairy margin falls below this level they receive an indemnity payment from the USDA (NMPF, 2014). The smaller the margin, the worse off the farmer is. The farmer experiences worse-off conditions in three situations: 1.) The average feed cost has increased, 2.) The all milk price has decreased, or 3.) The all milk price decreased and the average feed cost increased (USDA, 2016). The average feed cost is determined by a national feed ration, which is a mix of grains, proteins, feeds, minerals, vitamins, and additives that is prepared and fed specifically to milk cows and heifers (NMPF, 2014). The USDA updates the national dairy production margin every month to ensure accuracy.

This program replaced MILC that was implemented in the 2002 FAIR Act (USDA, 2006). MILC payments were given to farmers when the Boston Class I milk fell below a certain price level (USDA, 2006). Farmers would receive 34 percent of the difference between the Boston Class I milk price and the specified price level (USDA, 2006). While payments through the MILC program were given to all producers when prices fell below a certain level, payments through the MPP program are only awarded to participating farmers that pay an annual premium, and are presented when the all-milk price falls below the level that the producer indicated at the beginning of their coverage period.

The Dairy Product Donation Program

A second program within the Agricultural Act of 2014 emerged as a major change to dairy producers. In addition to MPP, the Dairy Product Donation Program (DPDP) also operates in regards to dairy producer margins. When farmer margins fall below a certain level for a period of two consecutive months, the USDA must purchase products from producers until margins rise above the that level (NMPF, 2014).

Under the previous programs, DPSP and DPPSP, the USDA purchased milk products during times of surplus, similar to the nature of the DPDP; however, the terms between these programs vary. During DPSP or DPPSP, the USDA purchased milk products at fixed prices that supported the all-milk price (Bozic et al., 2014). The quantity of products purchased by the USDA depended on how farmers felt about the USDA purchase prices (Bozic et al., 2014). In DPDP, the USDA consults with food assistance programs to determine the quantity of products they should purchase based on the needs of food assistant programs (Bozic et al., 2014). The USDA is not required to purchase the quantity of goods that food assistant programs suggest, and purchases are made at milk market prices (Bozic et al., 2014). In addition, the purchased products must be distributed to groups in need and cannot be stored by the government.

It should be noted that professionals claim that DPSP and DPPSP as well as DEIP, were seldom-used programs in the dairy industry (Bozic et al., 2014). The termination of these programs was expected to have little effects on dairy producers, while the termination of MILC greatly affected producers (Balagtas, 2011). This is because MILC awarded producers with counter-cyclical payments whereas DPSP/DPPSP and DEIP did not help producers nearly as much as MILC (Bozic et al., 2014).

Existing Literature: Dairy Policy Issues of Today

Consolidation and Concentration

Modern technology and price volatility has led to consolidation (a fewer number of firms) and concentration (a small number of firms controlling the market) in dairy production (Shields, 2010). Consolidation is occurring in the dairy industry because increasing technology and productivity has allowed large operations to conduct business at lower costs (Shields, 2010). When an operation's costs are lower, they can market their goods for lower prices, thus increasing their sales and pushing less profitable farms out of the market (Shields, 2010). As consolidation continues, rural and small farms exit the industry, which is known as concentration (Shields, 2010). This trend that has been occurring since the 1960s was finally addressed when policymakers realized that price stabilization policies have many economic effects. One possible effect of concentration is that it may reduce competition between operations and cause disparity of market power between interest groups (Chidmi, Lopez, & Cotterill, 2005). Concentration may also weaken the transparency of market prices. When a market becomes concentrated it makes it beneficial to producers and processors to have contracts with one another because there are less firms to do business with on the spot (Shields, 2010). This makes it difficult to keep track of observable prices because the transactions are being done in private rather than in the marketplace (Shields, 2010).

Furthermore, America's dairy industry has been experiencing vertical integration for years; however many dairy farmers were able to compete with this as they used local cooperatives to find local and regional markets, or niche markets. Vertical integration occurs when one operation enlarges its activities to include all steps of production. For example, one operation is producing milk, processing the milk, and marketing it to the consumer. In recent years, U.S. dairy farming has been experiencing horizontal integration as well, meaning that dairy operations are adding business activities that are at the same level of the value chain (i.e. yogurt producers are now also producing cheese). This has a possibility to decrease those regional and local markets, thus hurting medium sized dairy operations (Blank, 1998)

Dairy Policy and Market Price System

Analysts Charles Nicholson and Mark Stephenson performed analyses of possible implications of the new MPP program. In their two models, they found that MPP has the potential to weaken market-correcting forces, leading to an increase in milk production (Nicholson & Stephenson, 2014). Indemnity payments weaken price volatility because high prices that signal a need for increased supply and low prices that signal over-supply are no longer experienced when indemnity payments are apparent (Bakst, Sewell, & Wright, 2016). They argue that this safety-net program will lead to lower milk prices and lower producer margins which would trigger higher amounts of indemnity payments and government expenditure (Nicholson & Stephenson, 2014). Furthermore, lower fluid milk prices reduce the price of manufactured dairy products. This has the possibility to cause an increase in the amount of average annual exports of dairy products.

Other researchers have also found that both the new MPP program and the old MILC program have distortionary effects on milk supply (Bozic & Novakovic, 2014). MPP reduces natural market adjustments that would bring milk production, prices, and margins up if margins fell below a threshold level (MacDonald, Cessna, & Mosheim, 2016). Previous to MPP, during long periods of low milk prices or high feed prices farmers would decrease production by reducing herd size and altering feed rations and milking practices to lower milk production per cow (MacDonald et al., 2016). MPP insulates farmers against low margins, muting their supply response to low margin periods (MacDonald et al., 2016). In return, this sustains longer periods of low margins and therefore low milk prices, making higher levels of MPP coverage more attractive (MacDonald et al., 2016). Higher MPP coverage levels selected by farmers and a higher participation rate in the program increases the level of government intervention and therefore spending. Furthermore, the level of farmer participation alters the distributions of costs and benefits of the program (MacDonald et al., 2016). Farms not enrolled in MPP forgo the expense of premiums but receive no indemnity payments when margins are low. If MPP does prove to lower milk prices and sustain longer periods of low margins, the farms not enrolled in MPP will have to bear the financial burden (MacDonald et al., 2016).

Issues with Risk-Management Policy

In addition, MPP indemnity payments might reduce the financial risks of production for farmers. This could induce a higher level of milk supply regardless of price level and producer margins (Mark, Burdine, Cessna, & Dohlman, 2016). Reduced risk could increase the average returns of farmers because they become more confident in their production and therefore increase production levels (MacDonald et al., 2016**).** Another concern of MPP is that it is subject to asymmetric information incentives (Newton, Thraen, & Bozic, 2013). Allowing farmers to choose protection levels when they have access to forecasts of milk prices and can be almost certain there will be low margins is known as adverse selection (Newton, Thraen, & Bozic, 2013). This might cause farmers to increase production during low margins because they have government support**.** The subsidized insurance program could reduce the demand for other farm insurance from third parties, increasing the rate of consolidation in the dairy sector (Baskt et al., 2016).

Inequality of Farm Subsidy Recipients

Although the structure of the dairy industry has changed monumentally, Congress and the USDA have yet to address this in their policies (MacDonald et al., 2016). Before the MPP program, MILC was in place and favored medium and small farms because there was a cap on how much government support farms could receive based on their level of output (Raghunathan, 2014). Medium sized farms were found to be more sensitive to producer margins and government policies than large and small farms (Raghunathan, 2014)**.** After creating simulations of various amounts of government support, it was found that mid-sized farms alter their level of production quickest after periods of high and low margins (Raghunathan, 2014). Therefore, they are the most at-risk group of shutting down when there are no government subsidies (MacDonald et al., 2016). In addition, an economic analysis performed by the University of Illinois resulted in the theory that farms with less than 100 cows will receive 38 percent of the expected benefits from MPP and farms with herds over 1,000 cows wild receive 15 percent of the benefits (Thraen & Newton, 2014). This is similar to the distribution of payments under MILC, in which it was concluded that farms with less than 100 cows obtained 39 percent of benefits received and operations with 1,000 cows or more received 9 percent of benefits (Thraen & Newton, 2014).

With consolidation trends continuing, by 2013 60 percent of all U.S. milk was produced by large operations and only 40 percent of milk production nationwide qualified for support through MILC (Raghunathan, 2014). A new support system was needed. MPP allows for new farms to receive indemnity payments after they establish a production history based on their first few months of production. However, existing farms that have expanded their herd size do not receive coverage for their increase in production if it is not within the timeframe that the historical production period is determined (MacDonald et al., 2016). This has the potential to be a clear advantage to new operations as compared to existing operations because new operations are more likely to receive greater amounts of indemnity payments (MacDonald et al., 2016). In return, this could alter the structure of the dairy sector. Instead of the industry experiencing a decrease in number of farms nationwide and an increase in farm size, MPP could increase the number of new operations and cause existing production facilities to shut down (MacDonald et al., 2016).

Alston & James, two policy analysts argued that current economic models to determine welfare effects and the effects of policy on consumer and producer surplus do not accurately reflect all interest groups (Alston & James, 2002). For example, the structure of this industry has given processors more market power (Shields, 2010). Researchers created a new, intricate model to discover how policy effects are distributed among stakeholders. Before the 2014 Farm Bill was passed, policy analysts conducted a survey to determine what policy options dairy farmers favored (Wolf & Tonsor, 2013). Previous to this study, farmer preferences were unknown while the opinions of processors and other industry stakeholders were already identified. 2,000 random

Michigan farmers were asked to select the policy they would rate as the best option for themselves and the policy they would rate as the worst option. It was found that farmers in charge of large dairy operations believed ending ethanol import tariffs was the most important issue to be addressed in the next Farm Bill (Tyner, 2010). Smaller scale dairy operations favored programs that improve farmer income over programs that improve producer margins (Wolf & Tonsor, 2013).

The Environment: Why Does Dairy Surplus Matter?

The excess supply of dairy begs an important question: Where does it go? In recent dairy policy, the Dairy Product Donation Program was implemented, which redirects dairy products not purchased by consumers to low-income families. This decreases the amount of dairy products sent to landfills, and therefore decreases the environmental effects resulting from food waste.

Approximately 2 percent of all U.S. energy usage is used to produce food that is never eaten by consumers (Morrigan, n.d.). Ultimately, this excess energy demand increases the amount of greenhouse gas emissions, as 65 percent of electricity generation in 2016 was from fossil fuel sources (coal, natural gas, and petroleum), with the largest source being coal (U.S. Energy Information Administration). Coal mining results in detrimental effects via mountaintop removal, which harms aquatic wildlife downstream as pollutants such as rock and dirt, get carried downstream (Union of Concerned Scientists, n.d.). Furthermore, coal combustion emits dangerous toxins such as sulfur dioxide, which leads to acid rain and respiratory illnesses, and nitrogen oxides, which contributes to respiratory illnesses as well as smog (Union of Concerned Scientists, n.d.). The burning of coal, oil, and natural gas contribute to the creation of carbon dioxide

(Union of Concerned Scientists, n.d.). Carbon dioxide has been proven to contribute to Earth's warming by scientists at the various institutions. In a 2010 report it was stated that carbon dioxide "…decreases evaporative cooling by plants and that this decreased cooling adds to global warming" (Carnegie Institution). In addition, organic food waste sent to landfills produces 18 percent of all U.S. methane gas emissions (Allen, Cancel, & Orduna, 2015). Methane gas is 84 times more potent than carbon dioxide as it traps the sun's heat in, thus warming the atmosphere (Environmental Defense Fund, n.d.)

At the consumer level, according to the Innovation Center for U.S. Dairy, the U.S. discards 31 to 40 percent of its food supply (Frye, 2016). Consumers waste 15 to 25 percent of all food they purchase, which is equivalent to 133 billion pounds (Vogliano & Brown, 2016). Approximately 19 percent of this amount is strictly dairy products, accounting for 25.4 million pounds of dairy food waste (Vogliano & Brown, 2016). Economically, an average American family wastes $1,484 worth of food every year (Vogliano and Brown, 2016).

On the producer side, food waste occurs through overproduction, crop failures, and quality expectations ("Instock fights food waste by creating meals our of food surplus," 2017). This not only increases the amount of unneeded costs to producers and manufacturers, but also increases the amount of greenhouse gas emissions resulting from agricultural production.

Aside from federal dairy donation policies, dairy producers and manufacturers can also enroll in recycling programs that would allow dairy to be converted to bio-diesel, alternative fuels, and animal feeds (Winfrey, 2014). Unfortunately these programs are only found in a limited amount of states such as Texas.

The Timeline of Major Dairy Policy: A Summary

Title of Policy	Year	Reasons/Results of Policy	Policy Tool
Pricing Schemes -Excess Plan -Flat Pricing -Classified	1910- 1930	Aimed to create uniform prices to address inequity between producers and processors	Pricing
1933 Farm Bill	1933	Improve milk prices and farmer incomes	Price Supports Increase Demand
1941 Steagall Amendment	1941	Set price supports to incentivize production	Price Supports Increase Supply
1949 Farm Bill	1949	Implemented DPSP: A price support system	Price Supports
Trade Agreements Extension of 1951	1951	Enforced import restrictions	
1983 Dairy Production Stabilization Act	1983	Encouraged a reduction in supply	Decrease supply
Food Security Act of 1985	1985	Implemented DEIP: Decreased excess supply by increasing export subsidies	Decrease domestic supply
2002 Farm Security and Rural Investment Act	2002	Implemented MILC: Support farmer incomes by giving them payments when prices fell below a certain level	Safety-net
2008 Farm Bill	2008	Reauthorized MPSP as DPPSP: Government purchased excess cheese, butter, and nonfat dry milk	Price supports
2014 Farm Bill	2014	Discontinued MILC, DPPSP, and DEIP Implemented MPP: Support for farmers when margins fall below a certain level Implemented DPDP: Allows governmental purchases of dairy products and distributes them to food programs	Discontinues price supports Safety-net Decreases demand

Ethanol Policy

The Timeline of Ethanol Policy

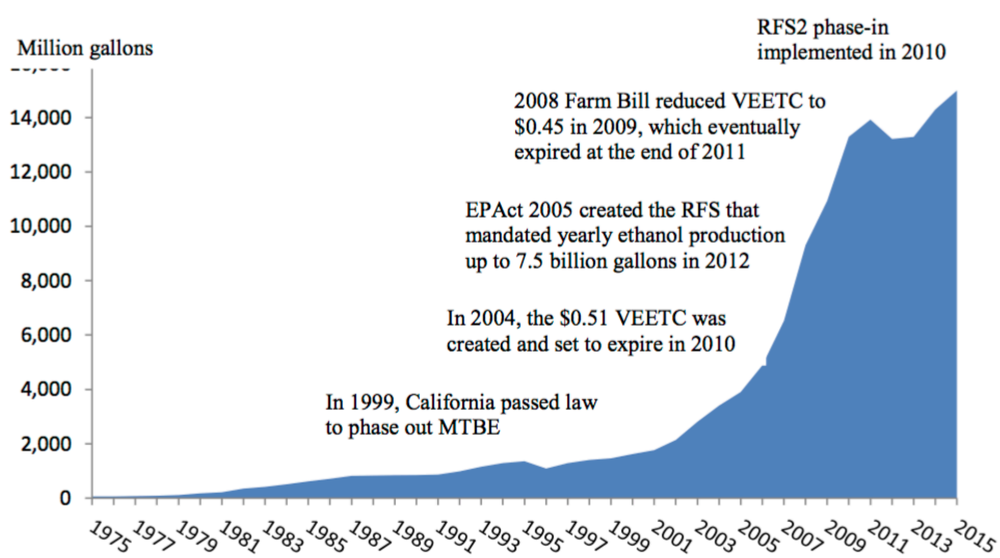
To study the relationship between dairy surplus and policy, I created a timeline of major ethanol policies. Since the 1970s, the government has subsidized corn ethanol, which has greatly affected the dairy industry as well as other agricultural industries such as beef, in which producers use corn in livestock feed rations. This timeline is displayed in Figure 2. Furthermore, a graph depicting ethanol production has been included in Figure 3.

Figure 2

Date	Event	Details of Policy/Law/Event
2002	Title IX in the 2002 Farm Bill *Policy tool: Government support for ethanol production*	• 1st energy bill in federal agricultural legislation • Created programs through 2007 to promote bioenergy production and consumption → Increased supply of ethanol
2004	American Jobs Creation Act of 2004 (Jobs Act) *Policy tool: Government support for ethanol production*	• Implemented the Volumetric Ethanol Excise Tax Credit (VEETC) for gasoline blenders using ethanol • Imposed an import tax on ethanol imported for fuel → Increased supply of ethanol
2005	Energy Policy Act of 2005 eliminates MTBE use *Policy Tool: Ethanol as a fuel additive*	• Passed a renewable fuel standard (RFS) that increased the percentage of ethanol used for blending • Removes the use of MTBE (an ethanol substitute) in the U.S. • Implemented a biofuel production mandate to have produce a minimum of 4 billion gallons by 2006 and at least 7.5 billion gallons by 2012 → Increased demand for ethanol
2006	MTBE eliminated *Policy Tool: Ethanol as*	• E10 (10% ethanol blend) becomes the most common motor fuel in the U.S MTBE is eliminated in all states by 2006

	a fuel additive	→ Increased demand for ethanol
2007 Goes into effect Jan. 1 2008	Energy Independence and Security Act (EISA) *Policy Tool: Renewable Fuel Standard*	• Replaces RFS more aggressive renewable fuel mandates (RFS2) → Increased demand for ethanol
2010	States of Hawaii, Florida, Oregon, and Missouri	• Multiple states pass E10 mandates by 2010 → Increased demand for ethanol
2014	2014 Farm Bill *Policy Tool: Government support for ethanol production*	• Reauthorized support for ethanol established in the 2008 Farm Bill → Ethanol supply increased
December 2011	Excise tax credit expires	• Ethanol excise tax credit created in the 2004 Jobs Act expires → Ethanol supply decreased

Figure 3



* Year 2015 is RFS2 volume requirement of 15 billion gallons. Sources: Renewable Fuels Association and National Agricultural Law Center. Note: RFS2 is the Renewable Fuel Standard-2; VEETC is the Volumetric Ethanol Excise Tax Credit; EPAct is the Energy Policy Act; MTBE is Methyl Tertiary Butyl Ether.

Source: Duffield, J., Johansson, R., & Meyer, S. (2015).

What is Wrong with Ethanol?

Economically, renewable fuel standards and other policies that encourage ethanol use in areas other than food production drive up the price of food pries. This is because corn ethanol is being diverted to supply fuel instead of being used solely for food production (Babcock, 2008). Furthermore, ethanol requires new pipeline infrastructure to be transported as it absorbs water from the atmosphere, making existing pipelines used to transport crude oil unsuitable to use in ethanol transportation (Whims, 2002). In addition, ethanol is also corrosive to older car engines car engines because it possesses chemicals that damage soft metals, and is overall a corrosive substance that can destroy plastic, rubber and metals, thus corroding vehicle engines (Borders and Burnett, 2007).

Governmental support for ethanol production diverts farmland from being used for other types of farm production. Not only could that land being used to grow corn for ethanol production be used to grow other food crops, but corn farmers are pressured to increase their crop yields under ethanol mandates, thus turning to chemical fertilizers and pesticides to do so (Borders & Burnett, 2007). Also, in order to meet ethanol mandates, the EPA has had to loosen clean air regulations. Ethanol production is more energy-intensive than refining gasoline, causing higher amounts of CO2 to be emitted from the ethanol distilling process (Borders & Burnett, 2007). Ethanol produces volatile organic compounds (VOCs) emissions and nitrogen oxide (NOx) emissions, both which contribute to smog (Borders & Burnett, 2007).

Methods

Part 1: The Reason Behind the Methods

A secondary quantitative data analysis was performed for this research topic. The USDA's National Agricultural Statistics Service (NASS), and Agricultural Marketing Service (AMS) publish raw data and relevant statistics on all aspects of the dairy industry. For this reason, I executed an analysis of data that was primarily collected by the government on a periodic basis. In general, this document looks at key features of milk production. According to Stillman et al. (1995), "Key features of milk production are its location, quantity (both aggregate and per cow), the size and distribution of herds, farm numbers and ownership, producers' financial conditions, and the ability of producers to respond to changing economic conditions" (Stillman et al., 1995). The methods for this research project aim to understand features of milk production such as the aggregate quantity, size and distribution of herds, farm numbers, and producers' responses to changing conditions.

Dairy Surplus

First, I have calculated the difference between the amounts of fluid milk put on the market by the producer and the amounts purchased by the consumer. In other words, I determined the amount of fluid milk that the producer attempts to sell on the market but is unsuccessful in doing so. This is useful in studying the amount of food waste resulting from the conventional fluid milk market as this measurement represents the difference between fluid milk marketings and actual fluid milk sales. Furthermore, fluid milk is difficult to donate or discard, as it is very perishable. Thus, it is important to study the amount of fluid milk that is unused as it rarely can be consumed if not purchased by consumers.

To continue this study of dairy surplus, I also studied the difference between supply and commercial demand of two dairy products: butter and lactose. Butter was chosen as a subject of study to represent a popular manufactured dairy product, and was chosen over other products such as American cheese because it contains three ingredients, whereas American cheese contains sixteen ingredients. Lactose was used in this study because it is the main sugar in milk and all other dairy products. Fluid milk and ice cream are the dairy products with the highest levels of lactose; however, lactose is also found in products such as breads, candy, cereals, and salad dressings (WebMD, n.d.). Thus, lactose is a product that is found in industries than dairy, making it useful in studying how other food markets might be affected by these results.

The surplus of lactose and butter were studied through two different analyses. First, I studied excess supply levels of lactose and butter to track the differences between supply and demand of lactose and butter throughout the past seventeen years. This was done to identify prevalent trends within manufactured dairy product surpluses and its relationship to agricultural policy.

Second, manufactured dairy product surplus was examined by studying the amount of ending commercial stocks of dairy for each product. The ending commercial stocks represent the supply of the good left over from the previous period. In other words, ending commercial stocks reflect the amount of an aggregate good that has not been purchased by consumers or government entities. Therefore, ending commercial stocks are useful in studying trends within food waste resulting from manufactured dairy products, although it is possible (but not extremely likely) that individual farmers use these stocks at the beginning of the next year.

The Landscape of Modern Dairy Farming

To study if there is a correlation between agricultural policy changes and the landscape of dairy farming as hypothesized in the work of MacDonald et al. (2016), I performed two distinct studies. First, I determined the national average herd size. In MacDonald et al.'s report, it was stated that government programs have failed to keep up with the changing structure of the diary industry (MacDonald et al., 2016). To examine the accuracy of this claim, I calculated the mean national herd size for years 2000 to 2015. The mean national herd size is useful in identifying trends within dairy farm size, as it is representative of the average number of cows in each individual dairy farm. The national average herd size is also useful in determining the concentration of the dairy industry because provides us with a baseline, or a measure of central tendency (MacDonald et al., 2016).

To study this feature of the dairy industry more in-depth, I performed a case study of Northeast dairy farms. Specifically, I determined trends within the proportion of Northeast dairy farms within different farm size categories. The Northeast region of the U.S. was chosen for this study because it has historically been the region within the U.S. that contained the majority of small farms, defined as 100 cows or less, but has recently experienced a vast increase in herd-size expansion (MacDonald et al., 2016). This information is useful in gaining a more detailed idea of trends within the modern landscape of dairy farming, and how farm sizes have been changing throughout the past seventeen years. Furthermore, this case study also allowed me to study trends within the consolidation of the dairy industry. Data was collected from Farm Credit East, a part of the nationwide Farm Credit System that provides credit services to individuals in agricultural industries. I received private access to their annual "Northeast Dairy Farm Summary" reports for years in which reports are no longer available to the public. Furthermore, data from the USDA was not used for this method because the USDA does not release this specific of information on a regular basis, as they publish these numbers using four-year increments, which does not give an adequate size of data to analyze this information.

This method answers two questions: what is the extent of structural change within the Northeast dairy industry today, and have medium-sized farms experienced the greatest change within the industry. The latter will address the statement made by MacDonald et al. that medium farms respond most to policy changes (MacDonald et al., 2016).

Farming Decisions Resulting from Dairy Policy

To analyze if new dairy policy has diminished the supply responses of producers to risk as hypothesized in reports by Newton, Thraen, & Bozic (2013) and MacDonald et al. (2016), I calculated annual national herd culling rates. Herd culling refers to the amount of cows that are removed from the main herd, and in this case I only studied the amount of cows that were slaughtered by their owners. Dairy farmers cull their herd for a number of reasons such as disease and natural factors; however one of the main reasons dairy farmers cull their herds is to maximize income while also controlling their costs of production (Agriculture & Horticulture Development Board, n.d.). Herd culling rates are useful in examining decisions made by farmers under different policies because it allows us to study the profitability of dairy farming and if reductions in financial risk are present. In theory, in times of economic hardship dairy farmers can either slaughter their cows or try to sell their milk at lower prices.

If the new MPP provision in the 2014 Farm Bill actually insulates farmers during low margin periods, which occurs when either milk prices are low or feed costs are high, it has been hypothesized by MacDonald et al., 2016 that low margin periods will be prolonged because indemnity payments have muted the supply response from farmers (MacDonald et al., 2016). During the MILC program farmers were very responsive to low producer margins and would reduce their herd size via herd culling to reduce their overall amount of milk produced. If the claim that MPP mutes supply responses is true, researchers hypothesize that producers are less likely to reduce production to the extent they would have under MILC. This information has led me to hypothesize that MPP will decrease herd culling rates if does reduce financial risks to farmers.

In addition, I have also calculated annual farm exit rates. Farm exit rates refer to the proportion of farms that have left the industry in a given year. This method mirrors analyses performed in a 2003 study on dairy farm exit rates by Glauben, Tietje, & Weiss. This measurement is useful in studying the dairy industry because it allows one to examine ownership trends within the industry as well how producers respond to economic conditions as farmers may decide to exit the industry if their margins are too low.

Part II: How the Methods Were Performed

Dairy Surplus

Marketings and Sales

I have calculated the annual disparity between fluid milk marketings and sales from 2000 to 2016. To do so, I collected data regarding fluid milk marketings from NASS's "Milk Production, Disposition, and Income Annual Summaries" reports. Information regarding fluid milk sales was extracted from ERS datasets "Fluid milk sales by product (annual)." The difference between the two variables was calculated using Excel and displayed graphically in two different ways.

Excess Supply of Butter and Lactose

Data collected for these analyses came from the ERS dataset, "Commercial disappearance for dairy product categories (monthly)." Commercial disappearance is a term created by the USDA that represents the relationship between commercial use (demand) and commercial supply. The USDA has this data published from 1995 to September 2016. For dairy studies, the USDA calculates total supply as beginning commercial stocks, which are the products left over from the previous year, plus current production and imports. Commercial use is calculated by the USDA as commercial demand plus commercial exports and is referenced as commercial disappearance.

Specifically, I created Excel spreadsheets that tracks total domestic excess supply. For the sake of clarity, I have defined these terms of measure as:

Total Domestic Excess Supply = Total Domestic Supply – Total Domestic Demand

Total Domestic Supply = Beginning Commercial Stocks + Production

Total Domestic Demand = Domestic Commercial Disappearance + Commercial Exports.

Annual Total Domestic Excess Supply levels were calculated and expressed graphically from years 2000 to 2015. Annual percentage changes of total domestic excess supply were calculated and years with very large or small percentage changes were noted and used in my analysis. In addition, monthly domestic excess supply levels were calculated and tracked graphically for lactose and butter.

Ending Commercial Stocks of Butter and Lactose

Ending commercial stocks of butter and lactose were extracted from the ERS dataset "Commercial disappearance for dairy product categories (monthly)." After extracting this data, I created a graphical figure using Excel to model levels of commercial stocks of both butter and lactose on an annual scale. In addition, to further study the relationship between these variables and the new programs within the 2014 Farm Bill, I analyzed this data only a monthly timeline from 2013 to 2016.

The Modern Landscape of Dairy Farming

Average Herd Size

The annual national average herd size was calculated as:

Average herd size = Number of total dairy cows in the U.S. / Number of licensed dairy herds

Data regarding the number of dairy cows in the U.S. and the number of licensed dairy herds was found and collected from annual February NASS "Milk Production" reports from years 2000 to 2016. Data regarding 2017 was incomplete. I have created an Excel spreadsheet with the annual average herd size, annual percentage changes, and a line graph to display this information. Annual percentage changes that were excessively high or low were noted and used in the analysis.

Case Study of Northeast Dairy Farms

I created an Excel spreadsheet with data from the years 2000 to 2015 that tracks the proportion of farms within various farm size categories. Data regarding years 2016 and 2017 have not yet been published. Farm Credit East defines the various dairy farm size categories as followed:

Years 2000 - 2011	
Small	89 cows or less
Medium	90-149 cows
Medium-Large	150-299 cows
Large	300 cows or more

Years 2012 - 2015		
Small	Represents Low Overhead Operator Farms	99 cows or fewer
Medium	Represents family operations utilizing hired help	100 – 299 cows
Medium-Large	Represents large family or multi-family operations with significant hired labor	300 – 699 cows
Large	Represents large operations with mostly hired help	700 cows or more

Using Excel, I first calculated the proportion of farms in each size category used by Farm Credit East by dividing the number of dairy farms in each size by the total number of farms in the survey. Then, I calculated annual percentage changes in each herd size category. Two line-graphs tracking herd-size categories were created for each time period (2000 – 2011) and (2012 – 2015).

Farming Decisions Resulting From Dairy Policy

Herd-Culling Rates

The annual national herd-culling rate was calculated as:

Annual national herd culling Rate = Number of annual U.S. dairy cows / Number of annual dairy cows slaughtered x 100

Information regarding the amount of dairy cows in the U.S. were extracted from February NASS "Milk Production" reports. Information regarding the amount of dairy cows slaughtered under federal inspection were extracted from NASS "Livestock Slaughter Annual Summary" reports. Using Microsoft Excel, I calculated the national herd-culling rate from years 2000 to 2016 and displayed these numbers in a scatter plot. Furthermore, to study the relationship between MPP and DPDP and herd culling rates I created monthly scatter plots for years 2014 and 2015. Dairy operations and other companies such as Hoards Dairyman use this measurement as a way to study the dairy industry. A healthy herd-culling rate has been defined as between 20 and 30 percent (Brett, 2011). For this reason, years with herd culling rates above or below this level were noted.

Farm Exit Rates

Annual farm exit rates were calculated as:

Annual farm exit rate= Number of dairy farms that shut down / Total number of dairy farms x 100

Both the number of dairy farms that shut down and the total number of dairy farms were extracted from annual February NASS "Milk Production" reports; however, I calculated the number of farms that shut down by subtracting the number of dairy operations from the following year from the previous year. In 2003, the USDA modified their definition of licensed dairy farms, so I created two different graphs: one for years 2000 to 2002 and one for 2003 to 2015. Data for years 2016 and 2017 was unavailable.

Results: Data Tables and Graphs

This section provides the results and findings from the methods performed. All tables can be found in the Appendix.

Measures of Dairy Surplus

Disparity Between Fluid Milk Marketings and Sales

The first method conducted for this project, the disparity between fluid milk marketings and sales, was performed to measure the differences between amounts of fluid milk marketed by producers versus the amounts of milk purchased by consumers. This study of milk food waste is useful in determining the amount of leftover fluid milk supplies. I found that between 2000 and 2015 the aggregate disparity between fluid milk marketings and sales increased by 42.55 percent. Only between 2000 and 2001, and between 2008 and 2009, was there a decrease in the percentage change in disparity between fluid milk marketings and sales. Years 2014 and 2015 experienced the greatest disparity between milk marketings and sales as this number reached above 150,000 in both of these years.

Figure 4

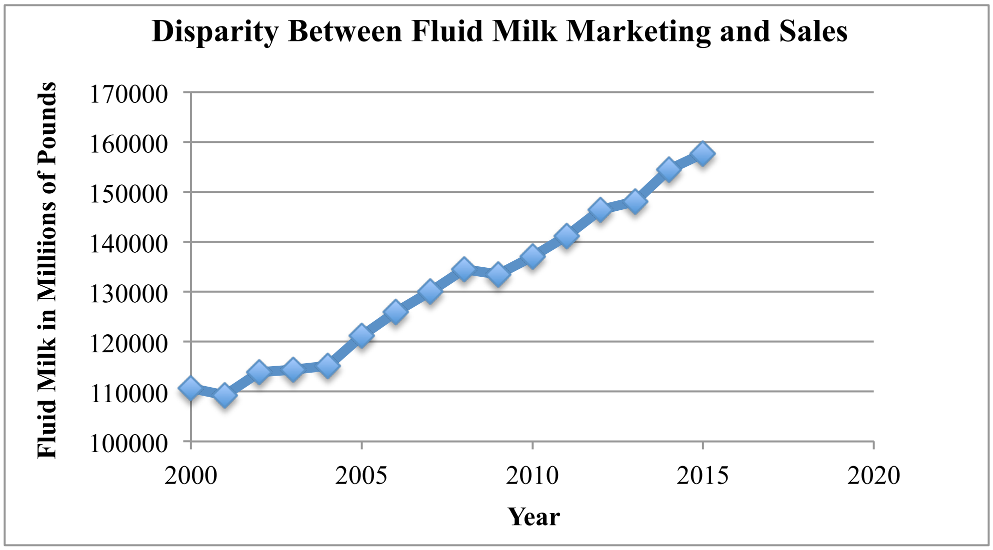


Figure 4 is a visual representation of this data. After the increase in disparity between 2001 and 2002, this measure levels off between 2002 and 2004. Between 2004 and 2008 there was an increase of disparity of 16.709 percent. Between 2008 and 2009, levels decreased by 0.746 percent. Between 2009 and 2015, the difference between marketings and sales increased by 18.204 percent.

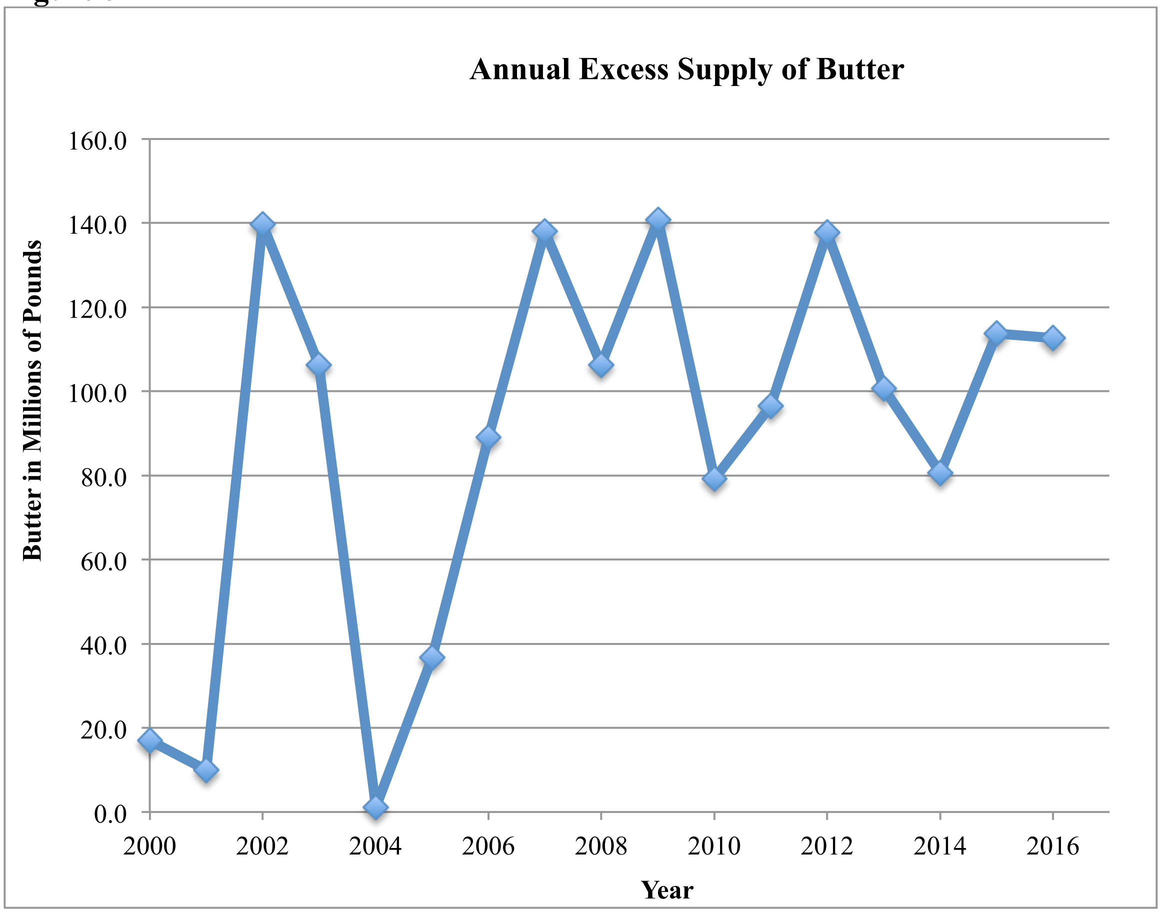
Excess Supply of Butter and Lactose

Annual Butter Excess Supply Data

After compiling data on the domestic supply and total commercial disappearance (commercial demand) of butter, I found that excess butter supplies have increased since 2000. Specifically, between 2000 and 2001 there was a decrease of 23.980 percent in excess supply levels. Between 2001 and 2002, excess supply levels skyrocketed and then decreased to 1.1 million pounds in 2004, the year with the lowest excess supply levels. From 2004 to 2006, the excess supply of butter increased to 89.1 million pounds. From

2006 to 2014 excess supply levels have hovered between 80 million pounds and 140 million pounds. This information is displayed in Figure 5.

Figure 5

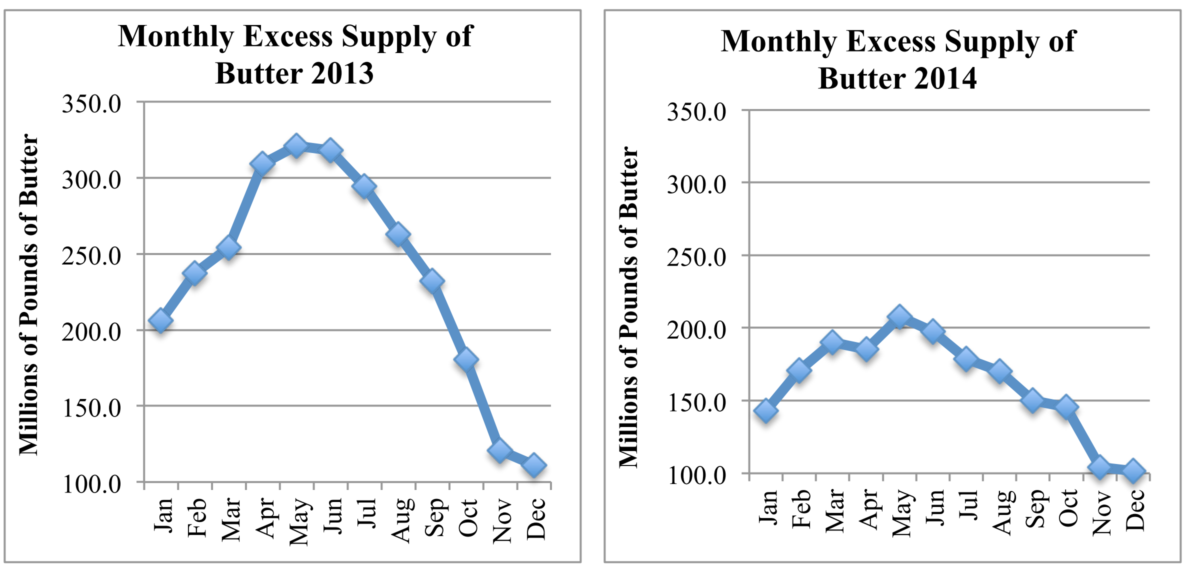


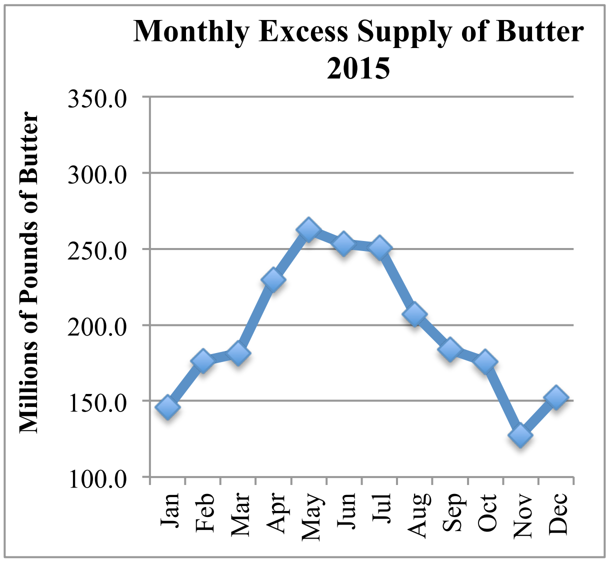
Monthly Excess Supply of Butter

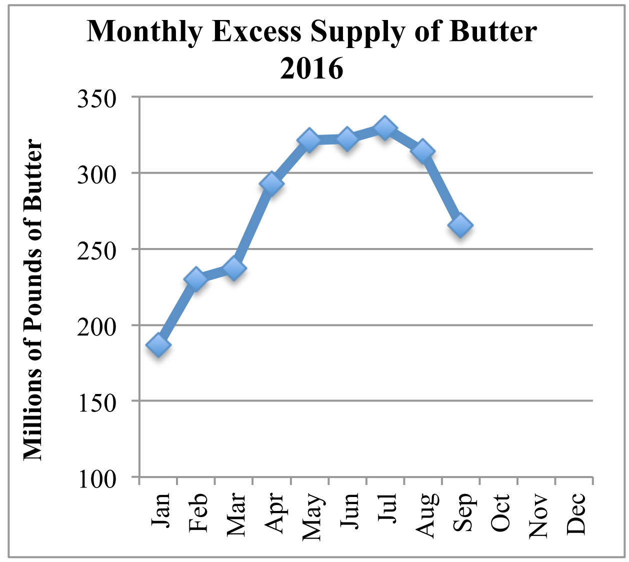
In addition, to study if there is a correlation between dairy policy change and excess supply levels, I also analyzed monthly excess supply levels. Analyses were performed for 2013, 2014, 2015, and 2016. Although the focus of my research is on the new programs implemented in the 2014 Farm Bill, I included 2013 in this in-depth study to use as a comparison. Data for the year 2016 has only been released for months January to September.

I found that in 2013, excess supply levels increased from Jan. to May, and then heavily decreased in the winter months of October to December. Excess supply levels of butter were high in 2013; however, 2014 experienced lower excess supply levels. Compared to 2013, peak excess supply levels were more than 100 million pounds less in 2014. There seems to be a seasonal trend in excess supply of butter: excess supply increases from March to July, and then starts to decrease until its lowest levels in November and December. Excess supply of butter in 2015 was similar to 2014 except excess supply increased in December 2015. 2016 experienced much higher excess supply levels than in 2014 and 2015. Peak levels were seen at 320-330 million pounds of butter. Monthly graphs are displayed in Figure 6.

Figure 6



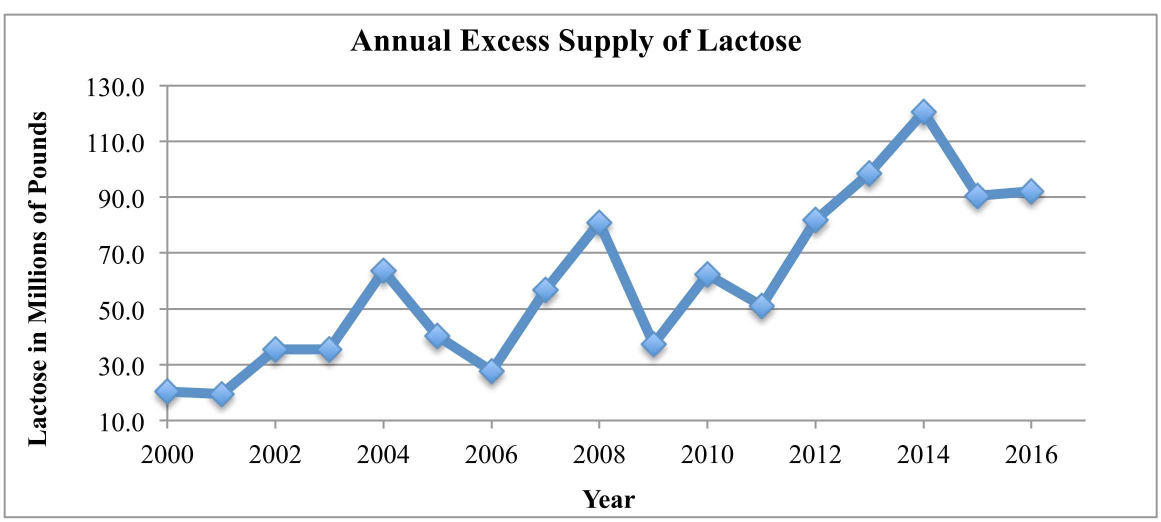




Annual Excess Supply of Lactose

When I examined data regarding lactose, I found that excess supply levels have increased although there was a large decrease from 2001 to 2002, where they remained at the 2002 level until 2003. Excess supply levels increased from 2003 to 2004, and then decreased from 2004 to 2006. After experiencing alternating increasing/decreasing excess supply levels from 2008 to 2011, excess supply levels rose from 2011 to 2014. From 2014 to 2015 there was a 24.895 percent decrease in this measurement. This is displayed in Figure 7.

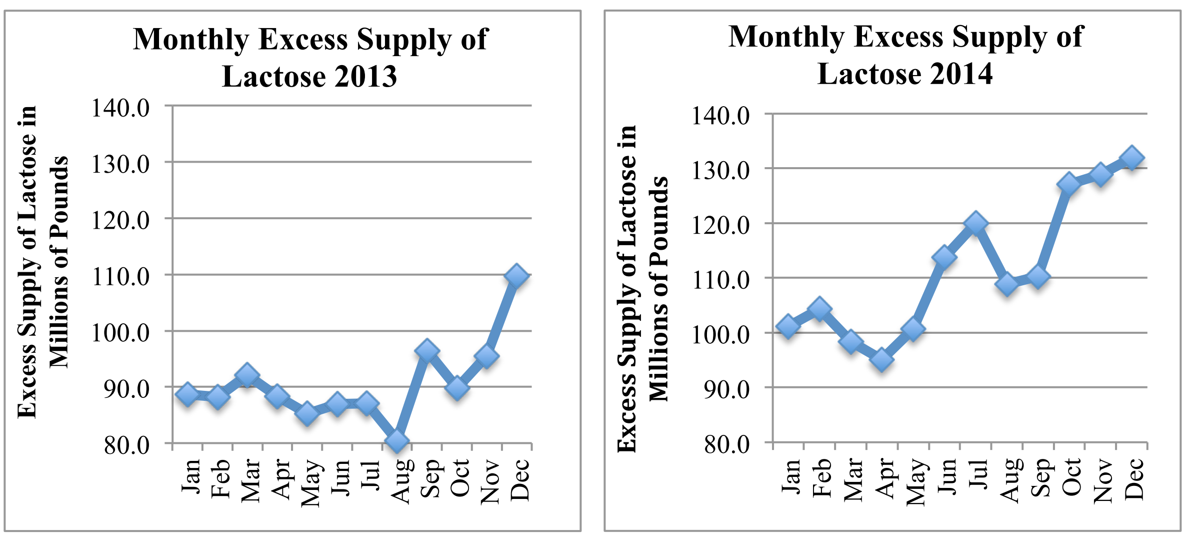
Figure 7

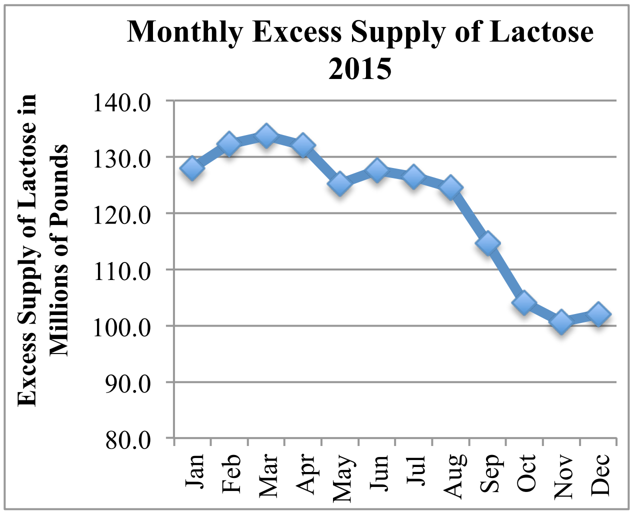


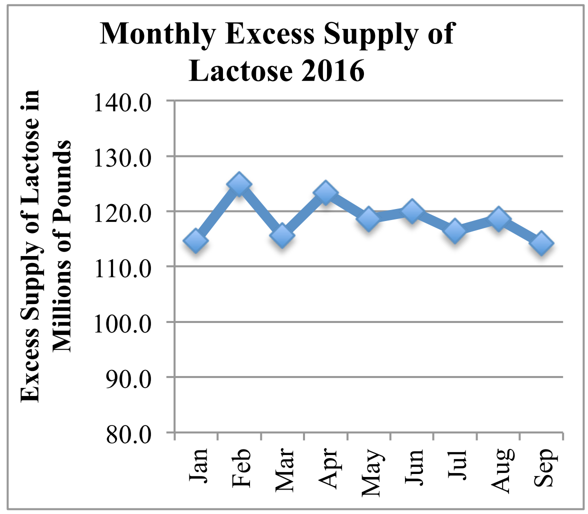
Monthly Excess Supply of Lactose Data

To study the relationship between dairy policy and excess supply levels, I also Examined monthly data for years 2013 to 2016. Data for January to September were available for the year of 2016. This data was interesting because in most of the months between 2013 and up to September of 2014 (when the new programs actually began), excess supply levels were between 80 and 120 million In October 2014 excess supply levels increased to 130 and between 130 and 120 for one year. In 2016, excess supply of lactose has been more stable than in previous years. It has stayed somewhat constant around 120 million pounds, which is 30 million more pounds than excess supply of lactose in the beginning of 2013. See Figure 8.

Figure 8





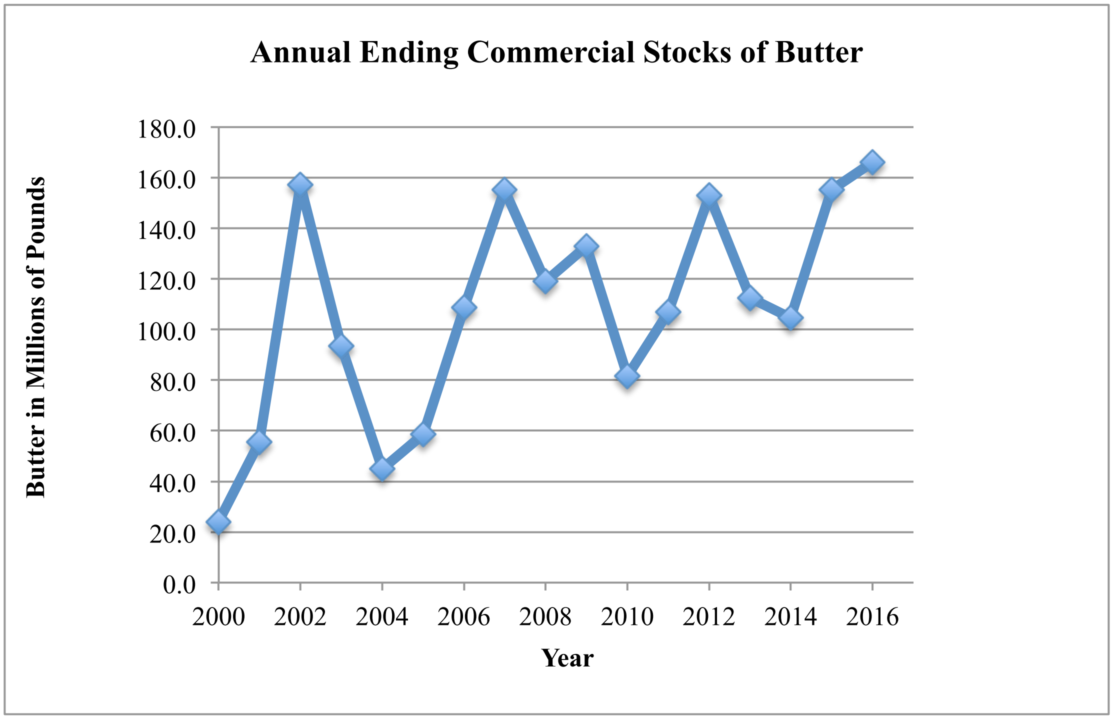


Ending Commercial Stocks of Butter and Lactose

Annual Ending Commercial Stocks of Butter

I conducted a similar study on the leftover stocks of butter products for all dairy farms in the U.S. found that there is a positive trend in this measurement. Furthermore, the changes in ending commercial stocks of butter vary less in years after 2006 than compared to those of years before. The largest annual changes in butter ending commercial stocks were seen from 2001 to 2002 where it increased by 101.8 million pounds of butter. Also, it should be noted that between 2003 and 2004 this level decreased by 40.584 percent and from 2014 to 2015, butter ending commercial stocks increased by 48.081 percent. See Figure 9 for more information.

Figure 9

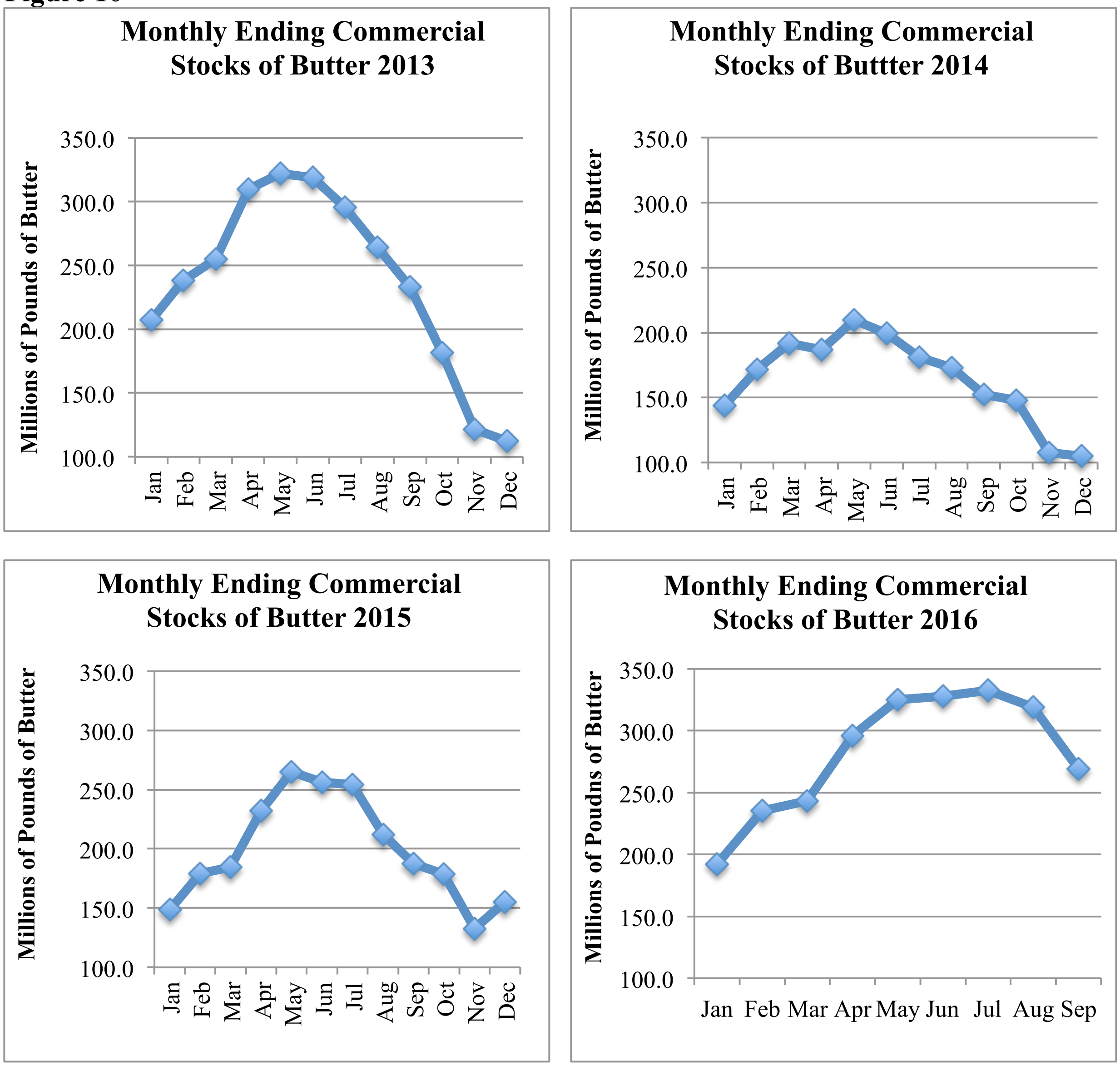


Monthly Ending Commercial Stocks of Butter

After creating graphs to track butter ending commercial stocks, it was evident that there are seasonal trends regarding ending commercial butter stocks. In 2013, five months out of the year experienced ending commercial stocks from 250 to 300 millions of pounds; however, starting in July ending stocks began to decrease until November. 2014 saw much lower and stable stock supplies of butter, and in November and December the dairy industry experienced the least amount of ending commercial stocks in this period.

There appears to be a seasonal trend in ending commercial butter stocks: stock supplies peak in the spring (March, April and May) and then start to decrease in the fall (July to September) until they reach their lowest amounts in November and December. I found that this measure decreased since 2013, but 2016 experienced very high ending commercial stocks; May 2016 had ending commercial stocks of almost 235 millions of pounds and in July there were 333 millions of pounds present. This information is displayed in Figure 10.

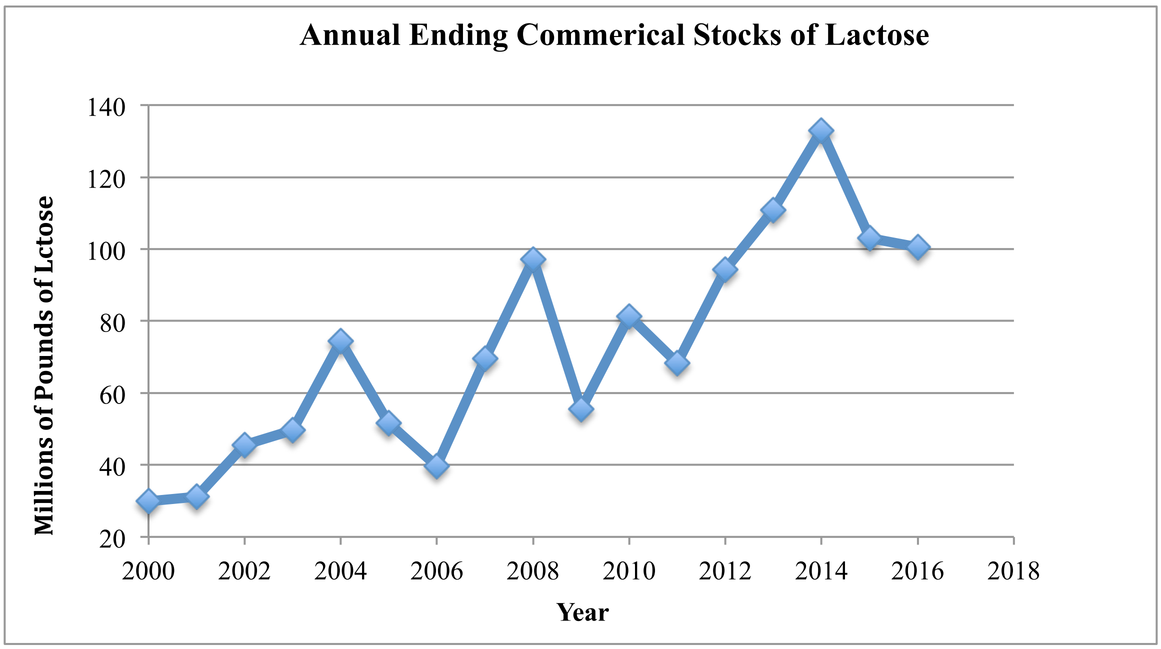
Figure 10



Annual Ending Commercial Stocks of Lactose

After examining the data for years 2000 to 2015, I found that the U.S. dairy industry has been experiencing increasing levels of ending commercial stocks of lactose. The largest increases in commercial ending stocks appeared from 2001 to 2002, from 2006 to 2007, from 2009 to 2010, and from 2011 to 2012. The largest decreases in annual ending commercial stocks were found from 2004 to 2005 and from 2008 to 2009. It should also be noted that from 2014 to 2015, excess stock levels decreased by 22.423 percent. Figure 11 displays this information graphically.

Figure 11

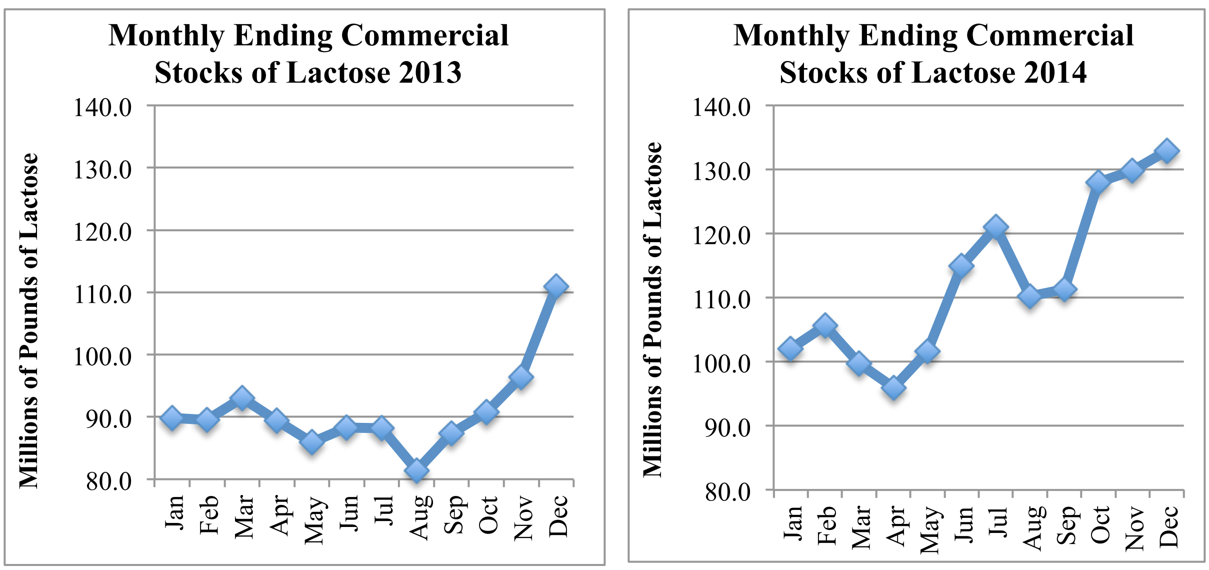


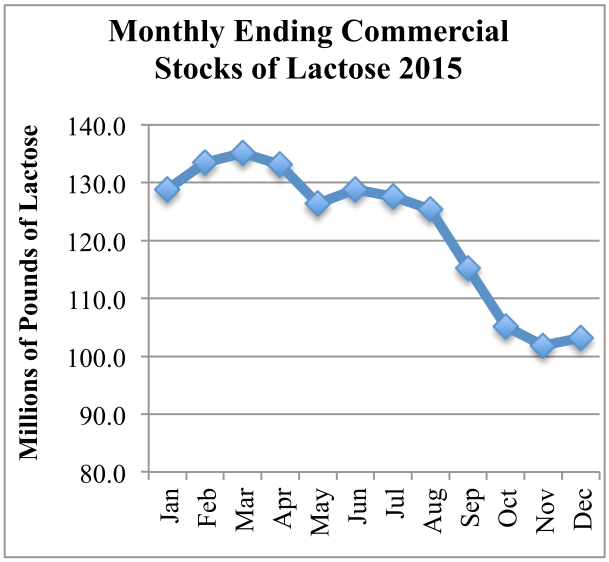
Monthly Ending Commercial Stocks of Lactose

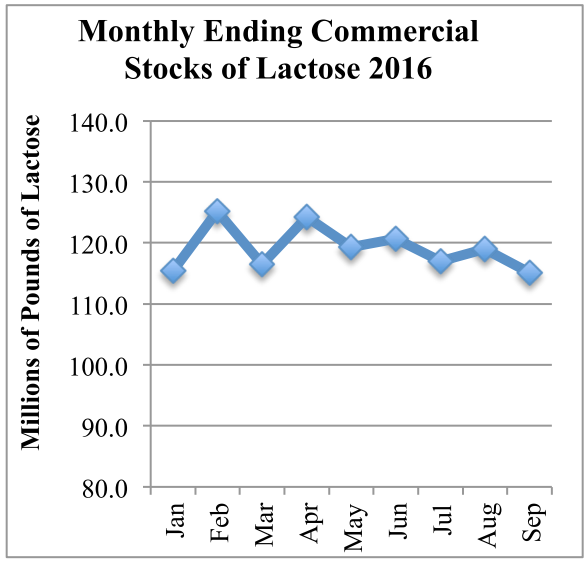
This data was interesting as I found that in 2013, ending commercial stocks of lactose stayed below 110 millions of pounds; however, after September of 2014 ending commercial stocks rose to almost 130 millions of pounds. Throughout 2015, ending commercial stock levels were above, at, or very close to 130 millions of pounds until

September. Levels then decreased to 100-110 millions of pounds, and in 2016 every month has been experiencing alternating increasing/decreasing ending commercial stocks of lactose. 2016 has experienced less volatile ending commercial stock levels than previous years, as ending monthly stocks have stayed around 120 millions of pounds of lactose. Also, in years 2013 and 2014 ending commercial stocks follow a trend of low ending commercial stocks at the beginning of the year, increasing throughout the year, and ending the year with high ending commercial stock levels. In years 2015 and 2016, the apparent trends are different: there were high ending commercial stock levels at the beginning of the year and low amounts at the end of the year. See Figure 12 for more information.

Figure 12





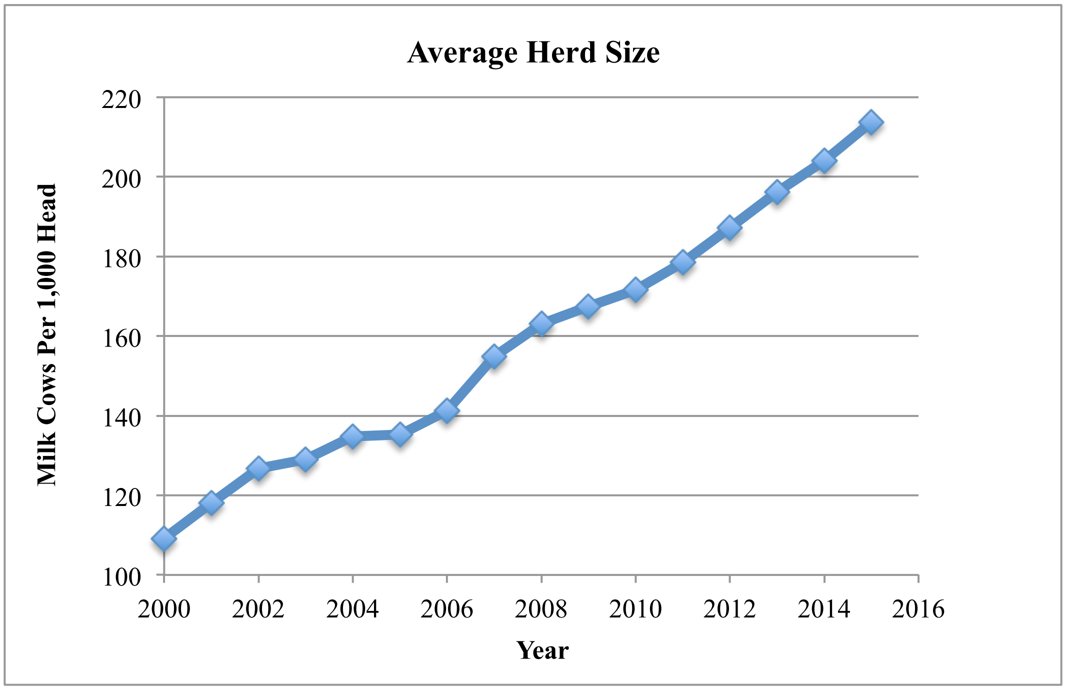


Measures of the Landscape of Dairy Farming

Average Herd Size

The results of this study were very powerful, as it is evident that the U.S. dairy industry is experiencing an increase in the mean dairy herd size. Specifically, the average herd size in 2015 is almost twice as large as it is in 2000. The biggest annual change in average herd size was found from 2006 to 2007 when it rose by 9.70 percent. There were no decreases in average herd size, which leads me to believe that this trend will continue into future years. Also, I found that the population standard deviation is 31.039 milk cows and the mean was 158.215 milk cows. Years 2013, 2014, and 2015 are the only years to have experienced average herd sizes that are more than one standard deviation away from the mean. See Figure 13.

Figure 13



Case Study of Northeast Dairy Farms

When I compiled and analyzed information regarding different herd size categories of dairy operations in the Northeast region, I found that in 2000 the largest percentage of farms had 99 cows or less, the 90-149 cow herd category made up the second largest proportion of dairy operations, the 150-299 cow herd category made up the third largest proportion of dairy operations, and the 300 cows or more category contained the smallest percentage of dairy farms. However, by 2011 the largest proportion of farms made up the 300 cows or more category, the second largest proportion of farms made up the 150-299 cows category, the third largest proportion of farms made up the 90-149 cows category, and the smallest proportion of farms made up the 89 cows or less category.

Also, the fact that Farm Credit East had to change the category thresholds of operation size shows that the dairy industry has had to adjust to larger herd sizes. In both time periods (2000 to 2011) and (2012 to 2015) the only categories that experienced long-term increases were the two largest categories. After 2013, the only category that has been experiencing increases in proportion to other categories has been the 700 cows or more group.

Furthermore, after 2013 the only operation size categories that increased in proportion of farms were the two largest categories (300 to 599 cows and 700 cows or more). Not only did operations with 700 Cows or More increase, but from 2013 to 2014, this proportion of farms increased by 12.4 percent, and from 2014 to 2015, it increased again by 13.3 percent. There appears to be an apparent correlation between the new dairy programs and the number of dairy farms with a large number of cows. Figure 14 displays this information for years 2000 to 2011. Figure 15 displays this information for years 2012 to 2015.

Figure 14

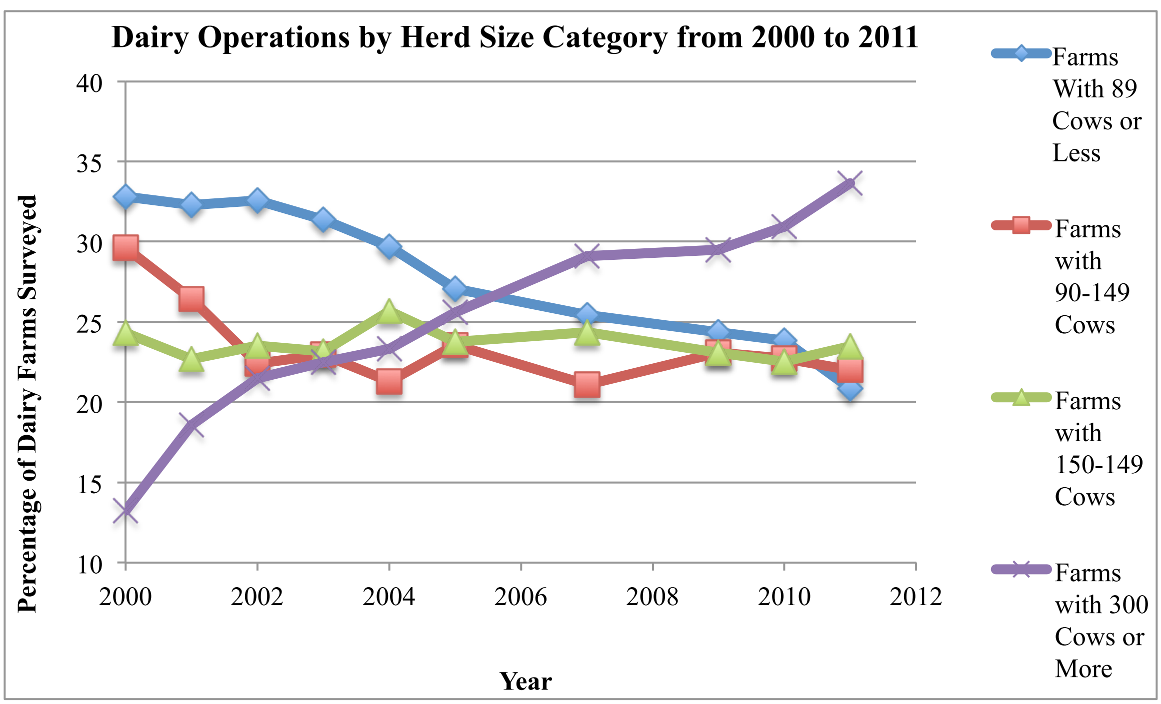
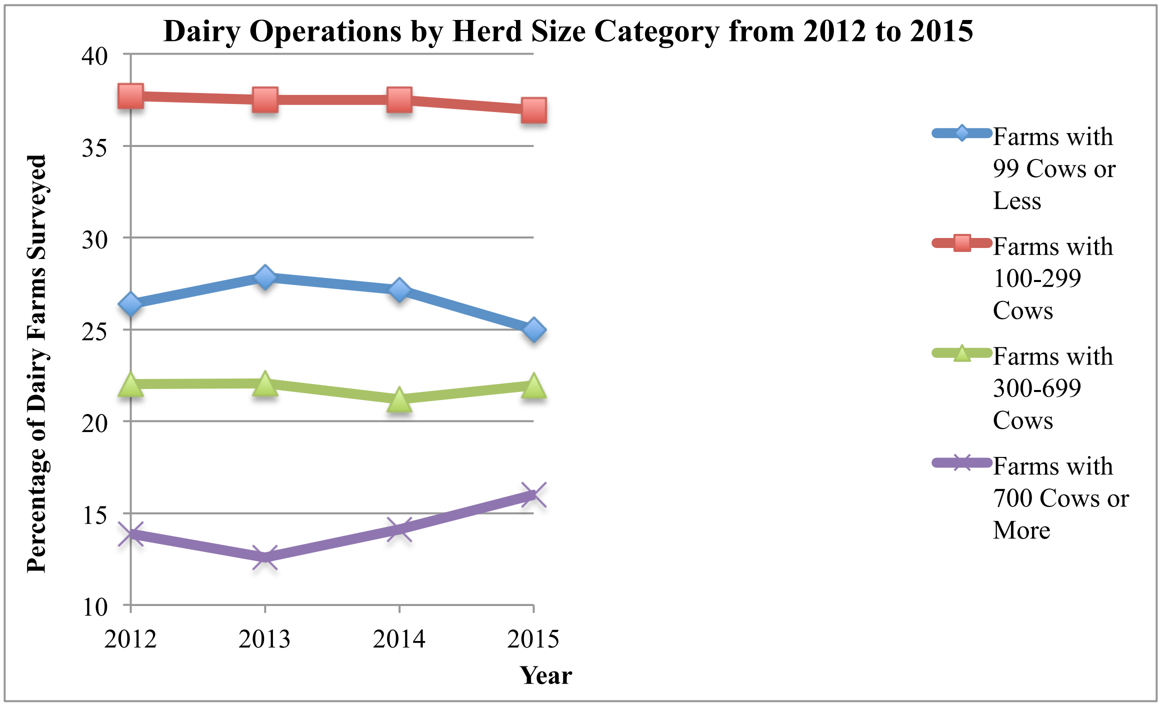


Figure 15



Farming Decisions Resulting From Dairy Policy

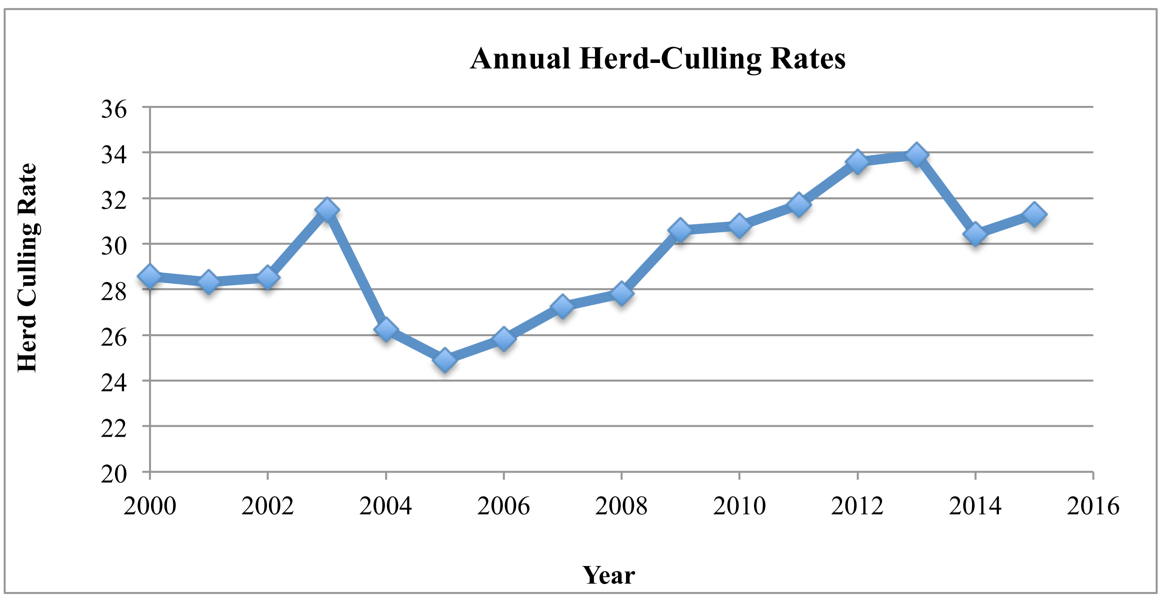
Herd-Culling Rates

Annual Herd-Culling Rates

This data displayed an upward trend of herd-culling rates over the past fifteen years. Dairy Herd Management Magazine published in an online article in 2011 that the recommended herd culling rate is between 20 and 30 percent. The U.S. displayed a healthy herd culling rate or years 2000 to 2008 with the exception of 2003 when the herd cull rate was 31.48 percent. Herd culling rates were very volatile from 2002 to 2005; the average percentage change in herd culling rate was +0.86% from 2000 to 2015; however, from 2002 to 2003 the dairy industry experienced a 10.38 percent increase. From 2003 to 2004 there was a 16.68 decrease, and from 2004 to 2005 there was a 5.03 percent decrease.

From 2009 to 2015, every year had a herd culling rate above 30 percent, the upper bound of the healthy herd-culling rate interval. In addition, there was only one year, 2014 that experienced a significant decrease in herd culling rates. Furthermore, the hypothesis made by MacDonald et al., 2016 that MPP will reduce the financial risk to farmers proves to be true according to my results. Since I found that herd-culling rates in 2014 and 2015 were much lower than that of previous years, I believe that the supply responses of dairy farmers to financial risks has decreased, which is in agreement with MacDonald et al.'s report. See Figure 16.

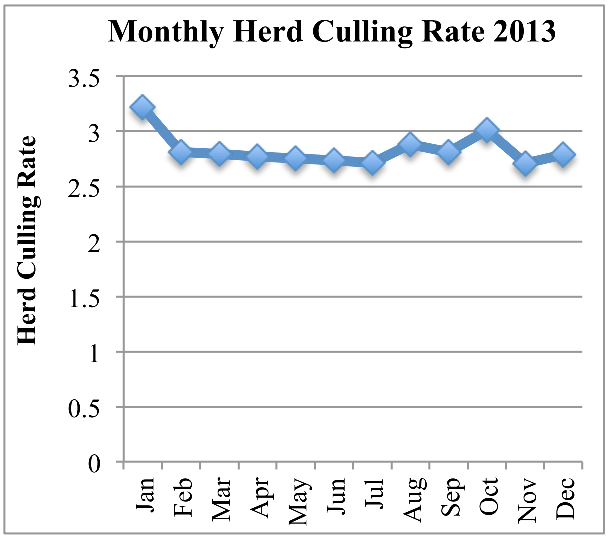
Figure 16

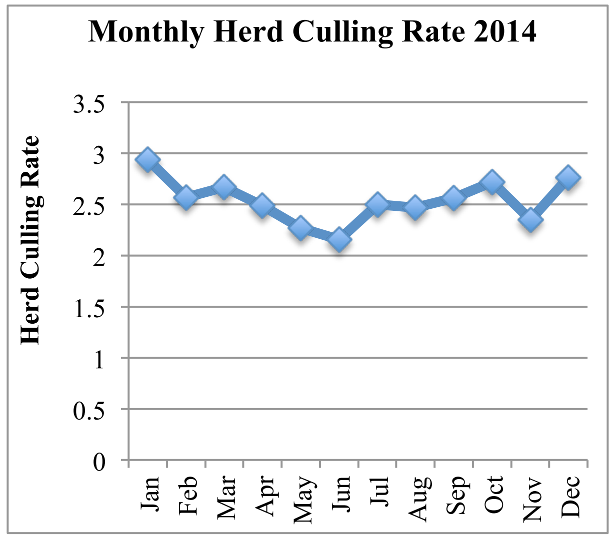


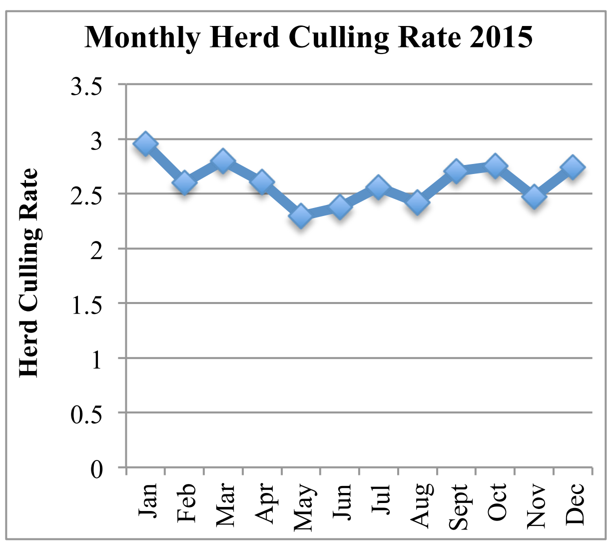
Monthly Herd-Culling Rates

It appears that recent policy change is correlated with a slight decrease in the national herd-culling rate. In 2013, given the available data, I found that the monthly herd culling rate stayed between 2.5 and 3.25 percent, with the average rate being 2.87 percent. In 2014, the average herd culling rate decreased to 2.53 percent, and all data values lied between 2 and 3 percent. By 2015, the average herd culling rate had increased to 2.61 percent and for all months, the herd culling rate was between 2 and 3 percent, similar to 2014. On the other hand, the standard deviation of herd-cull rates for 2014 and 2015 are larger than the standard deviations found in years 2012 and 2013. This information can be found in Figure 17.

Figure 17



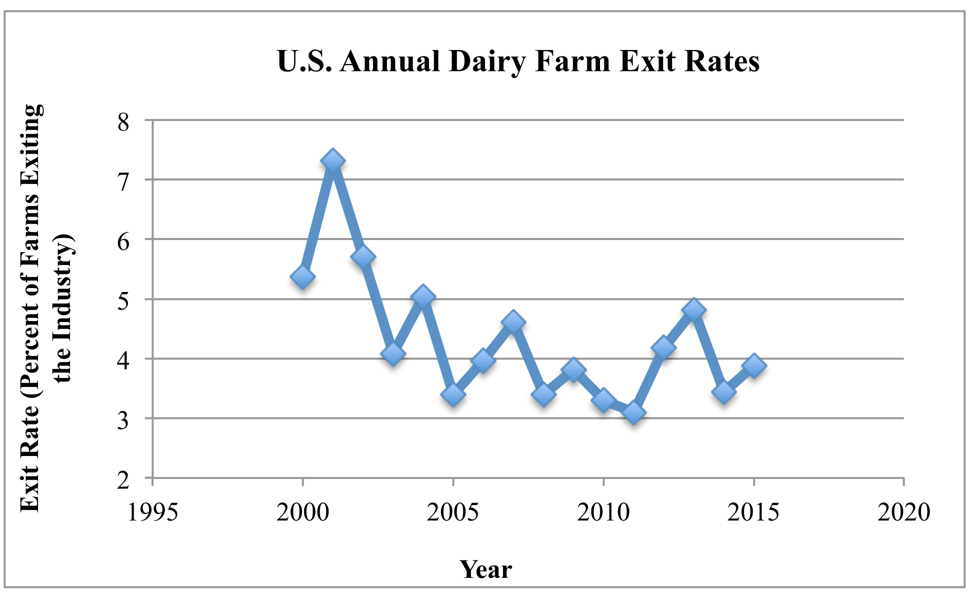




Farm Exit Rates

From 2000 to 2015, the number of dairy operations in the U.S. decreased, as well as the annual farm exit rate. The highest annual farm exit rate occurred from 2000 to 2001 where the number of dairy farms that seized operation was 7.31 percent. The average annual farm exit rate was 4.36 percent, which years 2000, 2001, 2002 and 2004 all exceed. After 2004, the dairy industry had a decline in farm exit rates for one year (2005) before returning to a two-year increase in farm exits (2006 and 2007). Exit rates began to decrease again in 2010, and by 2011 the annual rate of national dairy farm exits was 3.10 percent, the lowest level it reached from 2000 to 2015. Rates decreased again in 2012 and 2013, decreased in 2014, and increased again in 2015. There appears to be a correlation between an increase in farm size and a decrease in farm exit rates. This information is displayed in Figure 18.

Figure 18



Discussion

My research has found that the MILC and DPPSP programs has affected fluid milk waste, excess supply levels of butter and lactose, ending commercial stocks of butter and lactose, the landscape of Northeast dairy farming, herd culling rates, and farm exit rates.

Specifically, the years in which MILC payments were triggered (2002, 2003, 2005, 2006, 2009, 2012) were also the years in which there was increasing percentage changes in the difference between fluid milk marketings and sales. The years in which MILC was being phased out by the government (2000 and 2001) were the same years that there were percentage decreases in the disparity between milk marketings and sales. The old dairy policies of price supports have increased the amount of fluid milk food waste as it has supported a supply for a market that is decreasing in consumer demand.

MILC and DPPSP are also associated with higher excess supply level of butter because four of the years the years (2002, 2003, 2009, 2012), in which MILC payments were triggered are associated with higher levels of excess supply measurements of butter as well as high percentage increases in excess supply of butter. The years in which MILC payments were being eliminated were also the years with low excess supply levels of butter.

Furthermore, I did not find a strong relationship between MILC and excess supply levels of lactose; however, I found that ending annual commercial stocks of butter and lactose were both higher in years in which the MILC and DPPSP programs were in place. During the years with MILC and DPPSP in place (2002 to 2014), ending commercial stocks of butter increased while the years when MILC was being eliminated (2000 and 2001) correlated with low ending commercial stocks of butter. Ending commercial stocks of lactose acted in the same way during these two time periods, leading me to conclude that MILC and DPPSP have increased the surplus of manufactured dairy products. On the other hand, the relationship between MILC and DPPSP and the surplus of butter is much stronger than that of the surplus of lactose. This means that these programs have potential to affect different manufactured dairy products in dissimilar ways, leading to difficulty for manufacturers that produced a variety of goods during this time period, especially since the dairy industry has been experiencing consolidation.

The time period of MILC phase out by the government were also the years with very high increases in the largest farm size category as well as large decreases in the smallest farm size category. This leads me to conclude that the dairy market favors large operations over small operations in the absence of federal subsidies. This is consistent with other studies such as economists Mosheim and Lovell's "Economic Efficiency, Structure, and Scale Economies in the U.S. Dairy Sector, "that have concluded that U.S. dairy farms operate with regards to economies to scale (Mosheim & Lovell, 2016).

Lastly, years with the MILC and DPPSP programs were the same years with high herd culling rates. The years when MILC payments were non-existent were also the years with high farm exit rates. There are many reasons why producers decide to herd their cull as well as exit the industry, so I cannot make any distinct conclusions about the relationship between MILC and producer supply responses.

The New Dairy Policies

My analysis showed that the programs within the 2014 Farm Bill, including MPP and DPDP have led to several major changes in the dairy industry. First, the implementation of MPP and DPDP in late 2014 is correlated with lower levels of disparity between fluid milk marketings and sales. Unfortunately, only data up to 2015 was available for this analysis, so I cannot come to any sound conclusions whether the new Farm Bill has caused this decrease.

Since the new programs have been implemented, I found that these new programs have led to an increase in the surplus of manufactured dairy products as excess supply levels and ending commercial stocks of butter were much higher in 2015 and 2016 than previous years as well. Similarly, the excess supply of lactose and ending commercial stocks of lactose were higher in 2014 and 2015. Even in the absence of price supports, the new federal programs have supported a surplus of both fluid milk and manufactured dairy products.

Since the new dairy programs have been introduced, the average herd size has increased and continues the trend of increasing average herd size in the dairy industry. In 2014, the average herd size rose above 200, the highest herd size ever seen before in the history of the U.S. By 2015, the average herd size had increased by 9.6 cows. There is a very apparent increasing trend in the average dairy herd size, which I believe will continue well into the future; however, since this trend has been occurring since 2000, I am unable to conclude if the new Farm Bill programs are the sole cause of this phenomenon.

The landscape of Northeast dairy farming has also changed with the new dairy programs as the largest farm size category (700 or more cows) has experienced much larger increases than in previous years under the old Farm Bill programs. With the enlarging average herd size and increasing percentage changes in the largest farm size category, the U.S. dairy industry will experience even greater pressure to enlarge individual farm operations, leading to increased stress on land use for dairy cattle feed and expansion for larger sized operations. In return, increased demand for bulk corn, alfalfa, and hay will increase the detrimental environmental effects from conventional crop production as these crops will have to be grown and transported over large distances to reach large dairy operations while the amount of family-sized operations growing their own dairy cattle feed decreases.

To producers, there has been a decrease in incentives to herd cattle as well as new dairy provisions in the time period after MPP and DPDP were implemented. During the time period of previous dairy policy, farmers were hulling their herd in higher numbers than under the new dairy policy. While there are many explanations for herd culling such as age of cow, pregnancy status of cow, temperament of cow, and other reproductive issues, the new policies may have decreased the need to remove cows from farmer's herds. This leads me to conclude that the new dairy provisions, specifically MPP has decreased the financial risks to producers.

In addition, annual farm exit rates increased from 2014 to 2015 so MPP and DPDP may have led to increased farm exit rates. MPP payments were estimated to benefit larger farms more than MILC did. Specifically, small farms received 39 percent of MILC payments while large farms received 9 percent of the benefits (Newton & Kuethe, 2014). Under MPP, small farms receive 38 percent of benefits and 9 percent are received by large farms (Newton & Kuethe, 2014). If large farms receive a higher percentage of benefits under MPP than under MILC, farm exit rates will continue to increase as the remaining small-sized farms receive less governmental support and therefore lower producer margins.

The Margin Protection Program within the newest Farm Bill is a symbol of the modernization of federal dairy policy. With federal price supports no longer in place, farmers will need to expand or diversify their operations to remain competitive in the market. For example, the New Zealand agricultural support system has been successful after eliminating all governmental supports as farmers have diversified their crop production and adopted innovative technology to develop new products that consumers are demanding (Siegel, 2016). In comparison, the U.S. dairy is heavily dependent on the government to sustain dairy product prices and purchases, while consumer demand for some dairy products such as fluid milk is decreasing at a fast rate. Instead of supporting niches within the U.S. dairy market that is no longer being demanded by consumers, dairy farmers should explore diversification options.

Ethanol policy has a heavy influence on the excess supply of butter as well as the landscape of Northeast dairy farming. The years in which ethanol production greatly decreased were also the years in which excess lactose supply levels greatly decreased (2006 and 2011). In addition, the only year (2006) with a decrease in the largest farm size category was also one of the years with very low ethanol production. The Volumetric Ethanol Excise Tax Credit had expired in 2010, causing ethanol production to be much more costly (Duffield et al., 2015). Ethanol production rapidly decreased in 2011, where it stayed low until 2014. Farm Credit East altered their farm size categories in 2012 so it was impossible to study changes in Northeast farming landscape from 2012; however, I would expect for the largest farm size category to decrease during this year as well. Large, conventional dairy farms use corn as a main ingredient in their cattle feed, so when corn prices increase, the costs to dairy farmers increase, leading more large-scale farms to shut down or reduce operation size.

From 2005 to 2008, U.S. ethanol prices tripled as the Energy Policy Act of 2005 signed by president George W. Bush, included a renewable fuel standard that increased the percentage of ethanol used for blending in gasoline as well as a mandate to increase biofuel production (Duffield et al., 2015). During this time period, excess supply of butter and lactose almost doubled, ending commercial stocks of butter increased by 103.41 percent, and ending commercial stocks of lactose increased by 145 percent. The average herd size increased by 20.5 percent during these years, which is the largest increase that occurred for a time period of three years from 2000 to 2015. The proportion of Northeast dairy farms with 89 cows or less decreased by 10 percent whereas farms with 300 cows or more increased by 15 percent. Furthermore, 2005 was the year in which the proportion of large farms surpassed the proportion of small farms in the Northeast region. U.S. policies that encourage ethanol to be used in non-agricultural commodities directly affects dairy surpluses as well as the landscape of modern dairy farming.

The analysis and research performed for this study was subject to a myriad of limitations. First, for the seven different methods performed there were some years in which data was not published and/or collected by the government. Due to this, there were a variety of years without available data to use in this study. Also, this project examined the modern dairy industry by studying years 2000 to 2016. Long-term trends were not fully examined which limits the accuracy of the claims made by long-term policy implications. A large portion of this study focused on the effects of the newest provisions in the 2014 Farm Bill; however, some analyses only had data available up to 2015, such as ending commercial stocks of butter and lactose, average herd size, Northeast dairy farming, and herd culling rates. Due to this restraint, the claims made regarding the implications of the newest dairy provisions may be based upon incomplete information. While I was not able to study the effects of these new federal policies in the long-run, I predict that large farms will prevail over small and medium sized farms, farm exit rates will decrease, and excess supply levels will increase.

Conclusion

This interdisciplinary project is one of the few studies that reviewed industry trends in the newest century as well being one of the few resources that undergraduate students can understand without heavy baseline knowledge of agricultural studies. In conclusion, this research provides insight into the performance of federal dairy programs and how they affect the aggregate U.S. dairy industry. This research is focused, allowing undergraduate students to understand the short-run effects of new dairy policies. The nature of this study, an examination of trends within U.S. dairy data and annual federal policy allows one to acquire a baseline understanding of the recent situation in dairy production. Furthermore, this project was the first case study performed on data from Farm Credit East over a time scale of more than two years.

This project found that old dairy policy, specifically the MILC and DPPSP programs have led to an increase in fluid milk food waste at the consumer level and three out of the four measurements of surplus of manufactured dairy products. These programs have also provided support to small dairy operations that would be driven out of the market in the absence of price supports and indemnity payments. New dairy policy, including the introduction of MPP and DPDP as well as the elimination of MILC and DPPSP are related to decreases in fluid milk food waste, increases in the surplus of manufactured dairy products, and an increase in the proportion of large dairy operations. In addition, ethanol policies, including mandates for increased ethanol production have increased surplus levels of both manufactured dairy products studied in this project, increases in the average annual herd size, and increases in the proportion of large dairy farms.

This study has found that the new programs within the 2014 Farm Bill are better suited to the current landscape of dairy farming, which argues against the hypothesis made by MacDonald et al., 2016. Furthermore, the results of this project show that small and medium dairy operations have experienced the greatest changes from dairy policy changes, which are in disagreement with the hypotheses made in MacDonald et al., 2016.

The MILC and DPPSP programs were federal programs based on target prices while the newest dairy program MPP, is a federal policy focused on farmer profitability and producer margins. To address the issue of consolidation in the U.S. dairy industry by large operations, a policy could be implemented that provides support to farmers based on the size of their farm operation. For example, a subsidy program that allows for small and small-medium farms to receive equal or larger subsidies from the government than large operations would allow family-sized dairy operations to remain competitive in the market. This policy would be supported by many small and family-sized operations that are most typically located in the Midwest and Northeast region, as it would allow them to have more funds to use on their farm, such as installing new technology or furthering their marketing efforts. Critics of this policy would be California dairy farmers, large farms, and governmental leaders that are against "big government."

Furthermore, in MPP the producer margins are based upon average national feed prices. This may actually harm some producers as many smaller farms produce their own cow feed. To address this issue, a provision to MPP could be made that would allow dairy feed prices to be tailored to the individual producer's situation. This would allow producer margins to better reflect all producers. However, this amendment to MPP would be very time-consuming and difficult to ensure accuracy because it is dependent on many variables and factors. If technology was improved upon to create a computer program or mathematical equation that could easily determine the correct producer margin for each operation, then this policy could be feasible to implement within a few years. Many dairy farmers would be supportive of this provision, as it would provide for more equitable benefits from the federal government. Large dairy operations would most likely be critical to these policies as they might argue that it is an overreach of the federal government to provide such specific support and alters the natural fluctuations that would occur in the market if no federal support were present.

After conducting this research, I have found that MPP is a much more progressive and market-based policy than historical dairy programs and policies. It is representative of the modern efforts of policymakers to address the current landscape of dairy farming as it acknowledges that dairy prices are no longer uniform across the country. Furthermore, the nature of MPP signifies a more prevalent governmental response to risks within agriculture and farming. As commercial dairy farming increases, the effects of globalization and market liberalization result in greater risks to farming as farmers are unable to fully predict how these factors will affect their decision-making (Kahan, 2008). To lessen this uncertainty, MPP provides farmers with monetary assistance during times of low milk prices or high production costs. On the other hand, to receive the same coverage as provided in MILC, farmers would need to purchase MPP at higher premiums levels than the baseline premium (Sjostrom, 2014).

The USDA introduced another safety-net measure in 2008 called the Livestock Gross Margin Insurance (LGM-Dairy). While this tool is still available for farmers to enroll in, the USDA prohibits farmers from enrolling in both MPP and LGM-Dairy. LGM-Dairy allows enrolled farmers to receive indemnity payments when feed costs increase or milk prices decrease (USDA, 2015). The LGM-Dairy program is much more complicated than MPP-Dairy; however, it has been performing better in 2015 and 2016 than MPP according to Progressive Dairymen (Mortensen, 2016). The major differences between LGM-Dairy and MPP are that LGM requires this insurance to be purchased by an insurance provider while the government administers MPP (Mortensen, 2016). LGM is also adjusted for the amount of corn, soybean meal, and hay used in individual producer's feed ratios whereas this ratio is fixed in MPP calculations (Mortensen, 2016). Furthermore, MPP requires farmers to sign a contract to participate in MPP from the time they sign up to the end of the Farm Bill, while LGM allows farmers to sign up in contract periods that vary from one month to one year (Mortensen, 2016). It should be noted that LGM-Diary was not examined in this project, as it is not a direct federal governmental program.

To further examine the trends addressed in this study, a similar case study could be done on regions other than Northeast dairy farms. For example, it would be useful to expand this study to include the landscape of California and Midwest dairy farming. In addition, since the number of dairy operations is decreasing yet individual farm size is increasing, it would be interesting to perform a survey on family dairy operations to determine their attitudes and concerns of the future of their individual dairy farms. To address the sustainability and environmental impacts of the modern dairy industry, it would be beneficial to examine the ecological footprints of large, medium, and small sized dairy operations. To do so, one could study various sized operations' energy consumption, land use, greenhouse gas emissions, and transportation trends. Furthermore, this study did not address fiscal spending on the new provisions in the 2014 Farm Bill. It would be useful to compare governmental spending on MPP versus MILC to come to a conclusion regarding the national spending of federal dairy programs.

While the implementation of the new programs in the 2014 Farm Bill the surplus measurements of fluid milk and manufactured products have increased. To decrease these measures, U.S. ethanol policy needs to be restructured. If tax credits for ethanol production prove to cause increases in surpluses of manufactured dairy goods, then the relationship between fuel policy and agricultural surpluses needs to be studied and addressed.

After completing this project, I am unsure if dairy policy should continue or not. On one hand, I believe price supports have caused consolidation in the dairy industry to increase at a faster rate, ultimately pushing family farms out of business. On the other hand, dairy policies have increased the livelihood of small-scale farmers and have supported them during times of economic hardship. While I cannot make a precise conclusion in favor or against dairy policy, many dairy farmers are questionable as to where the dairy industry will end up as well.

Under President Donald Trump, the future of agriculture is uncertain. Trump's recent immigration laws threaten all agricultural producers that rely heavily on immigrant labor. Many individuals working on dairy farms are undocumented workers, and if those workers are deported under the president's new laws, it will make it very difficult for farmers to be able to find workers that are willing to perform those duties at wages as low as $13 per hour (Good, 2017). For example, 80 percent of hired workers on a large operation in Wisconsin are undocumented immigrants, and in California this percentage is higher (Good, 2017). If those laborers are no longer allowed to work in the U.S. it is very possible that those dairy operations will have to shut down because they would not be able to find inexpensive labor.

Congress has also terminated the Trans Pacific Partnership and President Trump has no intentions of negotiating in favor of it. This coupled with Trump's promise to deconstruct NAFTA, have caused experts to predict that dairy exports will decline. The U.S. exports 15 percent of aggregate milk supply, and is the third largest exporter of dairy, following the EU and New Zealand (Stephenson, 2015). If President Trump destroys NAFTA, Mexico and Canada will import dairy from the EU and New Zealand, which would be detrimental to the U.S. as Mexico is the biggest importer of U.S. dairy goods.

On the other hand, the dairy industry is expected to thrive throughout the remainder of 2017 (Tomson, 2016). The demand for fluid milk is decreasing due to the recent increase in popularity of fluid milk substitutes such as almond and soymilk but the demand for butter and whole milk products such as whole-fat sour cream and whole-fat yogurt are increasing (Tomson, 2016). Americans are realizing that milk fat itself is not unhealthy, thus increasing the demand for these products. With this trend, I hypothesize that milk producers will choose to diversify production on their own terms, which will only be supported by the decrease in support by the federal government that will occur under the new administration. If the U.S. follows in the footsteps of New Zealand, this could be very beneficial to dairy producers but will also harm those family farms that have relied on fluid milk sales for years.

While the future is unclear, I conclude with the belief that de-regulation could be beneficial to the dairy industry in the long-term but not in the short-term. The government, since the early 1930s has ruled the U.S. dairy industry. Does the U.S. dairy industry indeed, Got Milk? Or is this simply result of the government?

Appendix

Appendix I – Disparity Between Fluid Milk Marketings and Sales

Year	Disparity Between Fluid Milk Marketings and Sales (In Millions of Pounds)	Percentage Change From Previous Year
2000	110,659	
2001	109,191	-1.327
2002	113,880	4.294
2003	114,405	0.461
2004	115,200	0.695
2005	121,188	5.198
2006	125,910	3.896
2007	129,983	3.235
2008	134,449	3.436
2009	133446	-0.746
2010	137,019	2.677
2011	141,119	2.992
2012	146,361	3.715
2013	148,084	1.178
2014	154,427	4.283
2015	157,739	2.145

Appendix II- Excess Supply of Butter

Annual Excess Supply of Butter

Year	**Excess Supply of Butter (in millions of pounds)**
2000	16.9
2001	10.0
2002	139.7
2003	106.2
2004	1.1
2005	36.8
2006	89.1
2007	138.1
2008	106.3
2009	140.8
2010	79.2
2011	96.6
2012	137.8
2013	100.7
2014	80.6
2015	113.7

Appendix III- Excess Supply of Lactose

Annual Excess Supply of Lactose

Year	Excess Supply of Lactose in Millions of Pounds
2000	20.3
2001	19.5
2002	35.6
2003	35.4
2004	63.6
2005	40.2
2006	27.7
2007	56.9
2008	80.9
2009	37.4
2010	62.2
2011	51.0
2012	81.8
2013	98.4
2014	120.5
2015	90.5

Appendix IV- Ending Commercial Stocks of Butter

Annual Ending Commercial Stocks of Butter

Year	Annual Ending Commercial Stocks of Butter (in millions of pounds)
2000	24.0
2001	55.5
2002	157.3
2003	93.4
2004	44.9
2005	58.5
2006	108.5
2007	155.1
2008	119.0
2009	133.0
2010	81.7
2011	106.9
2012	153.0
2013	112.5
2014	104.7
2015	155.1

Appendix V- Ending Commercial Stocks of Lactose

Annual Ending Commercial Stocks of Lactose

Year	Annual Ending Commercial Stocks of Lactose (in millions of pounds)
2000	29.9
2001	31.1
2002	45.5
2003	49.6
2004	74.3
2005	51.7
2006	39.7
2007	69.5
2008	97.1
2009	55.6
2010	81.3
2011	68.4
2012	94.3
2013	110.9
2014	132.9
2015	103.1

Appendix VI- Average Herd Size

Year	Average Herd Size	Annual Percentage Change
2000	109.15	---
2001	118.09	8.19%
2003	129.07	1.76%
2004	134.82	4.46%
2005	135.29	0.35%
2006	141.18	4.35%
2007	154.88	9.70%
2008	163.06	5.28%
2009	167.50	2.72%
2010	171.61	2.45%
2011	178.59	4.07%
2012	187.16	4.80%
2013	196.30	4.88%
2014	204.15	4.00%
2015	213.77	4.71%

Appendix VII- Case Study of Northeast Dairy Farms

Year	Percent of Farms with 89 Cows or Less	Percent of Farms with 90-149 Cows	Percent of Farms with 150-299 Cows	Percent of Farms with 300 Cows or More
2000	32.8%	29.64%	24.31%	13.24%
2001	**-1.6%** 32.29%	**-10.9%** 26.42%	**-6.6%** 22.70%	**+40.4%** 18.59%
2002	**+0.9%** 32.59%	**-15.2%** 22.41%	**+3.6%** 23.52%	**+15.5%** 21.48%
2003	**-3.7%** 31.39%	**+2.6%** 22.98%	**-1.5%** 23.16%	**+4.6%** 22.47%
2004	**-5.4%** 29.69%	**-7.3%** 21.31%	**+10.9%** 25.68%	**+3.8%** 23.32%
2005	**-8.8%** 27.09%	**+10.6%** 23.56%	**-7.5%** 23.56%	**+9.8%** 23.75%
2006	--	--	--	--
2007	25.45%	21.09%	24.36%	29.09%
2008	--	--	--	--
2009	24.36%	23.08%	23.08%	29.49%
2010	**-2.1%** 23.85%	**-1.6%** 22.71%	**-2.4%** 22.52%	**+4.8%** 30.92%
2011	**-12.5%** 20.86%	**-3.2%** 21.99%	**+4.3%** 23.50%	**+8.8%** 33.65%
	Percent of Farms with 99 Cows or Less	**Percent of Farms with 100-299 Cows**	**Percent of Farms with 300-599 Cows**	**Percent of Farms with 700 Cows or More**
2012	26.39%	37.70%	22.02%	13.89%
2013	**+5.5%** 27.85%	**-0.5%** 37.52%	**+0.1%** 22.05%	**-9.5%** 12.57%
2014	**-2.4%** 27.17%	**-0.1%** 37.5%	**-3.9%** 21.20%	**+12.4%** 14.13%
2015	**-7.8%** 25.05%	**-1.4%** 36.96%	**+3.7%** 21.97%	**+13.3%** 16.02%

Appendix VIII- Herd Culling Rates

Annual Herd Culling Rates

Year	Herd-Culling Rate	Annual Percentage Change
2000	28.57%	--
2001	28.33%	-0.84%
2002	28.52%	+0.67%
2003	31.48%	+10.38%
2004	26.23%	-16.68%
2005	24.91%	-5.03%
2006	25.83%	+3.69%
2007	27.26%	+5.54%
2008	27.82%	+2.05%
2009	30.6%	+9.99%
2010	30.79%	+0.62%
2011	31.7%	+2.96%
2012	33.59%	+5.96%
2013	33.89%	+0.89%
2014	30.42%	-10.24%
2015	31.29%	+2.86%

Appendix VII- Farm Exit Rates

Year	Number of Operations with Milk Cows	Number of Exited Operations from Previous Year	Annual Farm Exit Rate
2000	105,250	5,970	5.37%
2001	97,560	7,690	7.31%
2002	91,990	5,570	5.71%
Year	**Number of Licensed Dairy Herds (in thousands)**	**Number of Exited Dairy Herds from Previous Year**	**Annual Farm Exit Rate**
2003	70,380	N/A	N/A
2004	66,830	3,545	5.04%
2005	64,555	2,275	3.40%
2006	61,990	2,565	3.97%
2007	59,140	2,855	4.61%
2008	57,130	2,008	3.40%
2009	54,940	2,185	3.82%
2010	53,130	1,815	3.30%
2011	51,481	1,646	3.10%
2012	49,331	2,150	4.18%
2013	46,960	2,371	4.81%
2014	45,344	1,616	3.44%
2015	43,584	1,760	3.88%

Bibliography

Agriculture & Horticulture Development Board. (n.d.). Cow culling. Retrieved March 30, 2017, from https://dairy.ahdb.org.uk/technical-information/animal-health-welfare/cow-culling/#.WNmqpBLytp8

Allen, T., Cancel, N., & Orduna, G. (2015). Food systems, sustainability and climate change. Retrieved March 12, 2017, from https://kb.wisc.edu/dairynutrient/375fsc/page.php?id=48783

Alston, J. M., & James, J. S. (2002). The incidence of agricultural policy. *Handbook of Agricultural Economics*, *2*, 1689-1749

Babcock, B. A. (2008). Breaking the link between food and biofuels.

Bakst, D., Sewell, J., & Wright, B. (2016). *Addressing risk in agriculture*. Retrieved from http://www.heritage.org/research/reports/2016/09/addressing-risk-in-agriculture

Bartlett, R.W. (1976). What government price policies for the dairy industry? *Illinois Agricultural Economics, 16(3)*, 23-25.

Blank, S. (1998), *The end of agriculture in the American portfolio*, Quorum Books, New York, NY

Bollard, A., & Jones, M. (2007). Commodities, dairy prices and the New Zealand Economy. *Speech by Alan Bollard to the Waikato Grasshoppers.* Retrieved from the Reserve Bank of New Zealand Web site: http://www.rbnz.govt.nz/-/media/ReserveBank/Files/Publications/Speeches/2007/3037373.pdf

Bolotova, Y.V., & Novakovic, A.M. (2014). An analysis of pricing in the United States dairy industry [PDF document]. Retrieved from University of Minnesota Ag Econ Search Web site: http://ageconsearch.umn.edu/bitstream/169752/2/AAEA2014%20Poster%234787%20An%20Analysis%20of%20Pricing%20in%20the%20U.S.%20Dairy%20Industry.pdf

Borders, M., & Burnett, S. (2007). The environmental costs of ethanol. Retrieved March 30, 2017, from http://www.ncpa.org/pub/ba591

Bozic, M., & Novakovic, A. (2014). Contemporary issues in economics of dairy markets and policy. *Journal of Agribusiness*, *32*(2).

Bozic, M., Newton, J., Novakovic, A. M., Stephenson, M. W., & Thraen, C. S. (2014). The Dairy Subtitle of the Agricultural Act of 2014. *Information Letter Series*, (14-01).

Brett, J. (2011). What is the ideal culling rate? Retrieved March 30, 2017, from http://www.dairyherd.com/dairy-herd/what-is-the-ideal-culling-rate-114038209.html

Carnegie Institution. (2010, May 4). Carbon dioxide's effects on plants increase global warming, study finds. Retrieved March 30, 2017, from https://www.sciencedaily.com/releases/2010/05/100503161435.htm

Casavant, K. L., Denicoff, M. R., Jessup, E., Taylor, A., Nibarger, D., Sears, D., ... & Olowolayemo, S. (2010). Study of rural transportation issues. The U.S. Department of Transportation. Retrieved from the U.S. Department of Agriculture, The Agricultural Marketing website: https://www.ams.usda.gov/sites/default/files/media/RTIFullReport.pdf

Chidmi, B., Lopez, A., Cotterill, R. 2005. Retail oligopoly power, dairy compact, and Boston milk prices. *Agribusiness* 21, 477-491.

Cropp, R.A., & Jesse, E.V. (1994). *USDA's recommended decision on replacing the MW price.* University of Wisconsin Madison, Department of Agricultural Economics.

Dairy Farmers of Canada. "The History of Milk." *The History of Milk*. N.p., n.d. Web. 25 Mar. 2017.

Dalal, R. (2012). *The illustrated timeline of the history of the world*. New York: Rosen.

Debreu, G. (1974). Excess demand functions. *Journal of Mathematical Economics 1(1), 15-21.*

Dixon, B. L., Berry, C. R., & Susanto, D. (1991). Supply impact of the milk diversion and dairy termination programs. *American Journal of Agricultural Economics*, *73*(3), 633-640.

Duffield, J. A., Johansson, R., & Meyer, S. (2015). US Ethanol: An examination of policy, production, use, distribution, and market interactions.

Environmental Defense Fund. (n.d.). Methane: The other important greenhouse gas. Retrieved March 30, 2017, from https://www.edf.org/methane-other-important-greenhouse-gas

Erba, E., & Novakovic, A. M. (1995). *The evolution of milk pricing and government intervention in dairy markets* (Vol. 95, No. 5). Department of Agricultural, Resource, and Managerial Economics, College of Agriculture and Life Sciences, Cornell University.

Farm Credit East. (2001). Northeast 2000 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2002). Northeast 2001 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2003). Northeast 2002 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2004). Northeast 2003 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2005). Northeast 2004 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2006). Northeast 2005 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2007). Northeast 2006 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2008). Northeast 2007 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2009). Northeast 2008 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2010). Northeast 2009 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2011). Northeast 2010 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2012). Northeast 2011 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2013). Northeast 2012 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2014). Northeast 2013 dairy farm summary. Retrieved from Farm Credit East

Farm Credit East. (2015). Northeast 2014 dairy farm summary. Retrieved from Farm Credit East

Farma, E. F. (1998). Market efficiency, long-term returns, and behavioral finance. *Journal of Financial Economics, 49(3),* 6-12.

Frederick, A. L. (2014). Agriculture and Food Act of 1981 a summary of the major provisions with comments and interpretation. University of Nebraska- Lincoln Extension, Nebraska Cooperative Extension Service.

Frye, C. (2016). Focus on food waste: What can dairy do? Retrieved March 12, 2017, from http://www.idfa.org/news-views/headline-news/article/2016/02/04/focus-on-food-waste-what-can-dairy-do

Gee, K. (2016). America's dairy farmers dump 43 Million gallons of excess Milk. Retrieved April 10, 2017, from https://www.wsj.com/articles/americas-dairy-farmers-dump-43-million-gallons-of-excess-milk-1476284353

Glauben, T., Tietje, H., & Weiss, C. (2003). Agriculture on the move: Exploring regional differences in farm exit rates. *Department of Food Economics and Consumption Studies, University of Kiel*.

Good, K. (2017, March 21). Immigration policy: Rural and agricultural Concerns. Retrieved from https://farmpolicynews.illinois.edu/2017/03/immigration-policy-rural-agricultural-concerns/

H.R. 6955. 97th Congr., U.S. G.P.O (1982) (enacted). http://socialwelfare.library.vcu.edu/eras/great-depression/beginning-of-great-depression-stoc

"Instock fights food waste by creating meals our of food surplus." (n.d.). Retrieved March 12, 2017, from https://www.instock.nl/en/food-waste/

Jesse, E., & Cropp, B. (2008). Basic milk pricing concepts for dairy farmers. *Retrieved from https://learningstore.uwex.edu/Assets/pdfs/A3379.pdf*

Kahan D (2008) Managing risk in farming. Farm Management Extension Guide. Rome: Food and Agriculture Organization of the United Nations.

Lipton, K. L., & Pollack, S. L. The U.S. Department of Agriculture. Economic Research Service. (n.d.). Major agricultural and trade legislation. Retrieved from https://www.ers.usda.gov/webdocs/publications/aib729/32945_aib729a3_002.pdf

Lynch, L. & Pollack, S.L. (1991). *Provisions of the Food, Agriculture, Conservation, and Trade Act of 1990.* U.S. Department of Agriculture, Economic Research Service.

MacDonald, J. M., Cessna, J., & Mosheim, R. (2016). Changing structure, financial risks, and government policy for the US dairy industry. *Economic information Bulletin; no. 205*.

Manchester, A. C., & Blayney, D. P. (2001). Milk pricing in the United States, Agriculture Information Bulletin No. 761. Retrieved from the U.S Department of Agriculture, Economic Research Service website: https://www.ers.usda.gov/webdocs/publications/aib761/15259_aib761fm_1_.pdf

Manchester, A., Weimar, M., & Fallert, R. (1994). The U.S. dairy pricing system. U.S Department of Agriculture, Economic Research Service. Retrieved from the U.S. Department of Agriculture, National Agricultural Library website: https://naldc.nal.usda.gov/naldc/download.xhtml?id=CAT10662825&content=PDF

Margin Protection Program for Dairy, 7 CFR 1430, (2016).

Mark, T.B., Burdine, K.H., Cessna, J., & Dohlman, E. (2016). *The effects of the Margin Protection Program for dairy producers.* Washington, D.C.: U.S. Department of Agriculture, Economic Research Service.

McFall, R. J. (1925). The farmer's foreign market. *The Annals of the American Academy of Political and Social Science*, 129-155.

Morrigan, M. (n.d.). Trashing our Food: The costs of food waste in America and what we can do about it. Retrieved March 12, 2017, from https://csf.uw.edu/project/499

Mortensen, R. (2016). Blog: LGM-Dairy's performance outshines MPP this year. Retrieved March 30, 2017, from http://www.progressivedairy.com/blogs/guest-blog/blog-lgm-dairy-s-performance-outshines-mpp-this-year

Mosheim, R., & Lovell, C. K. (2006). Economic efficiency, structure and scale economies in the US dairy sector. In Annual meetings of the American Economic Association, Long Beach, CA.

National Milk Producers Federation. (2014). *2014 Farm Bill – Summary of dairy title provisions.* Retrieved from http://www.org/files/file/Farm-Bill-Dairy-Title-Summary-012814.pdf

Newton, J., & Kuethe, T. (2014). Mapping the size of dairy safety net programs: Comparing MILC and the Margin Protection Program. farmdoc daily.

Newton, J., Thraen, C., & Bozic, M. (2013). Actuarially fair or foul? Asymmetric Information Problems in Dairy Margin Insurance. In *Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting and Market Risk Management. St Louis, MO.*

Nicholson, C. F., & Stephenson, M. W. (2014). Dynamic market impacts of the dairy Margin Protection Program. *Journal of Agribusiness*, *32*, 2.

Novak, J. L., Pease, J. W., & Sanders, L. D. (2015). *Agricultural Policy in the United States: Evolution and Economics* (Vol. 13). Routledge.

Novakovic, A. (1982). Implications of the Omnibus Budget Reconciliation Act of 1982 for the dairy industry with special reference to the cheese subsector. Retrieved from http://publications.dyson.cornell.edu/research/researchpdf/sp/1982/Cornell-Dyson-sp8228.pdf

Progressive Dairyman. (2016). [Map illustration of U.S. dairy statistics] *2015 U.S. dairy statistics.* Retrieved from http://www.progressivepublish.com/downloads/2016/general/2015_pd_stats_lowres.pdf

Raghunathan, U. (2014). The impact on the milk supply response to MPP-Dairy. *Journal of Agribusiness*, *32*, 2.

Richardson, R.W., Anderson, D.P., & Smith, E. G. (1999). *A brief summary of U.S. farm program provisions.* Texas A & M University. Department of Agricultural Economics.

Rojko, A.S. (1953). An application of the use of economic models to the dairy industry. *Journal of Farm Economics*, 35: 834-849.

Schwart, R.B., Knutson, R.D., Cropp, R., Harris, H.M., Jacobson, R.E., & Novakovic, A. (1988). *Dairy price and income support policy.* Retrieved from Texas A&M, Texas Agricultural Experiment Station Web site: http://oaktrust.library.tamu.edu/handle/1969.1/146698

Shields, D. A. (2009). Dairy Market and Policy Issues. Washington, D.C.: Congressional Research Service, Library of Congress.

Shields, D. A. (2010). Consolidation and concentration in the US dairy industry. *Congressional Research Service Report*, *41224*.

Siegel, J. (2016, September 22). New Zealand farmers thrive without government subsidies. Retrieved March 16, 2017, from http://dailysignal.com/2016/09/22/what-happened-when-new-zealand-got-rid-of-government-subsidies-for-farmers/

Sjostrom , L. (2014). What's the worst that could happen under MPP-Dairy? Retrieved March 30, 2017, from http://www.dairyherd.com/news/what%E2%80%99s-worst-could-happen-under-mpp-dairy

Stephenson, M. (2010). *Milk price discovery – alternatives to the current product price formulas*. Cornell Program on Dairy Markets & Policy. Retrieved from http://articles.extension.org/pages/11284/milk-price-discovery-alternatives-to-the-current-product-price-formulas

Stephenson, M. (2015). How the U.S. became a major dairy exporter. Retrieved March 30, 2017, from http://hoards.com/article-16440-how-the-us-became-a-major-dairy-exporter.html

Stillman, R., Blayney, D., Miller, J., & Crawford, T. (1995). The US dairy industry.

The Social Welfare Project. (2011). Stock market crash of October 1929. Retrieved from

Thraen, C., & Newton, J. (2014). The dairy safety net debate part III: The compromise dairy safety net solution. Retrieved March 16, 2017, from http://farmdocdaily.illinois.edu/2014/02/dairy-safety-net-debate-part3.html

Tomson, B. (2016). U.S. dairy industry seen bouncing back in 2017. Retrieved March 30, 2017, from https://www.agri-pulse.com/articles/7948-u-s-dairy-industry-seen-bouncing-back-in-2017

Tyner, W. E. (2010). The integration of energy and agricultural markets. *Agricultural Economics*, *41*(s1), 193-201.

Union of Concerned Scientists. (n.d.). The hidden costs of fossil fuels. Retrieved April 12, 2017, from http://www.ucsusa.org/clean-energy/coal-and-other-fossil-fuels/hidden-cost-of-fossils#.WO7O9hiZOfU

U.S. Department of Agriculture. (1984). *History of agricultural price-supports and adjustment programs, background for 1985 farm legislation*. Retrieved from https://naldc.nal.usda.gov/download/CAT10842840/PDF

U.S. Department of Agriculture. (2015). *Livestock gross margin insurance dairy cattle.* Retrieved from http://www.rma.usda.gov/pubs/rme/lgmdairy.pdf

U.S. Department of Agriculture. Agricultural Marketing Service. (1963*). Compilation of Agricultural Marketing Agreement Act of 1937.* Retrieved from https://naldc.nal.usda.gov/naldc/download.xhtml?id=CAT87209257&content=PDF

U.S. Department of Agriculture. Agricultural Marketing Service. (2010). Dairy Production Stabilization Act of 1983 (7. U.S.C. 4501-4514). Retrieved from https://www.ams.usda.gov/sites/default/files/media/Dairy%20Production%20Stabilization%20Act.pdf

U.S. Department of Agriculture. Agricultural Marketing Service. (2016). *Speech by Amanda Steeneck, Agricultural Economits, Agricultural Outlook Forum 2016*. Retrieved from http://ageconsearch.umn.edu//handle/236588

U.S. Department of Agriculture. Economic Research Service. (1996). *1996 Farm Bill*. Retrieved from https://www.ers.usda.gov/webdocs/publications/aib729/32943_aosupp_002.pdf

U.S. Department of Agriculture. Farm Service Agency. (2006). *Milk Income Loss Contract Program*. Retrieved from https://www.fsa.usda.gov/Internet/FSA_File/milc06.pdf

U.S. Department of Agriculture. Farm Service Agency. (2014). *2014 Farm Bill fact sheet Dairy Product Donation Program*. Washington, D.C.: Author.

U.S. Department of Agriculture. Farm Service Agency (n.d.a). Commodity Credit Corporation. Retrieved from https://www.fsa.usda.gov/about-fsa/structure-and-organization/commodity-credit-corporation/index

U.S. Department of Agriculture. Farm Service Agency. (n.d.b) Dairy Margin Protection Program. Retrieved from https://www.fsa.usda.gov/programs-and-services/Dairy-MPP/index

U.S. Department of Agriculture. Food and Nutrition Service. (2013). History and background. Retrieved from http://www.fns.usda.gov/fdd/fdd-history-and-background#1935_- Section_32_of_the_Agriculture_Act_of_1935)

U.S. Department of Agriculture. National Agricultural Statistics Service. (2001). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2000s/2001/LiveSlauSu-03-02-2001.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2002). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2000s/2002/LiveSlauSu-03-01-2002.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2003). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2000s/2003/LiveSlauSu-03-07-2003.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2004). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2000s/2004/LiveSlauSu-05-04-2004.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2005). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2000s/2005/LiveSlauSu-03-04-2005.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2006). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2000s/2006/LiveSlauSu-03-06-2006_revision.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2007). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2000s/2007/LiveSlauSu-03-02-2007.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2008). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2000s/2008/LiveSlauSu-03-07-2008_revision.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2009). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2000s/2009/LiveSlauSu-03-06-2009.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2010). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2010s/2010/LiveSlauSu-04-29-2010_new_format.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2011). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2010s/2011/LiveSlauSu-04-25-2011.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2012). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2010s/2012/LiveSlauSu-04-23-2012.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2013). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2010s/2013/LiveSlauSu-04-22-2013.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2014). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2010s/2014/LiveSlauSu-04-21-2014.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2015). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2010s/2015/LiveSlauSu-04-27-2015.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2016). Livestock slaughter annual summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/LiveSlauSu//2010s/2016/LiveSlauSu-04-27-2016.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2001). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2000s/2001/MilkProd-02-16-2001.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2002). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2000s/2002/MilkProd-02-15-2002.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2003). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2000s/2003/MilkProd-02-14-2003.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2004). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2000s/2004/MilkProd-02-17-2004.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2005). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2000s/2005/MilkProd-02-18-2005.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2006). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2000s/2006/MilkProd-02-17-2006.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2007). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2000s/2007/MilkProd-02-16-2007.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2008). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2000s/2008/MilkProd-02-15-2008.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2009). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2000s/2009/MilkProd-02-19-2009.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2010). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2010s/2010/MilkProd-02-19-2010.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2011). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2010s/2011/MilkProd-02-18-2011.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2012). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2010s/2012/MilkProd-02-17-2012.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2013). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2010s/2013/MilkProd-02-20-2013.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2014). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2010s/2014/MilkProd-02-20-2014.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2015). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2010s/2015/MilkProd-02-20-2015.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2016). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2010s/2016/MilkProd-02-19-2016.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2017). Milk production. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProd//2010s/2017/MilkProd-02-21-2017.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2001). Milk production, disposition and income 2000 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2000s/2001/MilkProdDi-04-25-2001.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2002). Milk production, disposition and income 2001 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2000s/2002/MilkProdDi-04-25-2002.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2003). Milk production, disposition and income 2002 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2000s/2003/MilkProdDi-04-24-2003.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2004). Milk production, disposition and income 2003 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2000s/2004/MilkProdDi-04-28-2004.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2005). Milk production, disposition and income 2004 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2000s/2005/MilkProdDi-04-28-2005.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2006). Milk production, disposition and income 2005 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2000s/2006/MilkProdDi-04-27-2006.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2007). Milk production, disposition and income 2006 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2000s/2007/MilkProdDi-04-27-2007.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2008). Milk production, disposition and income 2007 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2000s/2008/MilkProdDi-04-25-2008.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2009). Milk production, disposition and income 2008 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2000s/2009/MilkProdDi-05-29-2009.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2010). Milk production, disposition and income 2009 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2010s/2010/MilkProdDi-04-29-2010.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2011). Milk production, disposition and income 2010 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2010s/2011/MilkProdDi-04-27-2011.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2012). Milk production, disposition and income 2011 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2010s/2012/MilkProdDi-04-25-2012.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2013). Milk production, disposition and income 2012 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2010s/2013/MilkProdDi-04-25-2013.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2014). Milk production, disposition and income 2013 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2010s/2014/MilkProdDi-04-29-2014.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2015). Milk production, disposition and income 2014 summary. Retrieved from http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2010s/2015/MilkProdDi-04-30-2015.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2016). Milk production, disposition and income 2015 summary http://usda.mannlib.cornell.edu/usda/nass/MilkProdDi//2010s/2016/MilkProdDi-04-28-2016.pdf

U.S. Department of Agriculture. National Agricultural Statistics Service. (2011). Price program: History, concepts, methodology, analysis, estimates, and dissemination. Retrieved from https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Prices/Price_Program_Methodology_v11_03092015.pdf

U.S. Department of Agriculture, Rural Development. (2005). *Cooperatives in the dairy industry: Cooperative information report.* Retrieved from: https://www.rd.usda.gov/files/cir1-16.pdf

U.S. Department of Agriculture. Senate Judiciary Committee. (2009). *Statement by Joseph W. Glauber, chief economist, U.S. Department of Agriculture before the Senate Judiciary Committee September 19, 2009.* Retrieved from http://www.usda.gov/documents/9_19_09_Glauber_Cheif_Economist_Senate_Judiciary.pdf

U.S. Energy Information Administration. (2016, April 1). What is U.S. electricity generation by energy source? Retrieved March 30, 2017, from https://www.eia.gov/tools/faqs/faq.php?id=427&t=3

U.S. Senate Agriculture, Nutrition and Forest Committee. (2008). *Farm Bill: Investments for the future.* Washington D.C.: Author.

United States Tariff Commission. (1956). Operation of the Trade Agreements Program. Retrieved from https://www.usitc.gov/publications/332/otap_9_optimized.pdf

Vogliano, C., & Brown, K. (2016). The State of America's wasted food and opportunities to make a difference. *Journal of the Academy of Nutrition and Dietetics*, *116*(7), 1199-1207.

WebMD. (n.d.). What is lactose intolerance? Retrieved March 30, 2017, from http://www.webmd.com/digestive-disorders/lactose-intolerance-14/primer

Weimar, M. R., & Blayney, D. P. (1994). *Landmarks in the U.S. dairy industry*. U.S. Deptartment of Agriculture, Economic Research Service.

Winfrey, G. (2014). 3 Companies finding opportunities in food recycling. Retrieved March 12, 2017, from http://www.inc.com/graham-winfrey/what-you-need-to-know-about-food-recycling.html

Wolf, C. A., & Tonsor, G. T. (2013). Dairy farmer policy preferences. *Journal of Agricultural and Resource Economics*, *38*(2), 220-234

Womach, J. (1999). *Agriculture: A glossary of terms, programs, and laws 2nd edition.* Retrieved from https://efotg.pdf