ANALYZING THE EFFECT OF MULTIPLE COMPONENT PRICING ON PRODUCERS

A Thesis

by

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ABSTRACT

The price of milk depends on many factors. For example, if corn prices rise then feed costs will go up and milk prices will increase. Besides corn prices, inflation, import and export market situations, somatic cell count, natural disasters and management costs such as feed, marketing, breeding, hired labor, capital, machinery and utilities can affect milk price. Before multiple component pricing was introduced, profit increased in direct proportion to increased production. However, after multiple component pricing is used, producing more milk did not mean more profit anymore. The reason is that milk prices are decided by content of component in milk such as fat and protein. Thus, higher the percentage of fat, protein and nonfat solid, the more profit can be made. For this reason, dairymen are making an effort to produce milk with higher fat and protein content in many ways. Breed changes, genetic selections and feed rations are examples of those efforts.

The objective of this research is to analyze the differences between before and after adopting new FMMO in 2000 and differences of several factors that affect milk pricing between orders. At first, trends of several factors would be analyzed and the reason for those trends would be explained. Specifically, price and milk composition part will be of interest. Then, differences between the two orders, six orders using multiple component pricing and four orders using skim-fat pricing, and causes of differences will be investigated. By determining differences between the two marketing

orders, the effects of using multiple component pricing on milk price, composition, utilization and so on could be inferred. These will enable us to identify producers' strategies and changes made to production process when multiple component pricing as adopted.

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1. INTRODUCTION

1.1 Background

1.1.1 Federal Milk Marketing Order (FMMO)

Federal marketing order is a regulation that was issued by the Secretary of Agriculture. This regulation is in regard to an idea that commodity should be marketed by procedures. Before 1935, pricing program was called a license, and it has been called a marketing order since 1937. Marketing order that we use these days was refined in 1937. Grade A milk, all nuts, fruits and 15% of vegetables are marketed by marketing order. Among those, since milk is extremely perishable, marketing by order serves as an effective system.

Dozens of marketing areas existed before 2000. Marketing area has been called marketing order or federal order. For example, Southwest federal order was called FO 126. In 1950, there were 39 orders and federal orders increased to 80 as handlers increased in 1960. Then the number of these marketing orders started to decrease slowly and were consolidated as 11 marketing areas by the introduction of the new FMMO in 2000. That is because, with advance in packaging and transportation technology, fluid milk was sold in a much wider area, and the number of handlers declined. Later, the Western area was excluded in April 2004, so there are ten marketing orders now. Figure 1 shows ten federal milk marketing orders.

The purpose of FMMO is to stabilize the milk market status and benefits producers and consumers through orderly marketing. Besides, FMMO is to give a guarantee of environments that could provide pure and wholesome milk to consumers at reasonable prices. These purposes could be accomplished by the classified price plan and pooling. Classified price plan is for deciding minimum pay prices by classes. Classes are determined by milk and milk components that are used to make each dairy product. Pooling system makes it possible for producers to receive a uniform price for equal quality and composition of milk regardless of usage in each order.

Having knowledge about milk components makes it easier to understand about a pricing system. There are milkfat and solid not fat in milk. Milkfat could also be called fat or butterfat. The representative dairy product with butterfat is butter. General butter contains about 80% of butterfat. Butterfat is included in a large portion of cheese. According to kinds of cheeses, butterfat is contained in cheese as little as below 10% and as much as above 30%. Fluid milk product could be classified by butterfat content. Whole milk contains about 3.25% of butterfat, and reduced fat milk and low-fat milk contains 2% and 1% of butterfat, respectively. If butterfat is contained 0~0.5% in milk, then it is called skim milk or nonfat milk.

Solid not fat is composed of protein and other solids. Before 2000, when milk was priced, the information on total protein or crude protein was used. However, crude protein includes Non-protein nitrogen (NPN) that is useless and disturbs an accurate pricing. Hence, true protein information, useable protein, was used starting in 2000. True protein could be calculated roughly by subtracting 0.19 from crude protein because crude protein includes 0.19lbs/cwt of NPN generally. Other solids include all of the nonwater ingredients in milk that contains lactose, ash (mineral), NPN and etc. Cheese and yogurt are typical dairy products that include protein.

Milk is priced in an FMMO according to how it is used. There existed three classes of milk from 1960 to 1995. Since milk price was calculated based on Minnesota-Wisconsin price, milk price was called M-W price. M-W price is an average grade B milk price from a survey of grade B milk prices that were paid by buyers last month. Grade A milk is a high quality milk that could be used for fluid products. Grade B milk is only used for producing dairy products such as butter or cheese. The average price was then updated by the current month's price, and that price became a Class III price. If a fixed differential is added to the Class III price, then that would be a Class II price. If a variable differential is added to the Class III price, then that would be a Class I price. A differential that is added for finding the Class I price is varied by FMMO. Eau Clare, Wisconsin is a starting point for deciding a differential. As a distance of marketing orders from Eau Clare increases, the differential increases. Class I differential reflects costs incurred when making dairy products using Grade A milk instead of Grade B milk and costs incurred when transporting raw Grade A milk. At that time, when old FMMO was used, Class I was milk used for beverage purposes. Class II was milk used for soft products such as ice cream and yogurt, and Class III was milk used for hard products like butter and hard cheeses. Average grade A milk price that producers received is blend price. Blend price is the weighted average price based on utilization percentage of Class I, Class II and Class III milk. The formula of blend price is as follows:

$$P1*(\%C1) + P2*(\%C2) + P3*(\%C3) = \frac{\{(P1*Q1) + (P2*Q2) + (P3*Q3)\}}{Qt}$$

Basic Formula Price (BFP) system was used for pricing milk from 1995 to 2000. This period before adopting the new FMMO can be called transition period. In this period, there were efforts to cover the disadvantage of Minnesota-Wisconsin price. The new pricing system reflects the situation of the national market better than before. Grade AA butter, dry buttermilk, nonfat dry milk, and cheddar cheese were added to products for pricing. Base month price uses M-W survey information the same as before and adjusts that price by a formula of a product price instead of the second survey. The product price formula uses value for producing cheese, butter, and nonfat dry milk to adjust base month price.

There are problems in the surveying method. The decreasing amount of Grade B milk was due to survey caused statistical accuracy to become very low. Besides, since Grade B milk price was updated with dairy product price, increase and decrease in prices were double-counted. Thus, price fluctuation was more severe than in reality. Besides, BFP could not reflect market conditions accurately because of problems such as products made with Grade A milk were not included in pricing.

Hence, it was important and necessary to introduce a new pricing system. A new pricing system that was adopted in 2000 is more predictable and transparent because of being able to directly reflect product prices. In other words, double counting was eliminated, and product yield was affected by milk component contents. For example, butterfat and protein content affected cheese production and solid not fat influenced nonfat dry milk or nonfat yogurt production. The new pricing system was closely related to production of dairy products than the old pricing system.

As mentioned earlier, the federal milk marketing order is a USDA regulation that makes milk buyers pay specified minimum prices in each marketing area according to how Grade A milk was used. About 65% of the U.S. is regulated by FMMO at present. Since pricing is based on Grade A milk, new FMMO makes it possible to improve income of producers who produce Grade A milk and to supply milk to customers at a reasonable price.

New FMMO defines four classes of milk. Class I is milk used to make beverage products like white whole milk, skim milk, low-fat milk, flavored milks, liquid buttermilk and eggnog. Class II is milk used to manufacture soft products. Soft products include frozen dairy desserts, creams and cottage cheese. Class III is milk used for cheese, and class IV is milk used for butter and dry milk products, principally nonfat dry milk.

These class prices depend on dairy product prices such as butter, cheese and skim milk and are decided once a month. Class I is decided before the month begins, and other classes are decided after the month ends. For deciding prices for Class I skim milk, Class I butterfat and Class II skim milk, advanced prices are applied, and National Agricultural Statistics Service (NASS) 2-week prices are used for calculating advanced prices. NASS monthly prices determine Class II butterfat, Class III, and Class IV skim milk and butterfat prices.

Figure 2, 3, 4 and 5 illustrate Class I, II, III, and IV milk price structures. Class IV price is related to nonfat solids and butterfat. A nonfat solid is used for making nonfat dry milk. Butterfat is used for making butter. Formula 1 in table 1 shows that 100 pounds of Class IV milk contains 96.5 pounds of Class IV skim milk and 3.5 pounds of butterfat. Prices of other classes are calculated the same way as Class IV and use the ratio of skim milk and butterfat weights in milk. Formula 2 in table 1, shows a make allowance of 0.1715, which is an additional costs producing butter that is estimated by USDA. USDA estimated a yield factor that incurred by a conversion from butterfat to fat as 1.211. By substituting formulas 2 through 6 into formula 1, the Class IV price could be expressed in terms of butter price and nonfat dry milk price.

Class III price could be obtained from cheese price, butter price, and dry whey price. Class III skim milk price is calculated by using protein price and other solid price as shown by formula 8 in table 2. Formula 9 is used for calculating protein price, which is divided into two parts. The first part explains net value of protein for producing cheese and the second part reflects butterfat value that is not for making butter but for making cheese. Cheese price that is reflected here could be determined using formula 11, and this is a price of 40-pound blocks and 500-pound barrels of cheddar cheese.

Similar to Class III price calculations, Class II price is computed using Class II skim milk price and Class II butterfat price. Formula 15 in table 3 shows, that Class II butterfat price can be obtained by adding a constant differential of 0.007 to Class III and IV butterfat prices. As stated earlier, an advanced price is used to get Class II skim milk price. The formula for Class II skim milk price is the same as the formula for Class IV skim milk price. Nevertheless, the difference is, Class II skim milk price reflects an advanced price. Thus, Class II milk price is determined by nonfat dry milk prices of the previous month and butter prices of this month.

Both skim milk and butterfat of Class I milk price are used an advanced price that are announced on Friday or before the 23rd of the previous month. Class I differential is added to advanced butterfat price that is obtained by using formula 21 to get Class I butterfat price as shown by formula 20 in table 4. Class I differential is decided for every county, and it decreases as distance increases from the place where milk consumption is the highest in each marketing order. Class I differential plus the higher one between advanced Class III skim milk price factor, and advanced Class IV skim milk price factor result in Class I skim milk price. The higher price of advanced Class III skim milk price factor, and advanced Class IV skim milk price factor is called Class I price mover.

The objectives of the FMMO are achieved by using a classified price plan and pooling. Pooling is a system that requires handlers to pay the same prices for producer payment regardless of usage of milk in each federal order. Handlers include distributing plants, supply plants, and dairy cooperatives. Uniform price is milk price that producers receive equally. Uniform price is a weighted average price and weights are decided based on utilization. Approximate uniform price is computed by multiplying minimum price of each class by utilization percentage of each class. The way to find the accurate uniform price is more complicated than approximate uniform price. The uniform price is discussed in more detail in a later section. The brief explanation is that there are two different milk pricing systems. A producer payment for orders using skim-fat pricing is the same as the uniform price. When a uniform price that uses skim-fat pricing is added to a Producer Price Differential (PPD) and a Somatic Cell Count (SCC) adjustment, the result is a producer payment for orders using multiple component pricing.

Handlers draw from or pay into a producer settlement fund by comparing with the uniform price and milk value. A producer settlement fund is called a pool. Handlers with milk value higher than uniform price pay into the pool and vice versa. Thus, producers could receive the same payment from handlers no matter how milk is used.

1.1.2 Multiple component pricing and skim-fat pricing

As mentioned earlier, there are two ways of pricing milk for FMMO; Multiple Component Pricing (MCP) and Skim-Fat Pricing (SFP). Out of ten marketing orders six marketing orders use MCP system, and the remaining four areas use SFP system. Marketing orders that are using MCP are Northeast (FO 1), Upper Midwest (FO 30), Central (FO 32), Mideast (FO 33), Pacific Northwest (FO 124) and Southwest (FO 126), and marketing orders that are using SFP are Appalachian (FO 5), Florida (FO 6), Southeast (FO 7) and Arizona (FO 131).

Payments for producers are differentiated by several factors. Payments for producers are uniform prices by pooling. MCP and SFP are differentiated milk prices of each order according to location by Class I differential that is producer location adjustment. In addition to location, milk composition, which is the quantity of components, differentiates milk prices of each order. Producers of orders using SFP receive a uniform price directly. Producer payments of orders using SFP are based on skim milk and butterfat. In other words, handlers pay producer's sum of weighted average values of each class’s skim milk and butterfat. The uniform skim milk price is calculated for each hundredweight of skim milk, and the uniform butterfat price is calculated for each pound of butterfat.

Producer prices of orders using MCP are determined by considering the value of butterfat, protein, and other solids in marketed milk. Unlike orders using SFP, payments of orders using MCP depend on PPD also. PPD accounts for the difference between Class III price and prices of other classes. In other words, PPD is added value per cwt of Class I, Class II, and Class IV price that exceeded Class III price. By taking Class III price from uniform price, it leaves approximate PPD. Since the total value of butterfat, protein and other solids in total hundredweight of marketed milk is reflected in Class III, PPD is based on Class III price. Approximate PPD could be estimated as following formula:

PPD = % Class I * (Class I price – Class III price)

+ % Class II * (Class II price – Class III price)

+ % Class IV * (Class IV price – Class III price)

Among six orders using MCP, four orders consider SCC for calculating producer prices. SCC differentiates milk prices with milk quality. The cheese yield becomes higher, and a shelf life becomes longer with lower SCC in milk than before. Adjustment is based on the following:

Cheese price * 0.0005 (Count – 350)

Count in somatic cell count means the number of somatic cells in thousands of cells per milliliter. If SCC is lower than 350, then producers receive higher payment than average payment and vice versa. When producer payments data is used only to offer information, uniform price reflects Class III price and PPD without SCC adjustment.

1.2 Objective

The objective of this research is to analyze the changes that occurred in the pricing system. Specifically, differences in pricing before and after adopting new FMMO in 2000 and differences between marketing orders that use multiple component pricing and single component pricing were examined carefully. At first, trends of several factors over time were examined, and the reasons for those trends were. Price and milk composition are considered in the analysis. In addition, whether changes fit the objectives for new FMMO were examined which will help explain if new FMMO is performing properly. The effects of using multiple component pricing on milk price, composition, and utilization were found by looking at the differences between the two pricing systems.

2. LITERATURE REVIEW

As explained in the previous section, there are several reasons why multiple component pricing is an important topic of research. Over the last few decades consumer preferences have shifted away from fluid milk, and demand for protein increased. Previously, consumption of fluid milk was high, especially the whole milk. However, in recent years, consumers are reducing their intake of fat and increasing the intake of protein. Thus, consumption of reduced fat milk is increasing. The pricing method should take into account the components in milk, such as protein. Many studies argued that using multiple component pricing is more efficient and equitable. Besides, some studies predicted and analyzed what changes might arise from using multiple component pricing.

Smith and Snyder (1977) showed that the demand for milkfat is decreasing, and people tend to consume more products that emphasized protein content. They stated that milk production with higher protein level will increase cheese and dry milk powder yield. Milk production with higher level of protein and fat is available through feeding, breeding, and selection. Demand for beverage milk and manufactured dairy product significantly shifted since 1990 (Cropp and Jesse, 1995). Specifically, the demand for butterfat and whole milk has dropped, and cheese and low-fat milk consumption increased. Lenz et al. (1990) asserted that dairy producers' milk component production that focused on a retail level component demand creates an economic incentive, in the long run.

Likewise, as protein consumption has noticeably increased, a new pricing system was needed, and many studies claimed multiple component pricing was the most efficient and equitable pricing system under a present situation. Gillneister et al. (1996) said, even though an argument exists between single component pricing system and multiple component pricing system, multiple component pricing is more efficient. While demand for solid not fat is increasing, if multiple component pricing is not adopted, milk producers will tend to overproduce water and butterfat and underproduce solid not fat. Morris Whitaker (1978) contended that multiple component pricing is more equitable than butterfat pricing. He expected milk prices for individual producers would be more equitable when switch over from butterfat pricing to multiple component pricing because of decreasing overpay for producers who produce lower protein level than average level at protein test. Besides, he forecasted multiple component pricing would lead to more efficient utilization of resources and increasing the production of protein through producer and processors' proper resource use and technology on farm and in the plant. Perrin (1980) stated that multiple component pricing would increase social surplus about 2% of the value of milk production as well as affect the producer returns.

Many studies looked at equitableness and efficiency of multiple component pricing system and predicted the effect of using multiple component pricing. Many studies predicted similar outcome for short-run and long-run effects of introducing multiple component priding (Lenz et al., 1990, Gillmeister et al., 1996, and Buccola and Iizuka, 1997). They predicted that in the short-run, producers will try to increase content of each component in milk through feed ration changes, and in the long-run changes in breeding program and genetic stock of the dairy cow will occur. Buccola and Iizuka (1997) forecasted that protein price will increase because of generated cost caused by efforts in trying to produce milk with higher protein content. Over time, marginal productivity of protein product would rise, and marginal cost of protein product would decline. Kirkland and Mittelhammer (1986) studied the impacts of multiple component pricing on production using nonlinear programming analysis. They asserted that significant component pricing incentives could not be reached by modifying feeding management. On the other hand, they conclude that if producer adopts methods of adjustment in the long-run such as genetic selection for improving components content other than butterfat component, producers could make profit from using multiple component pricing. The impacts of multiple component pricing on producer and handler are studied by Cropp and Jesse (1995). They predicted that producers would try to change milk composition using proper feeding and breeding strategies. Feeding is the rapidest way to change milk composition. However, genetics is preferable because it is permanent and cumulative. They explained that multiple component pricing would have an equal but opposite effect on handlers and producers. If handlers' profits increase, producers' profits decrease, and vice versa. Multiple component pricing does not seem to affect producers' total revenue. However, it could affect a distribution of the revenue in the short term. Cropp and Jesse predicted that in the long-run, multiple component pricing will encourage feeding practices and a genetics selection and raises protein content in milk. As a result, multiple component pricing is expected to have a positive impact on producers' total revenue. Bailey and Tozer (2001) predicted that multiple component pricing would bring market-oriented consequences by fewer lags than the old pricing system. They also expected farmers who have higher component levels than average component levels could receive higher Class III price. Furthermore, milk quality would be upgraded by the pricing that considered somatic cell counts. Multiple component pricing would also make the role of the dairy price support program bigger. Lastly, they anticipated that the pool of federal orders' focusing on sales of class I and class II products would increase and those focusing on sales of Class III products would decline.

Milk component composition became important and studies on factors affecting milk component composition were carried out by introducing multiple component pricing system. Bailey et al. (2005) researched how much of an effect herd size would have on milk components and somatic cell counts. They found that milk has higher fat and protein content when produced at smaller herd size than larger herd size. Because of higher fat and protein content, producers could receive higher Class III price. They got a result that the bigger the herd size, the higher the somatic cell count levels. High somatic cell count levels mean low-quality milk. Smaller size producers' standard deviation of butterfat content, protein content and Class III value is higher than larger size producers'. Hence, They contended that we should find a trade-off point between gains and losses by herd size. They also insisted that management factors affect variation in milk composition about 45%, and genetics affects variation in milk composition about 55%. Similar to other studies, they stated that effects of management factors could be verified in the short term, and a genetics selection takes a longer time to prove their effects than management factors. Lastly, they found that milk yield has a positive correlation with butterfat and protein yield. However, milk yield has a negative correlation with butterfat and protein content in milk. Kirkland and Mittelhammer (1986) found that feed ration potentially affects milk components and on-farm revenue over feed cost in the short-run. Thus, they found optimal feeding using a nonlinear programming analysis. Even though a multiple component pricing system was not introduced at the time of the study, they assumed that producers raised Holstein cows and used a multiple component pricing system. When producers increased Acid Detergent Fiver (ADF) and decreased Crude Protein (CP) in feed, producers' revenue rose. Thus, the optimal feeding could be found by deciding optimal ADF and CP first and deciding optimal amounts of total digestible nutrients based on optimal ADF and CP. There is a study about which inputs influenced milk outputs (Cho et al., 2009). They argued that milk component composition was affected by other inputs even though it was earlier believed that breed and feed rations affected most milk component composition. They found how much each input affects fluid milk yield, butterfat content, protein content and other solid content using a multiple output distance function. Finally, they reached conclusions that increasing purchased feed is the most influential in increasing production of milk components, and that butterfat is negatively correlated with production of aggregate milk and other components. Another study found that milk component level changes according to breed of cattle (Bailey et al., 2005). Bailey et al. accounted for how nutritional factors and factors other than nutrition affect milk component. Nutritional factors include protein in feed, added fat or oil, forage level and other. They explained about factors other than nutrition such as stage of lactation, season, mastitis and mechanical errors like cooling problems in the bulk tank, and sampling problems. They concluded that nutritional factors, among all factors that affect milk composition, are the most likely cause of problems, and they said management factors could change content of milk components quickly and dramatically. On the contrary, changes in milk component composition affect other things. Cropp and Jesse (1995) claimed that cheese yield was greatly influenced by production of protein. Thus, cheese yield increases as production of protein increases.

3. DATA DESCRIPTION

Two types of data were used in the analysis; data on dairy market and factors that could affect milk prices, component and contents, and data for analyzing the effect of FMMO.

The first set of data consists of five datasets that provide information about dairy market. Monthly data on milk production, milk production per cow and the number of milk cows on the farm are from 1998 to 2014. Additionally, number of U.S. fluid milk bottling plants and average size of U.S. fluid milk bottling plant would tell about whether the dairy market is growing or getting smaller. Hence, the annual data on bottling plants from 1988 to 2007 were obtained. Next, annual per capita consumption of different dairy products such as butter, total cheese, yogurt, total dry milk, total plain milk, several plain milk, and creams for the last two decades were also collected. The annual data on sales of dairy products for the past 20 years was also used in this research. These are plain whole milk, flavored whole milk, 2% plain milk, 1% plain milk, buttermilk, skim milk, flavored milk, total beverage milk, yogurt, half and half cream, light cream, heavy cream, total cream, sour cream, eggnog and total fluid milk and cream sales. Proportions of fluid milk that are used in each dairy products and sales trend of dairy products over time are available from these data. Consumer Price Index (CPI) and Producer Price Index (PPI) data were also used in the analysis. CPI here is based on the year 1982. In other words, price is lower than the price in 1982 then CPI is below 100 and vice versa. Weights that used for calculating the index are based on household expenses. CPI shows price fluctuations of goods and services that spend by consumers in their daily life. PPI here is also based on the year of 1982. Even though items are same, imposed weights are different from each other. Therefore, PPI is distinct from CPI. Weight for PPI is based on sales. PPI provides information on raw and intermediary materials costs, expenses of producers, products supply and trend of dairy market. If raw and intermediary materials costs increase then, it means that supply has not expanded to meet demand. Excessive increase in raw material cost will lead to increase in prices of products. Because of overgrowth of products prices, sales would decline, and inventory would increase. Finally, a decrease in production and the economic recession would occur with a high probability. Since PPI and CPI have different price standard, PPI's range of price fluctuation is narrower than CPI's. In other words, while products prices in PPI are factory prices that do not include a value added taxes, products prices in CPI are retail prices and higher than factory prices. Retail prices include retail margins, value added taxes and other kinds of taxes. Thus, moving range of CPI is wider than PPI. Butter, food-at-home, dairy and relate products, cheese and related products, whole milk, other than whole fresh milk, all fresh milk, ice cream and related products and other dairy products are in CPI data. There are also prices received all dairy products, all dairy products, fresh processed milk, whole milk, low-fat milk, skim milk, bulk fluid milk, cream, all cheese, several kinds of cheese, butter PPI. These data are monthly data from 1998 to 2014. All data used in the analysis from U.S. Department of Agriculture (USDA) Agricultural Marketing Service (AMS). U.S. monthly average temperature are used in the research to observe seasonality of several variables such as production according to temperature, and these data were obtained National Climate Data Center (NOAA).

The next set of data is used for analyzing the effects of FMMO. Effects of FMMO are shown in the above data also. The above data tell general trend of the dairy market. Whereas this data shows effects of FMMO more directly. Data were obtained from the Federal milk order statistics public database generated by the administration of the Federal milk order program except for the data related to utilization. All the data are monthly data from 2000 through 2014. Each class price, components prices for butterfat and skim milk, uniform price, PPD, SCC and milk components contents are examined using this database. Data about utilization are divided into two major categories; a total amount of utilization, and percentage of utilization. These data were obtained from individual marketing order websites and provide information on how produced milk was used by each marketing order. Price data provided are the final class prices and data that are related to all components price for calculating class price. Movement of components price and change of class prices depending on components price are available from these data. Uniform prices with PPD and SCC data show differences between milk prices of each marketing order and difference between orders that use MCP and SFP. In addition, data about fat content, protein content and other solids content of each order show how components content are changing over time before and after admitting FMMO. Total receipts and number of producers could explain changes in total receipts according to pricing method. All of the data above help will us to figure out effects of MCP through comparing averages of orders’ where MCP was used with averages of orders’ where SFP was used.

4. RESULTS

4.1 Analysis of dairy market trend

The changes are examined over time with data that explained earlier. Producers prepared for the change of pricing method from 1995 when the discussion about the change of the pricing system had started. Thus many things such as milk composition and milk prices have begun to change since then. MCP is a pricing method that prices according to a content of each component. Therefore, producers would try to increase content of each component in milk. In that way, producers could earn higher profits with same milk production. For this reason, although data from 1990s should be looked, there are limits. For example, since protein content and other solid content are not reflected in pricing methods such as old FMMO and SFP, orders using SFP and old FMMO do not test protein content and other solid content. Hence, it is difficult to observe the effects of MCP by comparing old FMMO or SFP with new. Changes in each class price, utilization, and content of components were examined and analyzed from 2000.

The trend of the dairy industry was analyzed over time at first. Description of the data about milk production, consumption and sales and analysis of what changes occurred and why these changes occurred were discussed. After that, analysis of utilization of milk, milk price and milk composition changes were provided. The analysis of overall dairy industry shows the effects of MCP on producers indirectly and the second analysis shows the effects directly.

4.1.1 Production

First, in U.S. dairy production, milk production continues to grow as shown in figure 6. We observe some seasonality in milk production. Milk production is higher when temperature is high. The level of milk production is the highest in May, lower in March and the lowest in September, November and February. Milk production has increased an average of about 20 million lbs. every month and has grown 30.98% between 1998 and 2014. Milk production per cow is also (figure 7). Figure 8 shows that the number of cows shows an increasing trend, except for sharp decline in 2003 and 2009. However, the increase was not big, less than one hundred thousand cows per year. The decrease in the number of cows in 2003 and 2009 can be explained by the spread of mad cow disease. Milk production per cow and total milk production show similar growing trend. Figures 9 and 10 display a decline in the total number of U.S. fluid milk bottling plants and an increase in the average size of U.S. fluid milk bottling plant. Decreasing number of plants and growing size of plants are the result of efforts to improve efficiency of plants and reduce fluid milk production costs.

4.1.2 Consumption and sales

Next, consumption and sales of dairy product trend were analyzed. Even though consumption and sales seem similar, there are differences between them. Consumption reflects consumer preferences, and sales reflect disappearances such as inventory or government purchases other than consumption. Thus, the consumption and sales need to be examined separately. Trends in per capita consumption of different dairy products were shown in figures 11 to 15. Butter, total cheese, yogurt and total dry milk consumption has grown between 10% to 50% over past 20 years. On the other hand, total plain milk consumption has declined. The changes in consumer preference for dairy products are explained in this section. Consumers used to consume plain milk mainly, but their preferences shifted over time to other dairy products such as cheese and yogurt.

The figure 16 shows consumer price index (CPI) for whole milk, butter I, cheese and related products, dairy and related products and food-at-home. Costs to purchase dairy products in households are rising overall in figure16 and table 5. Total consumption of food in households is increasing, and the rate of increase of dairy products is relatively low. The rate of increase of butter CPI is the lowest and cheese CPI is the highest among others. CPI of cheese has higher growth rate than other dairy products. There are several probable causes of high growth rate of cheese CPI. A rise in price of raw material of cheese (raw milk), a rise in price of protein or fat or a rise in price of tax that occurred during the distribution could cause high cheese CPI. However, the most likely cause is an increase in demand for cheese by consumers, and it is shown in figure 12. Although has supply increased as demand increased, increased supply has not met increase in demand. Thus, cheese price continues to rise and figure 17 shows the trend.

Producer Price Index (PPI) of whole milk, butter, cheese and related products and dairy and related products are shown in figure 18. PPI of whole milk shows the highest rate of increase (figure 18 and table 5). The reason is that price of raw milk increased, and this increase had the greatest effect on whole milk price. If the trend continues, then supply problem would occur. Besides, demand for whole milk is decreasing. In the end, whole milk would lose a competition gradually in the dairy product market.

Trends in sales are shown in figures 19 and 20. Sales of fluid milk is decreasing. A graph of fragmented sales of fluid milk (figure 20), shows which kind of product made fluid milk sales decline. According to figure 20, whole milk had sold more than reduced fat milk until the early 2000s. However, sales of whole milk has continuously decreased, and sales of reduced fat milk has slightly increased. Since 2004, reduced fat milk was sold more than whole milk. It means consumer's preference has changed to milk that contains more protein and less fat. Sales of cream and yogurt has also increased especially sales of yogurt.

4.2 Analysis of Federal Milk Marketing Order (FMMO)

The trend of prices between orders could be compared with uniform prices. That is because uniform price is weighted average that reflects class price and milk utilization of each order. Thus before comparing uniform prices of each order, utilization and class prices would be comparatively analyzed. After comparing uniform prices, milk composition that have a major impact on milk price would then be analyzed.

4.2.1 Utilization

Two types of data about the utilization of milk exist: Amount of each class usage and class utilization percentage. Since the information that is figured out from each data is different, these data should be examined separately. Data on amount of each class usage have information about which order mainly produces each class product. Class utilization percentage data includes information about what kind of product is mostly produced and how much they are produced in each marketing order.

4.2.1.1 Total amount of utilization

Since information on which products were mainly produced at which order could be found from our data on the amount of utilization, the data should be examined class by class first. As shown in figure 21, Class I products were produced mainly in Federal Order (FO) 1, accounting for about a quarter of total production. Class II and IV products were also produced mainly in FO 1. In a case of Class III products, the milk from FO 30 is chiefly used. The comparisons of an average amount of utilization between federal orders using MCP and SFP are as follows. Since average milk production of orders that use MCP is far higher than orders' that use SFP, products of almost all classes are made in orders that use MCP. Especially, milk for producing Class III products are chiefly produced in orders that use MCP. Total amount of utilization for Class I and Class II from orders that use MCP remain largely unchanged. On the contrary, a total amount of utilization for Class III and Class IV show huge swings. Hence, utilization percentage of each class fluctuates widely. Figure 22 illustrates differences in utilization between orders that use MCP and SFP. Average production of Class II, III, and IV of orders that use SFP is less than one-third of MCP orders'. Total production of milk in orders that use MCP is increasing and fluctuating, and total production of milk in orders that use SFP is fairly constant. Class I, II, III and IV production trends of orders that use MCP are likely be the same compared to orders that use SFP. The amount of Class I utilization is declining, and the amount of Class VI utilization is increasing in each order. This could be explained by changes in fluid milk consumption and sales. Since sales and consumption of fluid milk are decreasing, it could be inferred that amount of Class I utilization is also decreasing. Likewise, a reason for decreasing the amount of Class IV utilization could be explained by the decrease in consumption and sales of dry milk products. The amount of Class II utilization in MCP orders shows growing trend, and there are few changes in SPF. In the case of Class III utilization, it is stationary in order that use MCP, and it is declining in order that use SFP. Higher content of protein and fat in milk will enable more production of cheese. Class II and III are cream, hard cheese and soft products such as soft cheese. Thus, they are greatly influenced by a composition of components in milk. The increase in content of fat and protein in orders that use MCP enable to produce more soft products. On the other hand, since the content of protein and fat are not increasing, utilization of Class II and III are either stable or decreasing in orders using SFP.

4.2.1.2 Percentage comparisons

Figure 23 shows that there is a regular seasonal cycle and no huge changes in orders that use SFP. Their Class I has the highest percentage, more than 50%. Trend of Class I is almost stable and slightly decreasing. They have maintained an about 63% average. Class II, III and IV are about the same, from 11 to 14%. There is a slight decrease or increase but almost steady the same as Class I. MCP has larger fluctuations than SFP. MCP orders' percentage of Class I repeatedly rises and falls around 40% and slightly decreases overall. Class II and IV of MCP orders increase in 13~15% like SFP orders, and a percentage of Class III is about 30%, higher than SFP orders', and there is a downward trend. Since SFP orders' percentage of Class I is higher than MCP, uniform prices of SFP orders are higher than uniform prices of MCP. Percentages of Class III are decreasing in both MCP and SFP orders. The reason for declining in percentage of Class III, even though consumption, sales and production of hard cheese are increasing, is the rate of increase in total milk production of MCP orders is faster than the rate of increase in hard cheese production. A close look at the figure 24 reveals that which order use their milk mainly to produce which class products. The fluctuation of FO 1 is quite small in comparison with the other MCP orders. Class I percentage of FO 30 is likely to be higher than other orders'. Thus produced milk of FO 30 is usually used for manufacturing Class I products. Class III percentage of FO 32 and 33 are relatively higher than other MCP orders. FO 124 has higher percentage of Class IV and lower percentage of Class II than other orders. Other characteristics are low Class III percentage of FO 5 and the average percentage of all classes in FO 7. Because of quite high Class I percentage of FO 6, more than 80%, other classes percentage of FO 6 is lower than average. In the case of FO 131, Class I and II percentage are low, and Class III and IV percentage are high.

4.2.2 Prices

4.2.2.1 Class prices

Class II, III, and VI prices are all the same in every order, and Class I price differs from order to order according to Class I differential. The price structure that was explained earlier should be examined to figure out changes in prices and trends of factors that are affected by prices. Class III price is thought to be the most important price since Class III price is affected by all three products; butter, cheese and dry whey. Thus, Class III price is examined first. Since Class III price is calculated by a linear equation with butterfat and Class III skim milk price, butterfat and Class III skim milk price trends inform Class III price trend. Furthermore, butterfat price is computed by NASS butter price, and Class III skim milk price is computed by NASS butter, cheese, and dry whey price. Thus, identifying NASS butter, cheese, and dry whey price trends enable to measure the general change in Class III price. Butter, cheese, and dry whey prices have been increasing since 2000. All three prices are increasing similarly, and cheese price is increasing the fastest among the three. This can be explained by the increasing price of protein. Figure 26 shows that although fat price and protein price was similar when they started to use new FMMO, the gap between both prices is widening as protein price starts increasing rapidly. Cheese price is the fastest increasing price due to the fact that cheese contains protein, the most among butter, cheese and dry whey as seen in figure 25. Even though the calculation of Class III price is based on butter, cheese, and dry whey price all, cheese price and Class III price have the most similar trend as shown in figure 27.

Class IV price in computed by using butterfat price and Class IV skim milk price. Butterfat price for calculating Class IV price is same with butterfat price that is used for calculating Class III price. Thus, Class IV skim milk price is examined only here. Class IV skim milk price is based on nonfat solid price, and nonfat solid price is based on NASS nonfat dry milk price. Class IV skim milk, nonfat solid, NASS nonfat dry milk price are similar as seen in figure 28 and 29. This trend is because Class IV skim milk price changes depending on NASS nonfat dry milk price. While NASS nonfat dry milk price did not alter significantly right after 2000, the price is increasing faster over time. Nonfat dry milk contains 34~37% of protein and fewer than 1.5% of milkfat. Therefore, nonfat dry milk is affected by factors that are related to protein such as protein price. As following figure 30, Class IV price trend was similar to butterfat price trend in the early 2000s, and Class IV price trend has become similar to Class IV skim milk price trend since the late 2000s. This trend could be interpreted as Class IV products prices are influenced by protein than butterfat as time goes.

Class II price is calculated by Class II butterfat price and Class II skim milk price also in the same manner. Since Class II butterfat price is based on butterfat price and butterfat price is based on NASS butter price, Class II butterfat price trend is figured out by examining NASS butter price trend. NASS butter price here is same with that is used to compute Class III and Class IV. Thus, Class II butterfat price has the same pattern with butterfat price, and Class II butterfat price is 0.007 higher than butterfat price. Advanced prices are used for calculating Class II skim milk price. In other words, Class II skim milk price is found using advanced Class IV skim milk price factor, and advanced Class IV skim milk price factor is found using NASS 2-week NFDM (Nonfat Dry Milk) price. Therefore, NASS 2-week NFDM should be examined. In figure 31, there was not much alteration in NASS 2-week NFDM price in the early 2000s. However, even though there exist significant fluctuations, on average, NASS 2-week NFDM price has been increasing since the mid-2000s. This trend is due to a rise in price of nonfat dry milk product that is caused by the faster rate of increase in demand than the rate of increase of supply. Finally, compared to the change of Class II price, Class II butterfat price and Class II skim milk price, Class II price had been affected by Class II butterfat price more until mid 2006 and has been affected by Class II skim milk price since mid 2006 as seen in figure 32 and 33. Thus, the trend of Class II price was similar to the trend of Class II butterfat price, and Class II skim milk price did not alter significantly before mid-2006. After mid-2006, the trend of Class II price is similar to the trend of Class II skim milk price.

Class I price is also determined by Class I butterfat price and Class I skim milk price. Class I butterfat price and Class I skim milk price is decided based on advanced butterfat price, advanced protein price, and advanced other solids price. Class I price is determined to reflect Class I differential to Class I butterfat price and Class I skim milk price. Simply speaking, Class I price is equal to Class I base price plus Class I differential. Class I base price is also called Class I mover. Class I base price is same in all areas and Class I differential makes difference between areas. Class I base price is currently increasing as seen in figure 36. Class I butterfat price, Class I skim milk price and Class I price are increasing gradually, and they show a similar trend in figure 34 and 35. Class I differential is generally computed as $3 per 1000miles from the standard point. The following table 6 shows the differential of the representative area for each order. At the conclusion, trends of Class I, II, III, and IV are similar as seen in figure 37.

4.2.2.2 Uniform price

Uniform price is a weighted average price that is based on utilization. Thus, uniform price is affected by a change in utilization percentage. Changes of every order show the similar pattern. Uniform price rises and falls in 4-year cycles and is increasing overall. Comparison with orders where use MCP and SFP indicates that a uniform price of orders which use SFP is higher (figure 38). Class I price is the highest among all classes, and SFP orders' percentage of Class I utilization is higher than MCP orders'. Since the rate of decline in Class I utilization proportion of MCP orders is greater than SFP orders', the gap between uniform prices of MCP orders and SFP orders is ever widening.

As explained earlier, federal orders (FO) 5, 6, 7 and 131 that use SFP did not implement PPD for calculating producer price. On the other hand, federal orders 1, 30, 32, 33, 124 and 126 use PPD for pricing the milk, and federal orders 30, 32, 33 and 126 use SCC for computing milk price. From figure 39, we can see that PPD has been decreasing. This decrease can been due to decline in a rate of Class I production and increase in a rate of production of other classes at the same time. Orders using SCC have lower PPD on average than orders that do not use. This is a result of higher Class I utilization percentage and lower other classes utilization percentage in orders which use SCC than other orders.

SCC has been gradually declining. In the initial phase of admitting MCP, there were some orders which exceeded the standard value of 350 (figure 40). However, the average of SCC decreased nearly by half. This is the outcome of producers' efforts to improve their profit.

4.2.3 Milk composition

Milk composition tests started in 2000, after introducing new FMMO. Thus, information on milk composition before 2000 are not available. The effect of MCP could be inferred by examining changes in component contents from early 2000. SFP is pricing method that considered percentage of fat content in milk, and for that reason orders that use SFP tested only the fat content of milk. The effect of the pricing that considered protein content and other solids content in milk is enabled to know by the comparison of fat content between MCP orders and SFP orders. However, protein content and other solids content could not be compared for MCP and SFP orders because the information is not available for SFP orders. Thus, the impact of MCP on protein and other solids content could be figured out by examining only changes in MCP orders' contents of protein and other solids.

Figure 41 shows monthly average fat content of 6 MCP orders and 4 SFP orders, and also shows the effect of MCP on fat content. Average fat content of MCP orders has been increasing. On the other hand, there are few changes in average fat content of SFP orders. Even though protein and other solids content of MCP orders and SFP orders are not comparable, in figure 42 and 43, at least MCP orders' average content of protein and other solids have been increasing. It would appear from this that producers of MCP orders have attempted to improve contents of components in milk for higher profits, and contents of components and profits are improving as a result of their efforts.

5. CONCLUSION

Trends of the dairy market and changes in milk utilization and price in marketing orders were examined in this thesis. First, the overall movement of the dairy market was analyzed. Total milk production has increased over time because of the increase in production per cow rather than increase in number of cows. Many small size bottling plants were replace by fewer number of large bottling plants has been changing in a direction that operate more efficiently. Many small size bottling plants were replaced by fewer number of large bottling plants over the years. This is consistent with economic literature on economies of scale. Form of dairy products consumption has also changed over the years. Consumption of total plain milk products that represent existing dairy products is decreasing. In fluid milk, consumers' preference is shifting from milk that is high in fat such as whole milk to milk that contain less fat such that reduce fat or low-fat milk. Consumer preferences are shifting away from fluid milk towards other dairy products such as cheese and yogurt. These shifts in preferences were also observed when analyzing sales data.

Next, changes after new FMMO, and the effect of adopting MCP are addressed. Direct effects of MCP are more evident than in overall dairy market trend. Changes in utilization are studied. Total production of orders which use MCP is increasing and is larger than production of orders where use SFP. On the other hand, trend of total production in SFP orders has declined slightly. Percentage of Class I and III utilization are decreasing, and Percentage of Class II and IV utilization are increasing as seen in the trend analysis of dairy market (table 7). All class prices are rising. Class price had been influenced by each class's butterfat price until early 2000s, and they have been influenced by each class's skim milk price since mid-2000s. This happening because products prices are affected more by protein than butterfat. Uniform price of SFP order is higher than MCP orders' because percentage of Class I utilization in SFP orders is higher than in MCP orders'. Since the percentage of Class I utilization in MCP orders is decreasing rapidly, the gap in uniform price between MCP and SFP orders has widened.

Finally, effects of FMMO and MCP, whether they are working the way that were intended or not, could be known by comparing objectives of new FMMO and changes that occurred since then. First object of new FMMO is to stabilize the milk market status. Total production of MCP orders is increasing, and trend is changing depending on shifts in consumers' preferences. With respect to prices, MCP orders is more stable than SFP orders. The second objective is to benefit producers. Figure 44 shows whether changes are fitting the purpose or not. Total receipts of SFP orders is declining gradually, whereas total receipts of MCP orders is increasing. The third objective is to benefit consumers. Trend of SCC and changes in milk components content shows suitability of MCP for the third objective. Producers' effort to receive more money closely linked with supply of high quality dairy products to consumers. Besides, new FMMO assures consumers of dairy products quality. The last objective is to ensure minimum price for a producer and reasonable product price for a consumers. This objective is also attained by uniform price and orderly marketing. According to the above passage, changes in MCP orders meet the objectives of FMMO. Therefore, if orders which use SFP were to adopt MCP, then components content would increase by effort of producer to earn more money, and milk quality would be improved as a results. In the end, producers' profits would increase, and consumers could buy high-quality dairy products.

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APPENDIX A

FIGURES

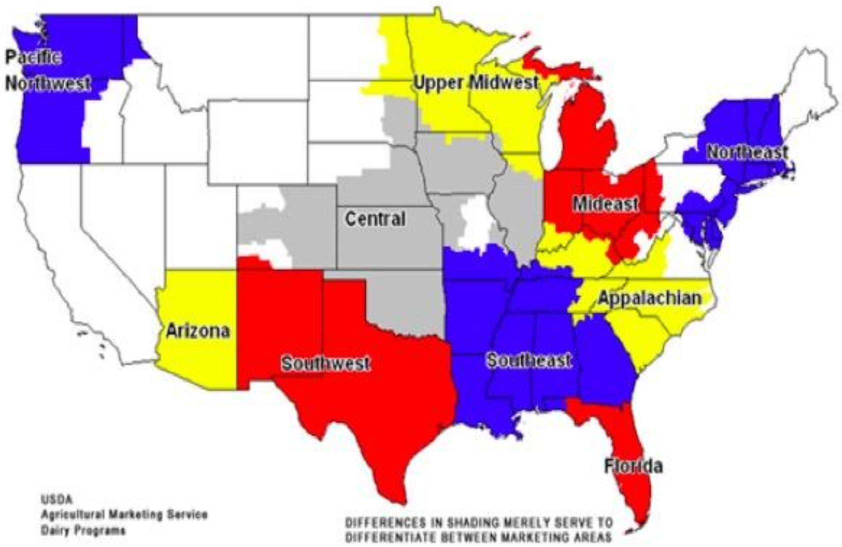

Figure 1. Federal Milk Marketing Orders Map (Source: USDA,http://www.ams.usda.gov)

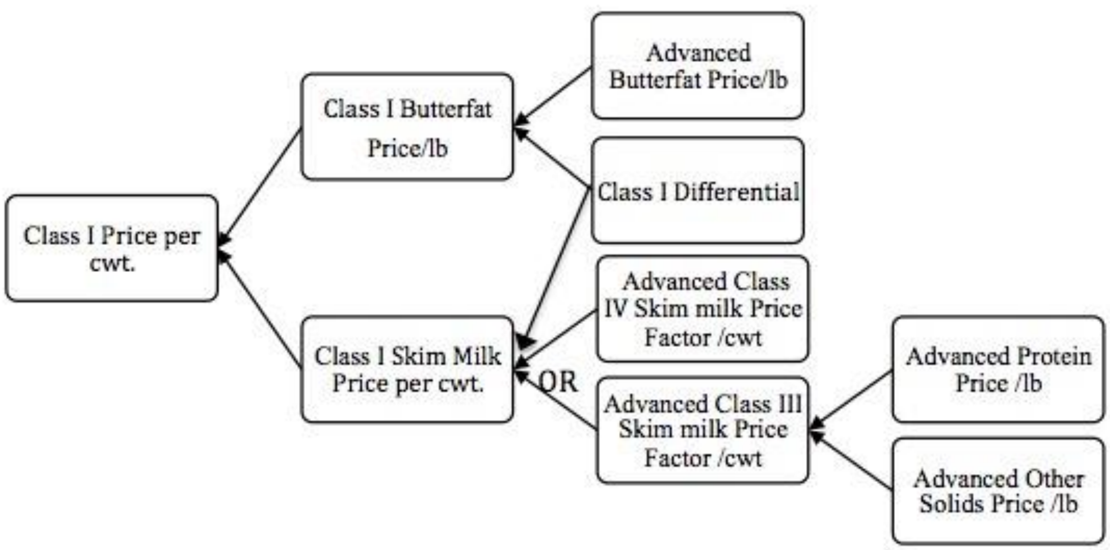

Figure 2. Class I Price

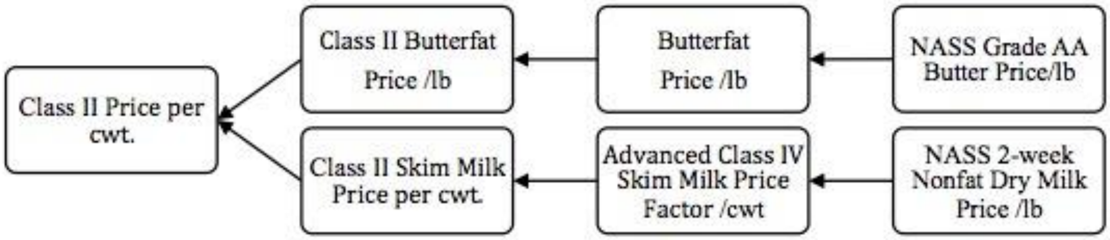

Figure 3. Class II Price

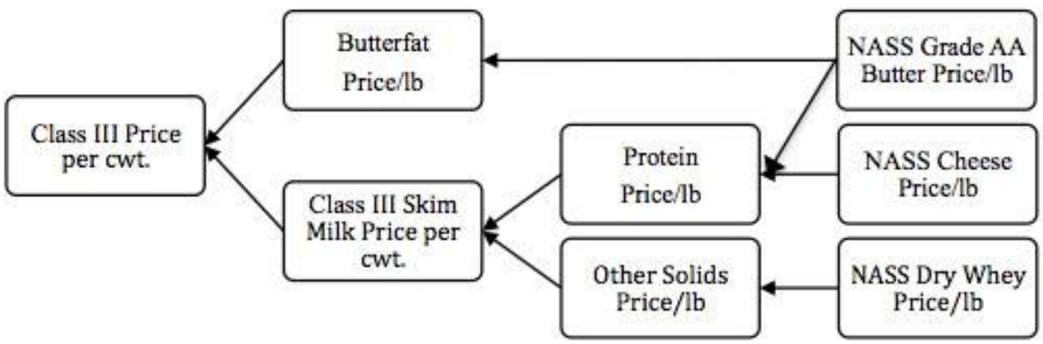

Figure 4. Class III Price

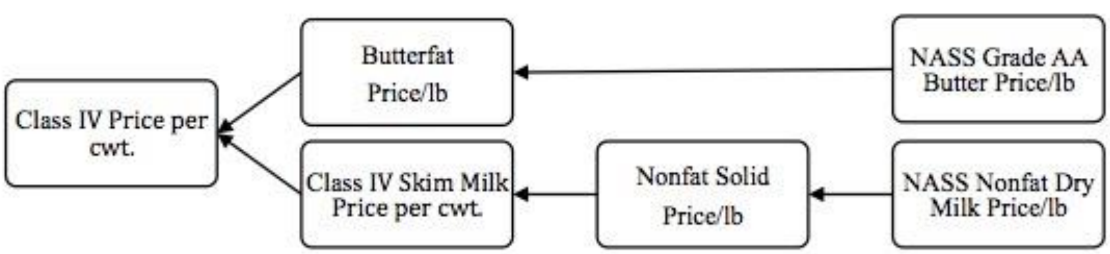

Figure 5. Class IV Price

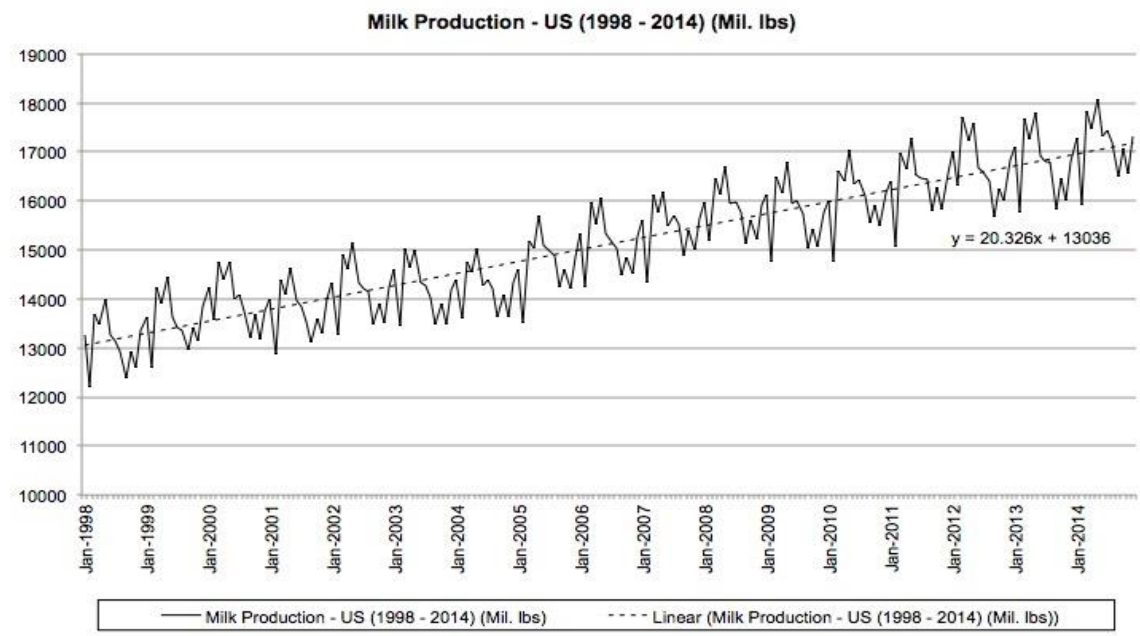

Figure 6. Milk Production

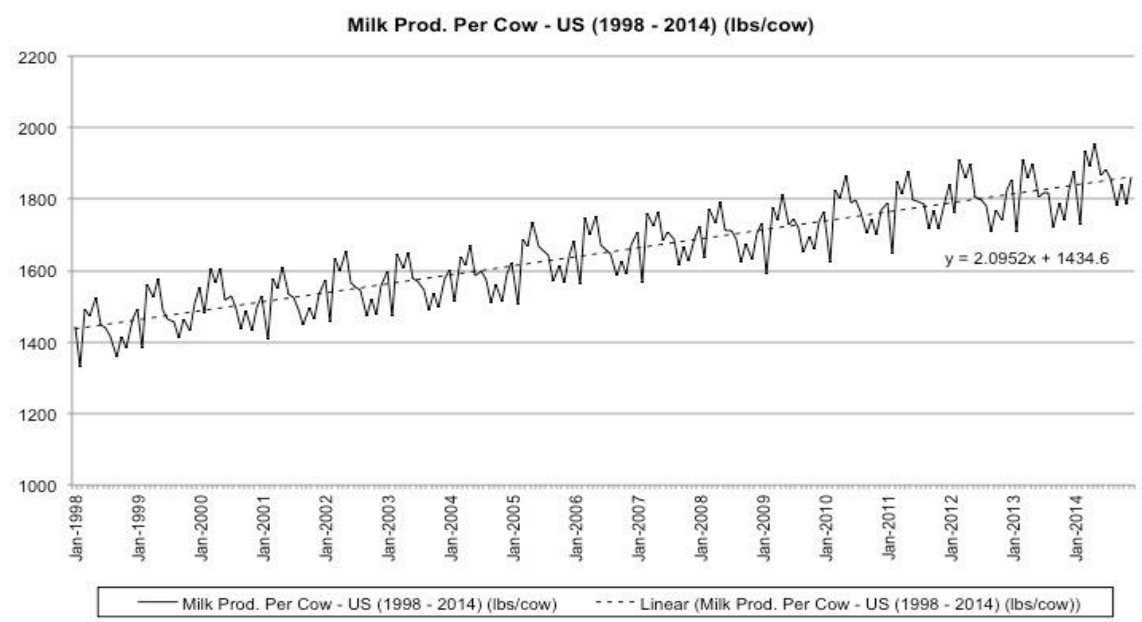

Figure 7. Milk Production Per Cow

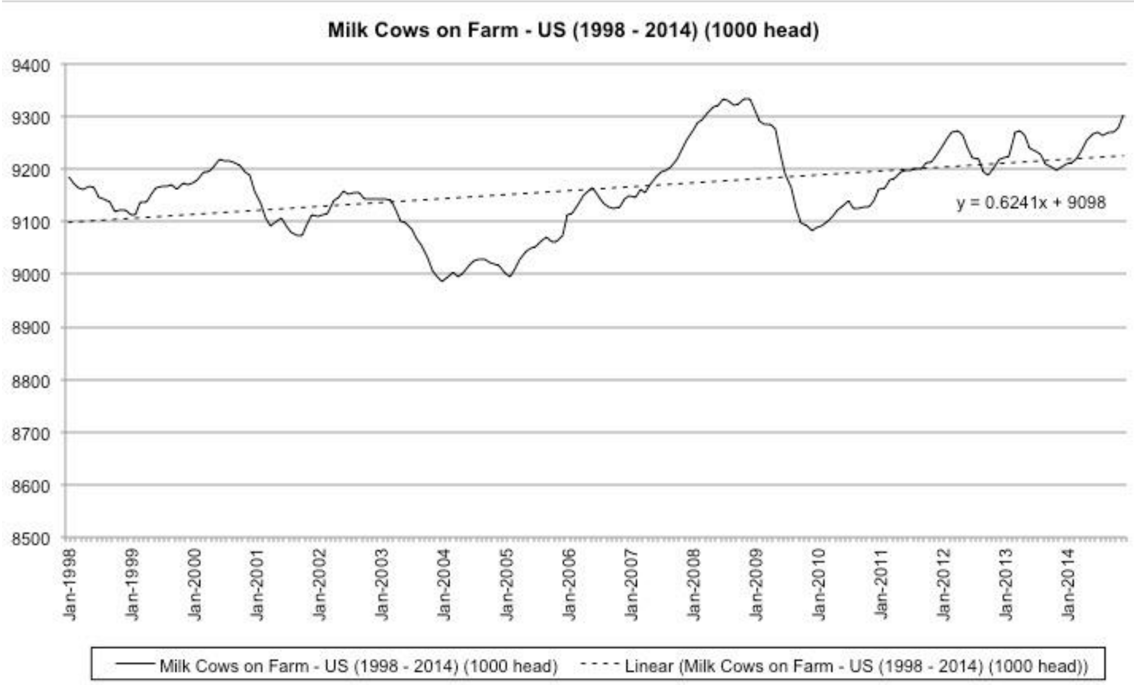

Figure 8. Milk Cows On Farm

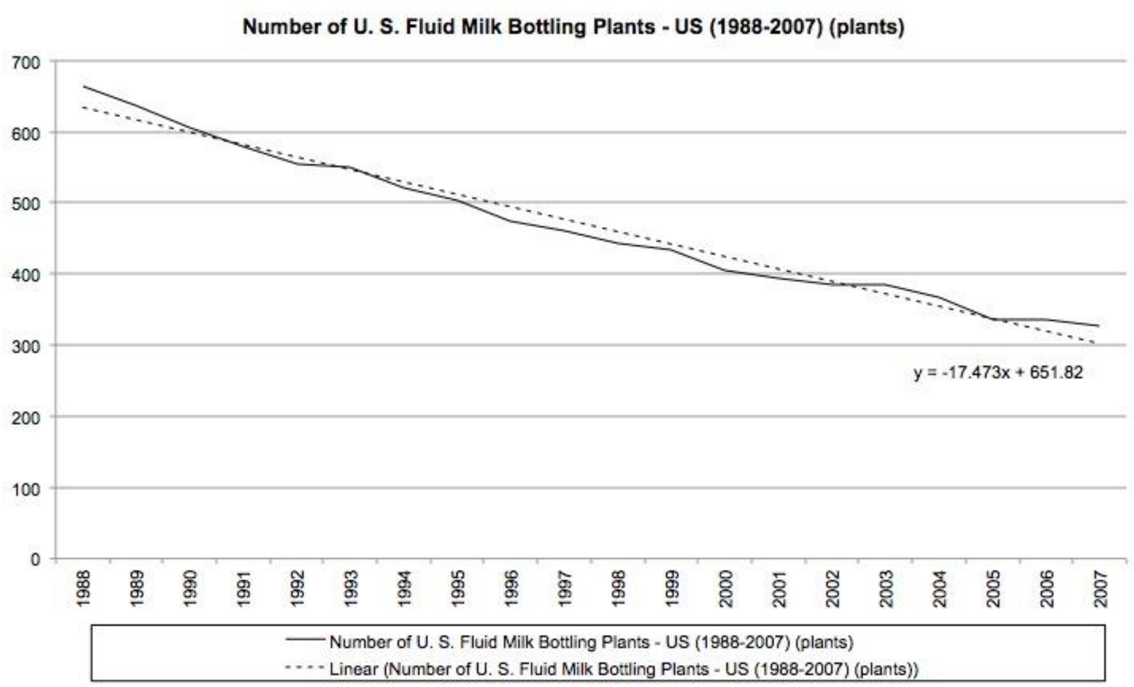

Figure 9. Number Of U.S. Fluid Milk Bottling Plants

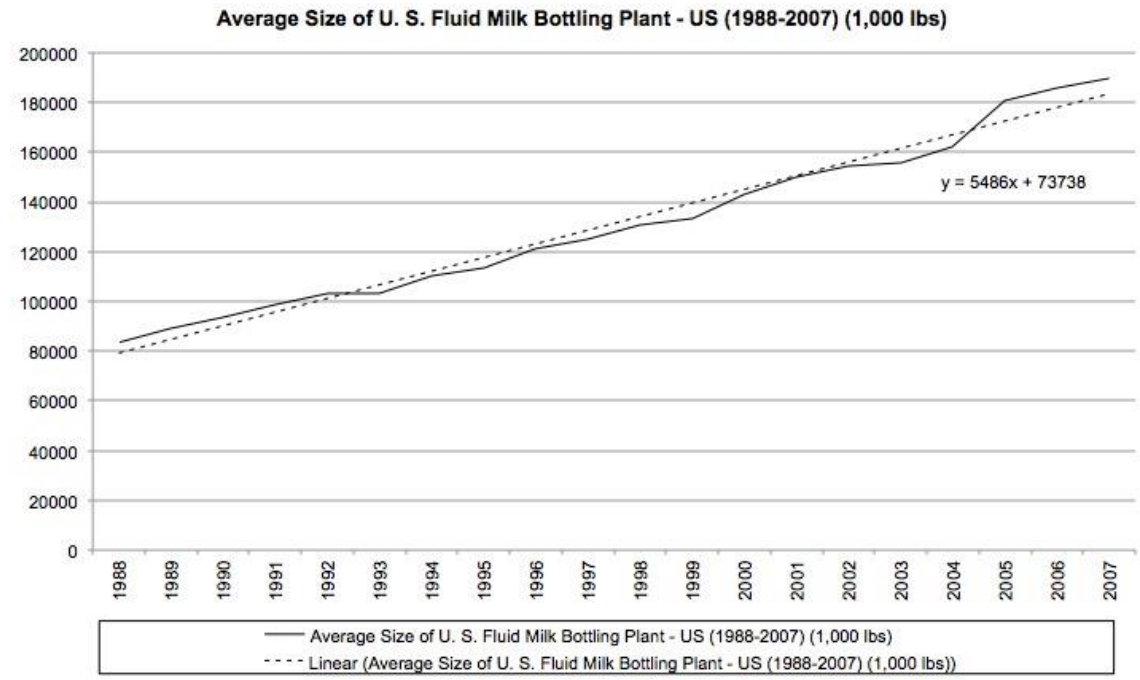

Figure 10. Average Size of U.S. Fluid Milk Bottling Plant

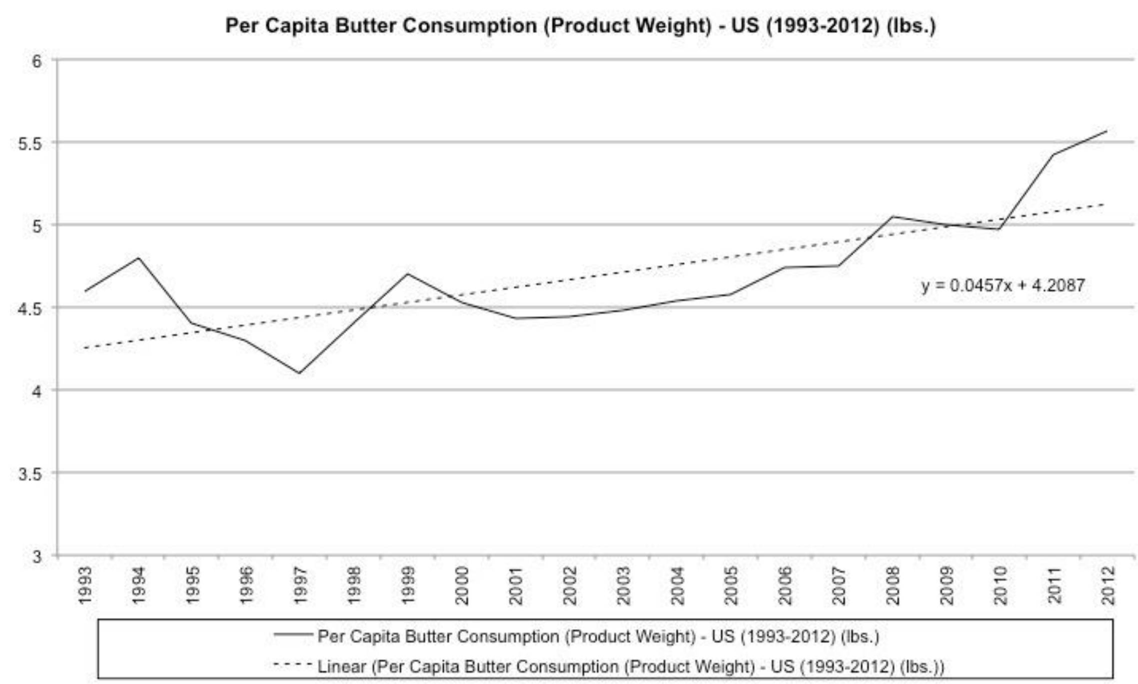

Figure 11. Per Capita Butter Consumption

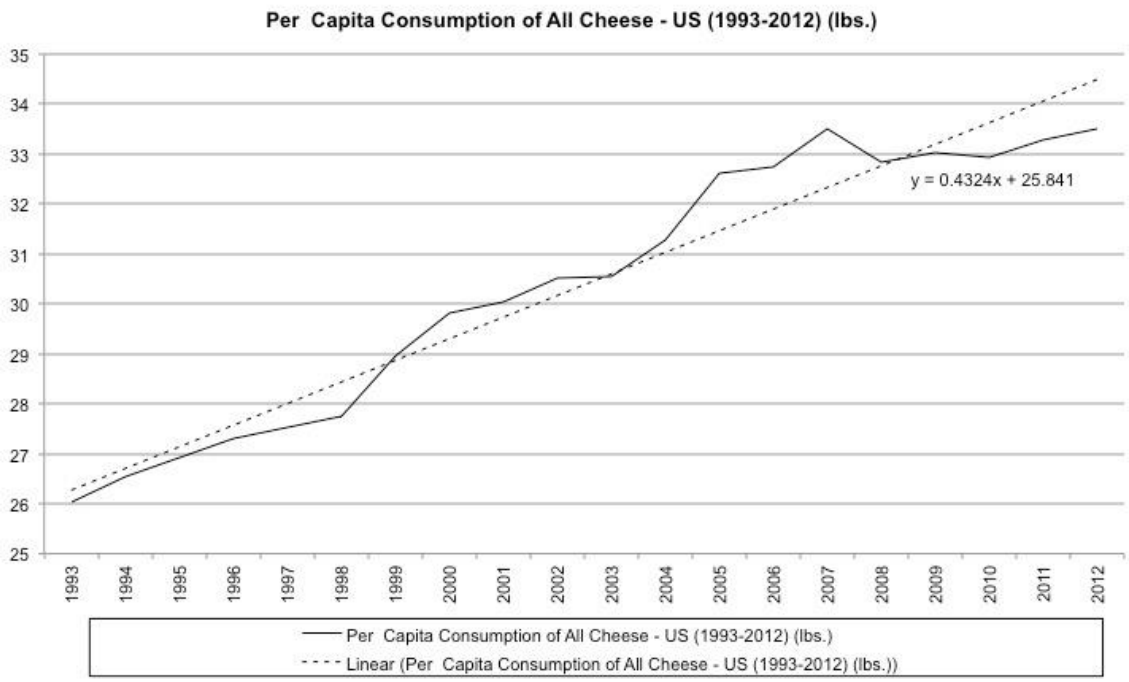

Figure 12. Per Capita Consumption of All Cheese

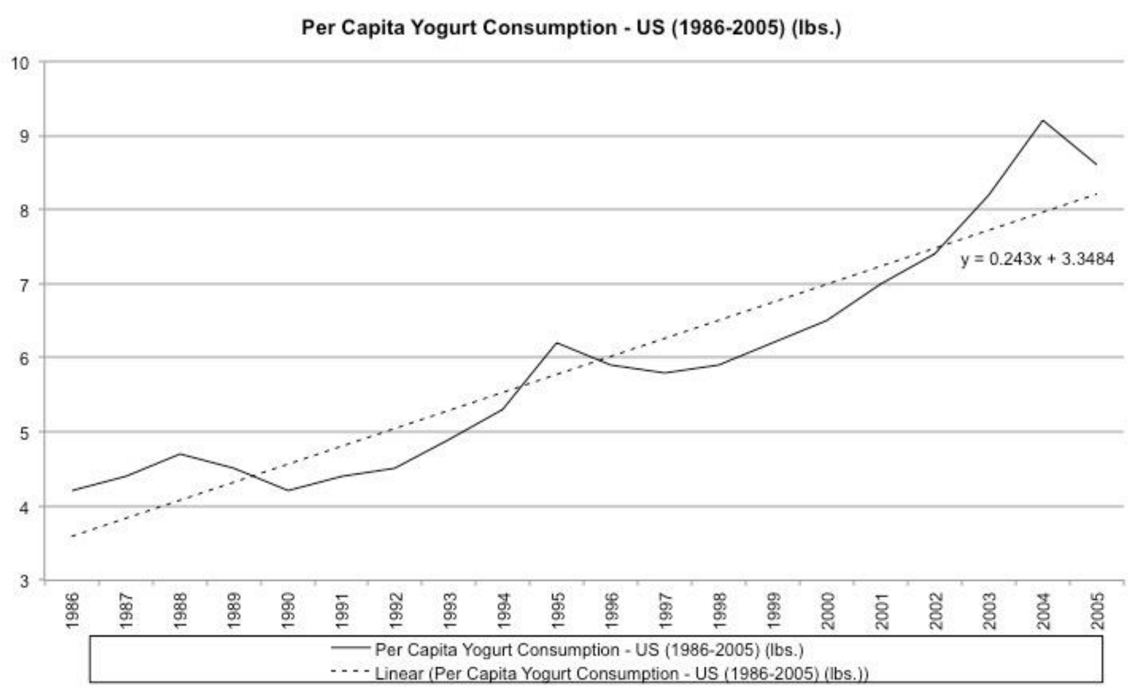

Figure 13. Per Capita Yogurt Consumption

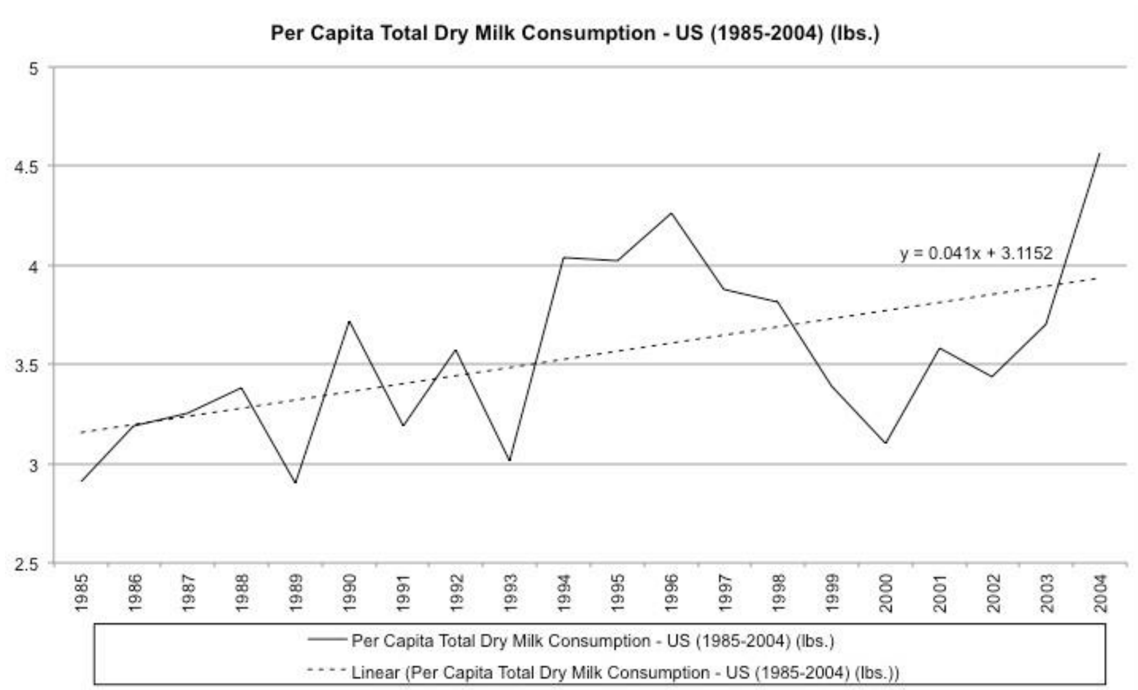

Figure 14. Per Capita Total Dry Mild Consumption

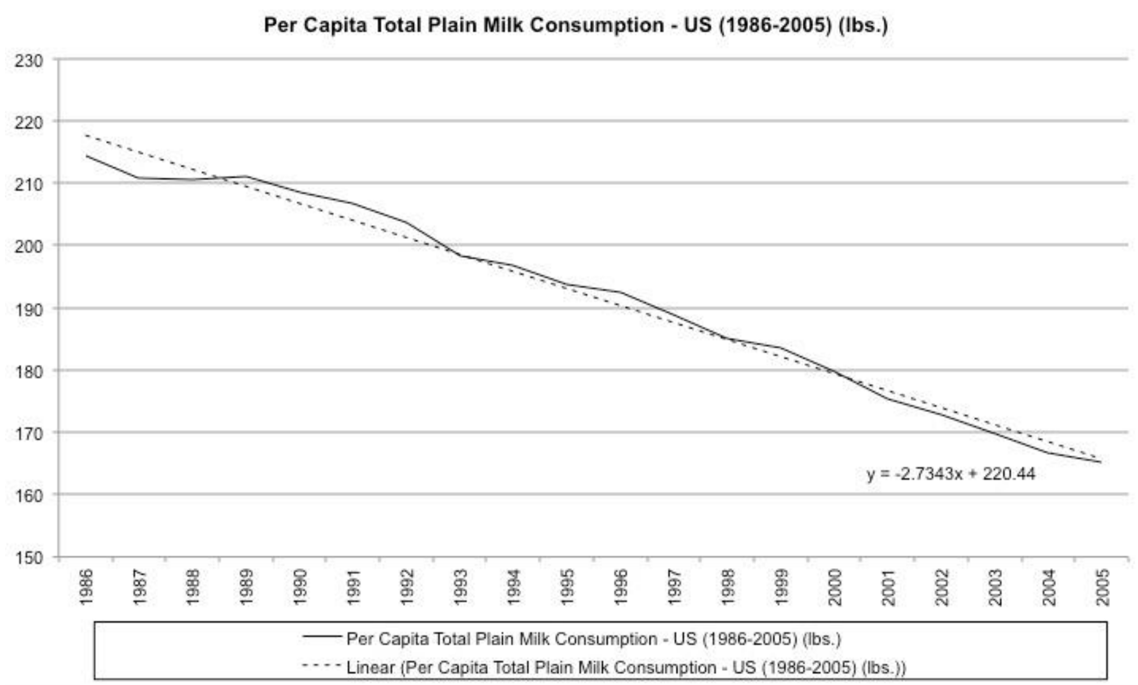

Figure 15. Per Capita Total Plain Milk Consumption

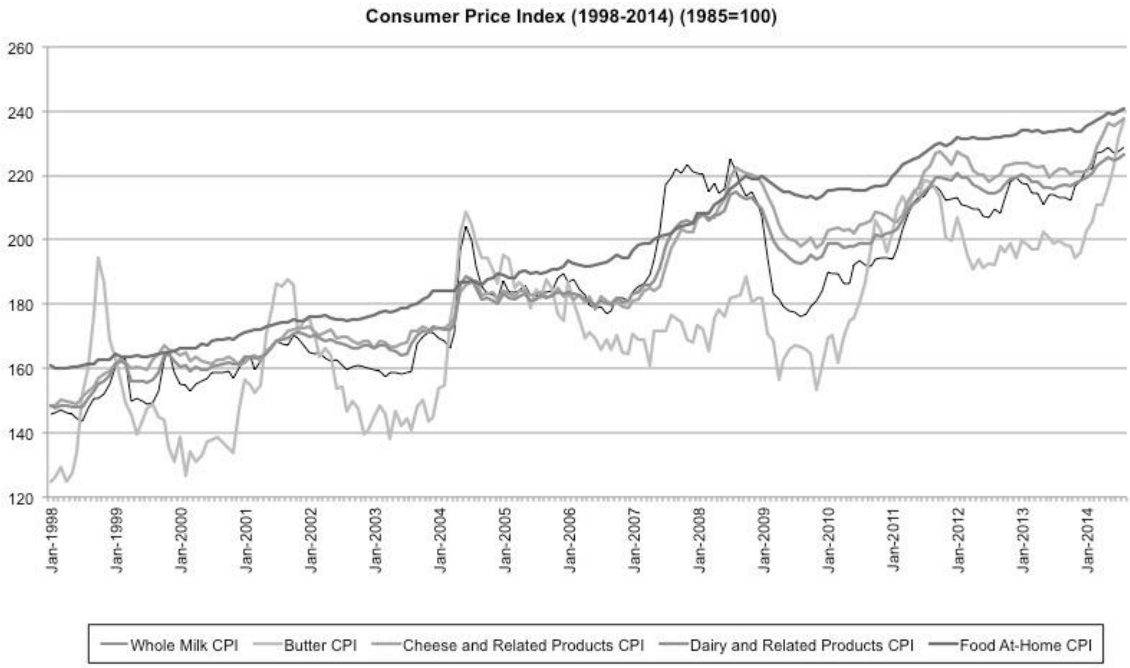

Figure 16. Consumer Price Index

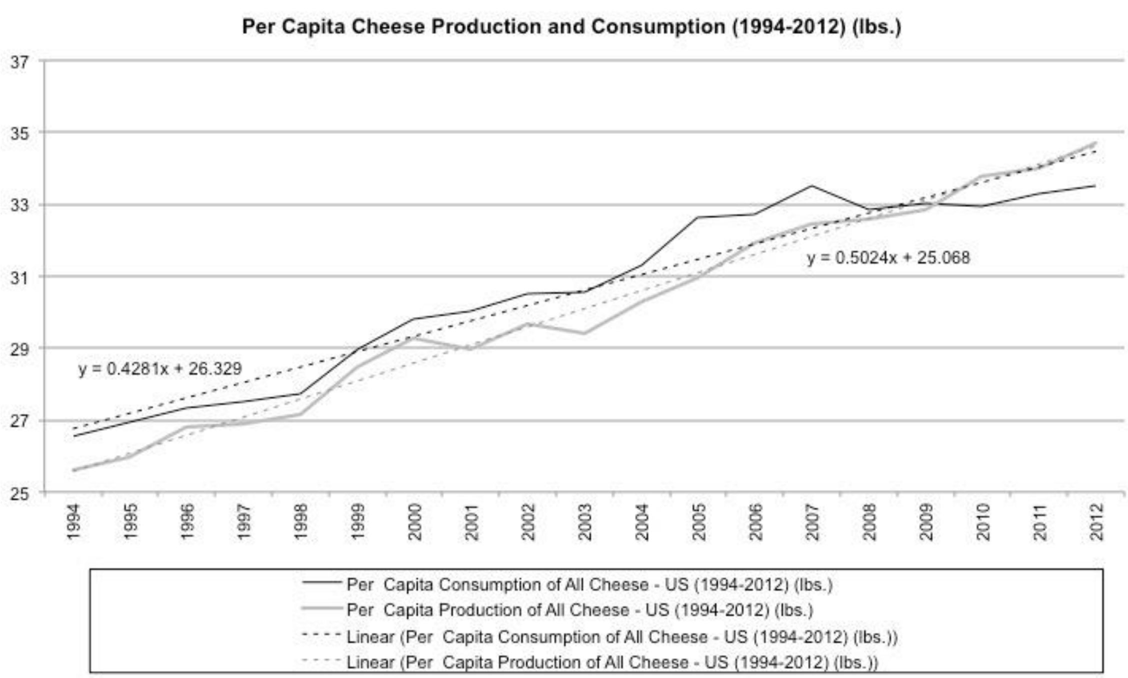

Figure 17. Per Capita Cheese Production and Consumption

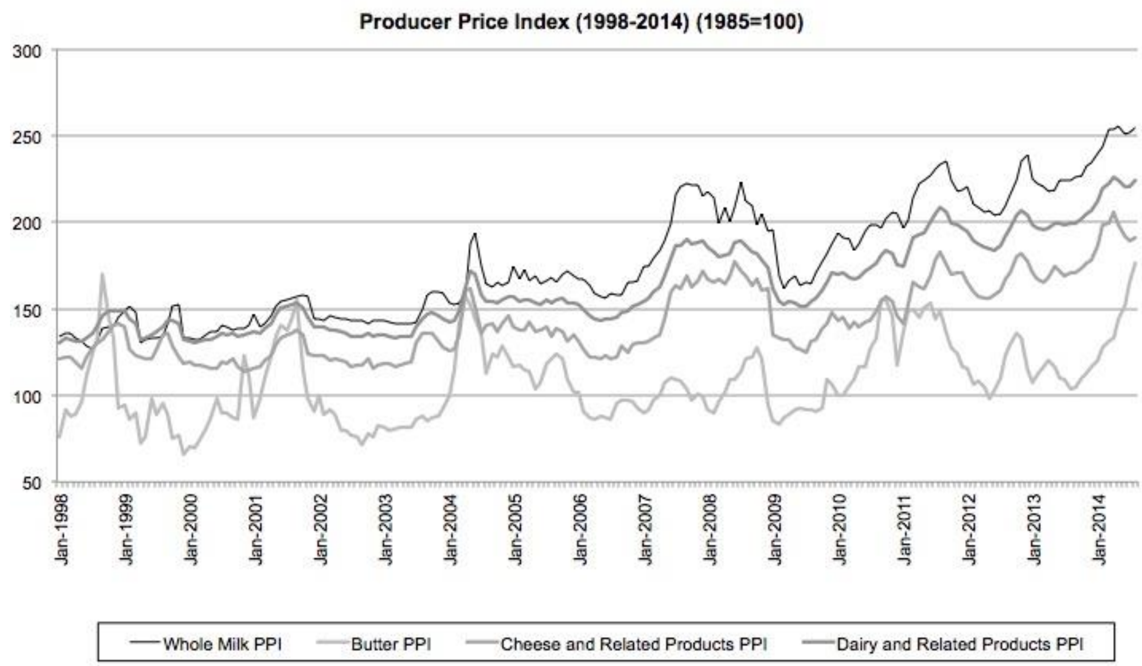

Figure 18. Producer Price Index

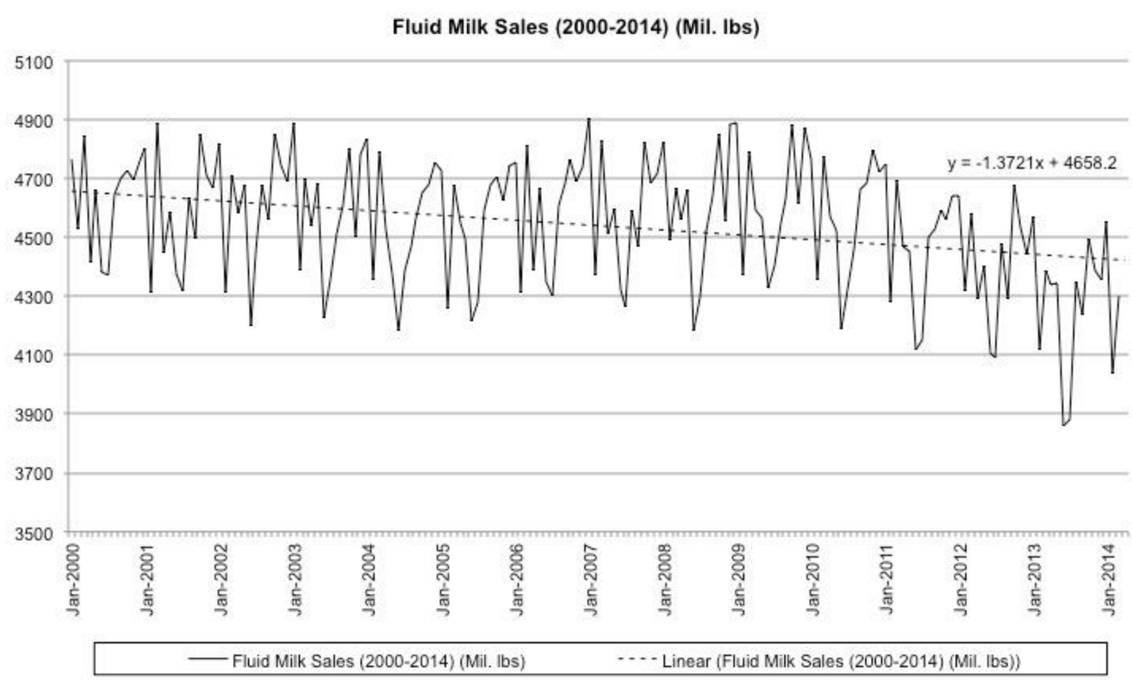

Figure 19. Fluid Milk Sales

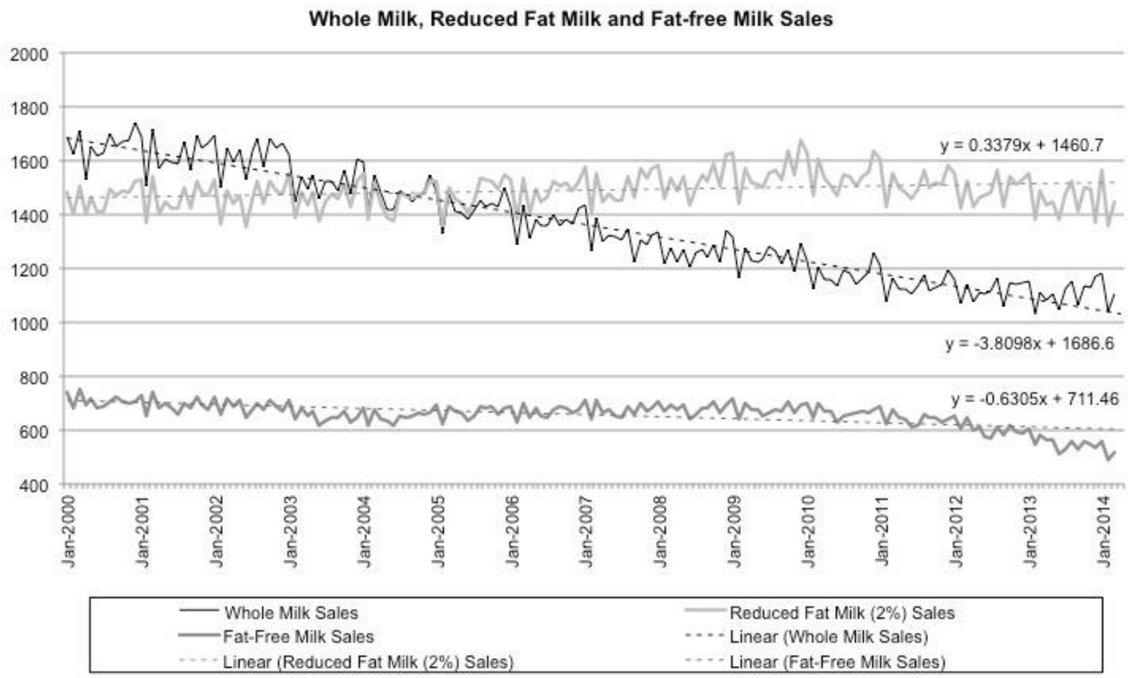

Figure 20. Whole Milk, Reduced Fat Milk and Fat-free Milk Sales

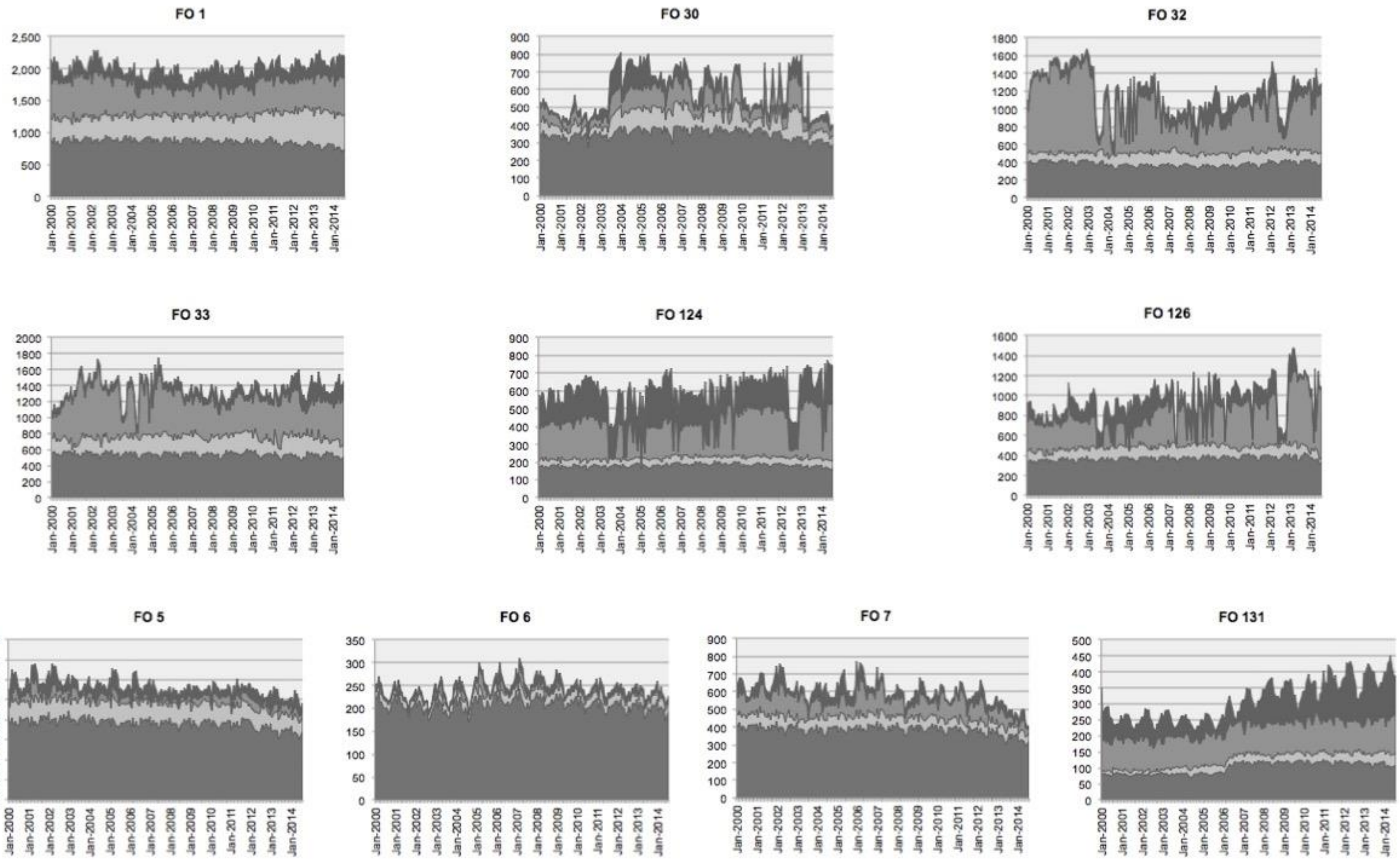

Figure 21. Amount of Utilization of Each Federal Order

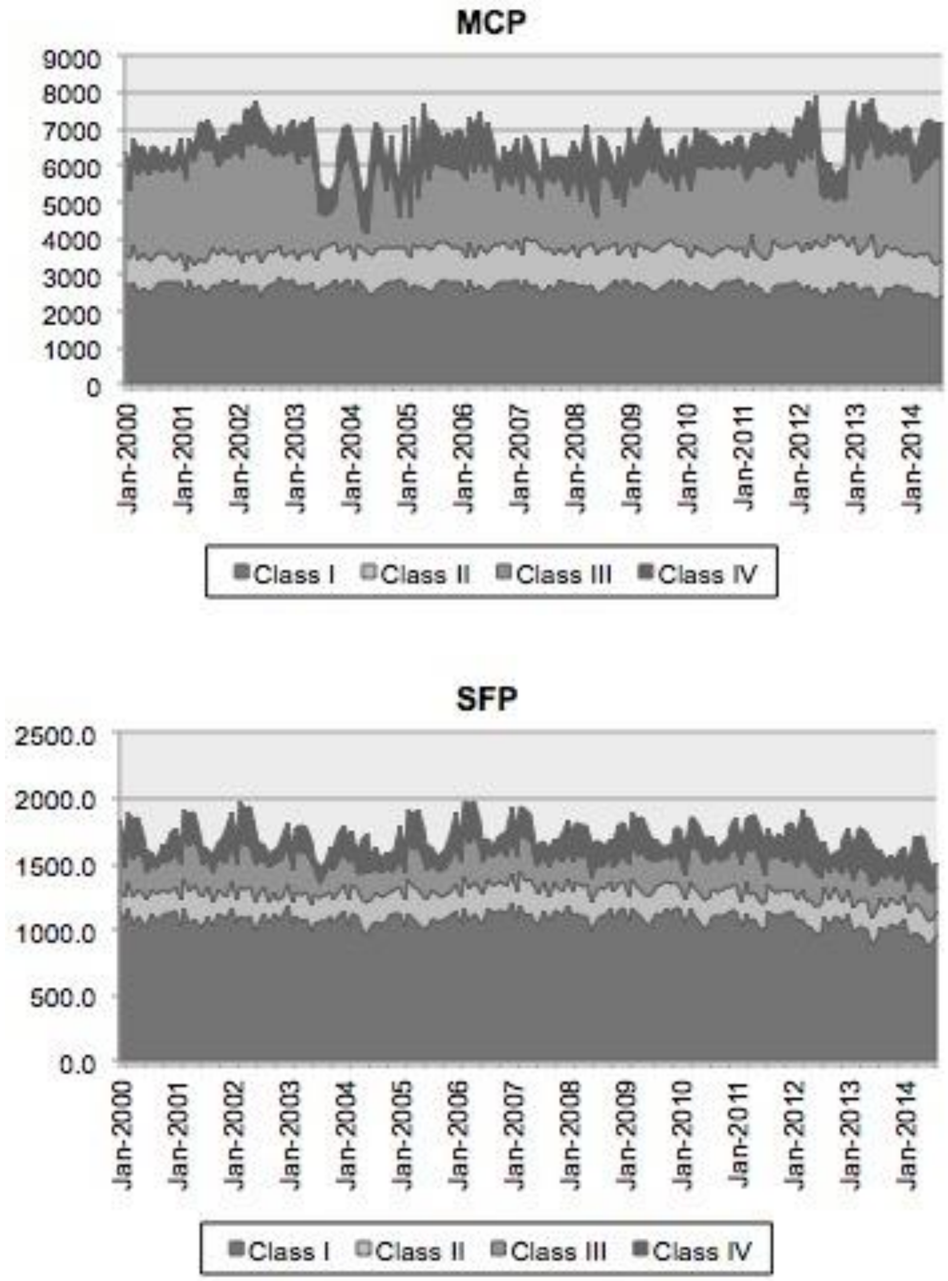

Figure 22. MCP and SFP Orders' Total Amount of Utilization

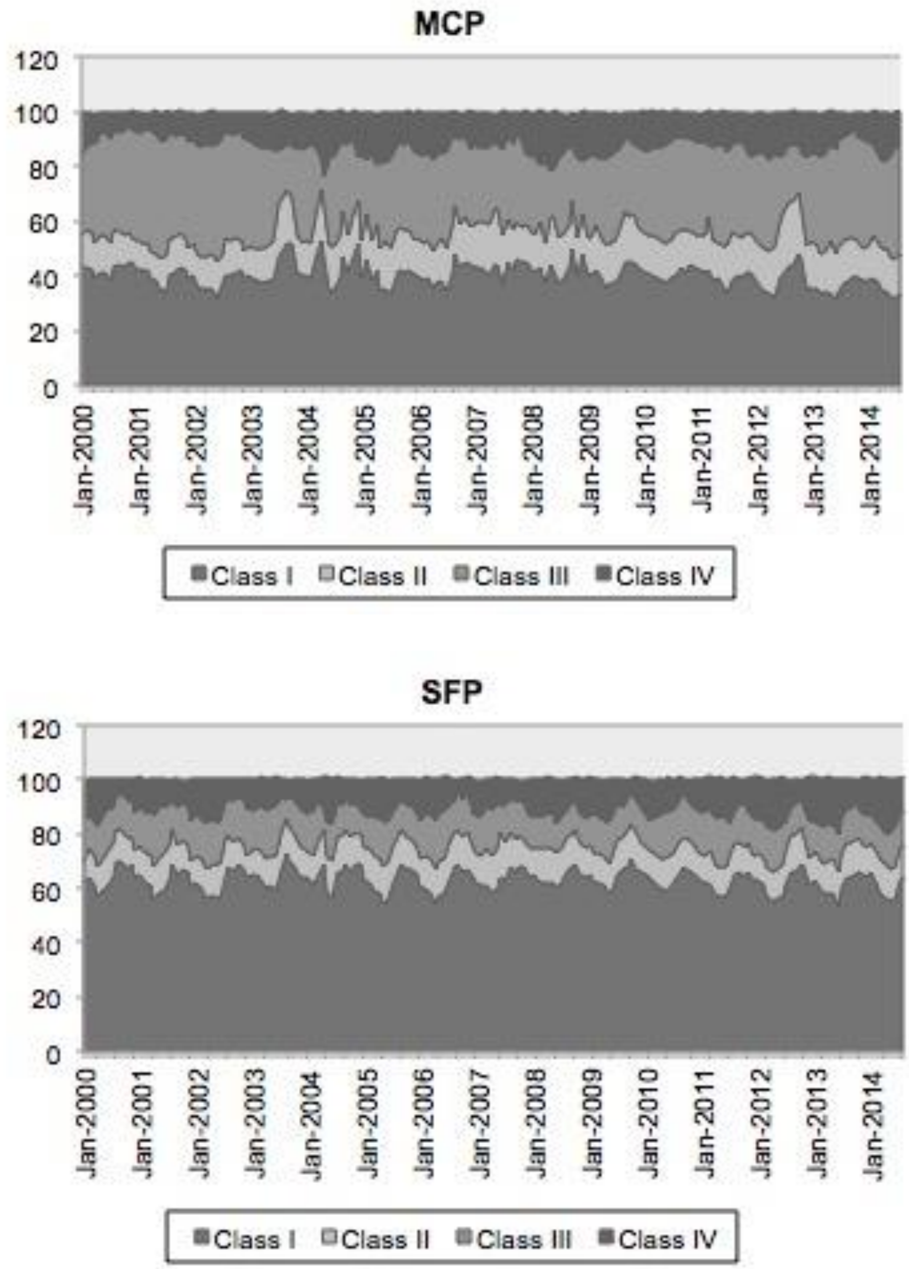

Figure 23. MCP and SFP orders' Percentage of Utilization

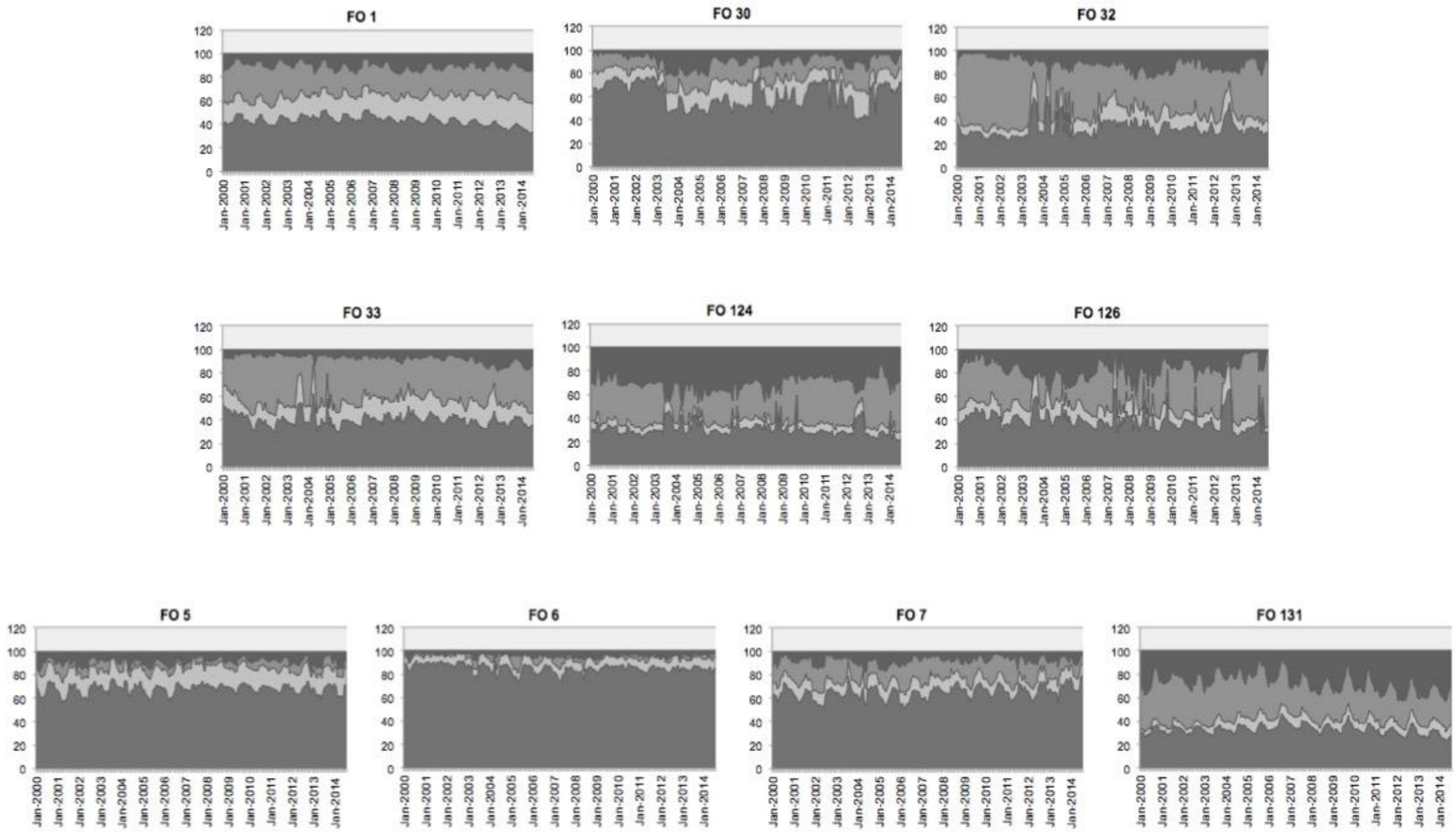

Figure 24. Percentage of Utilization of Each Federal Order

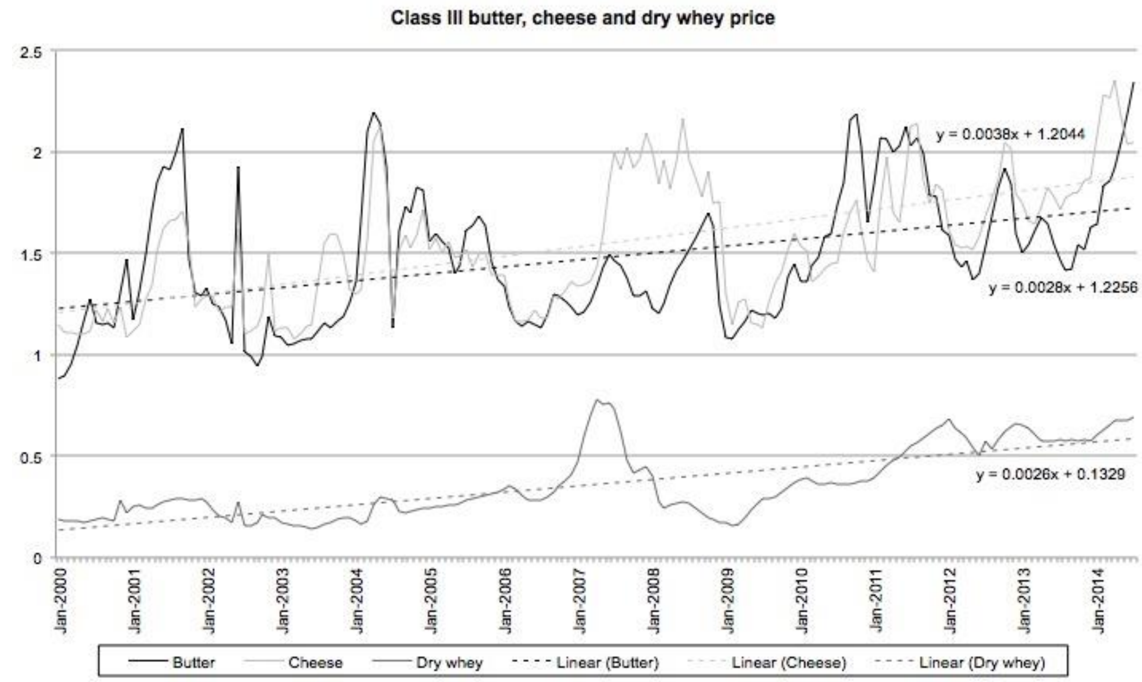

Figure 25. Class III Butter, Cheese and Dry Milk Price

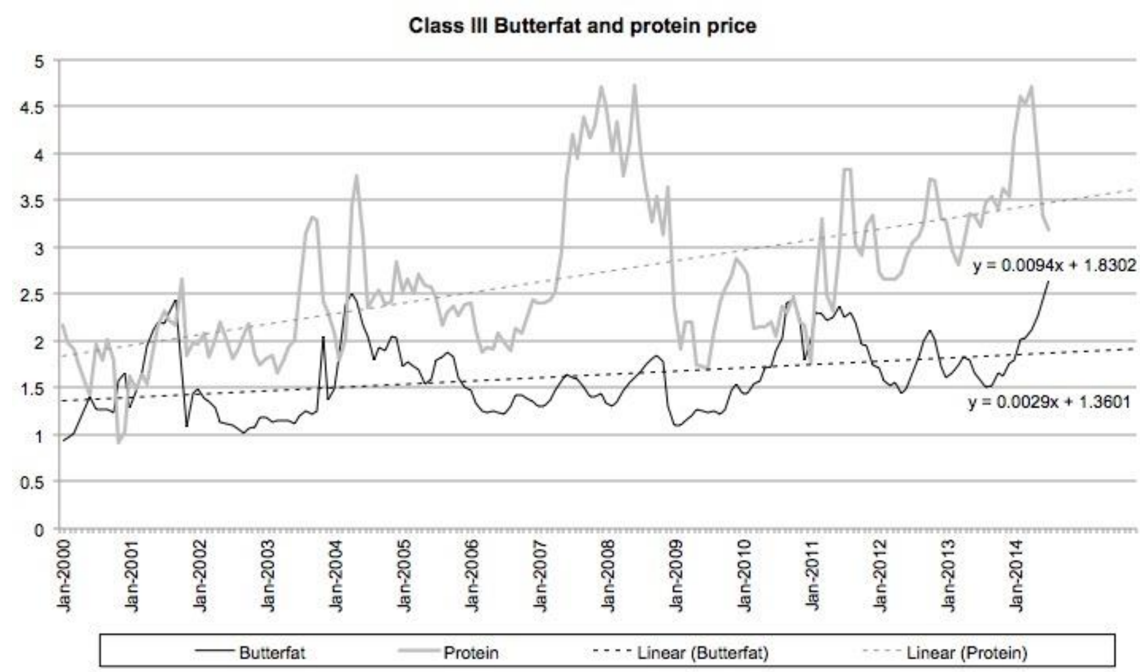

Figure 26. Class III Butterfat and Protein Price

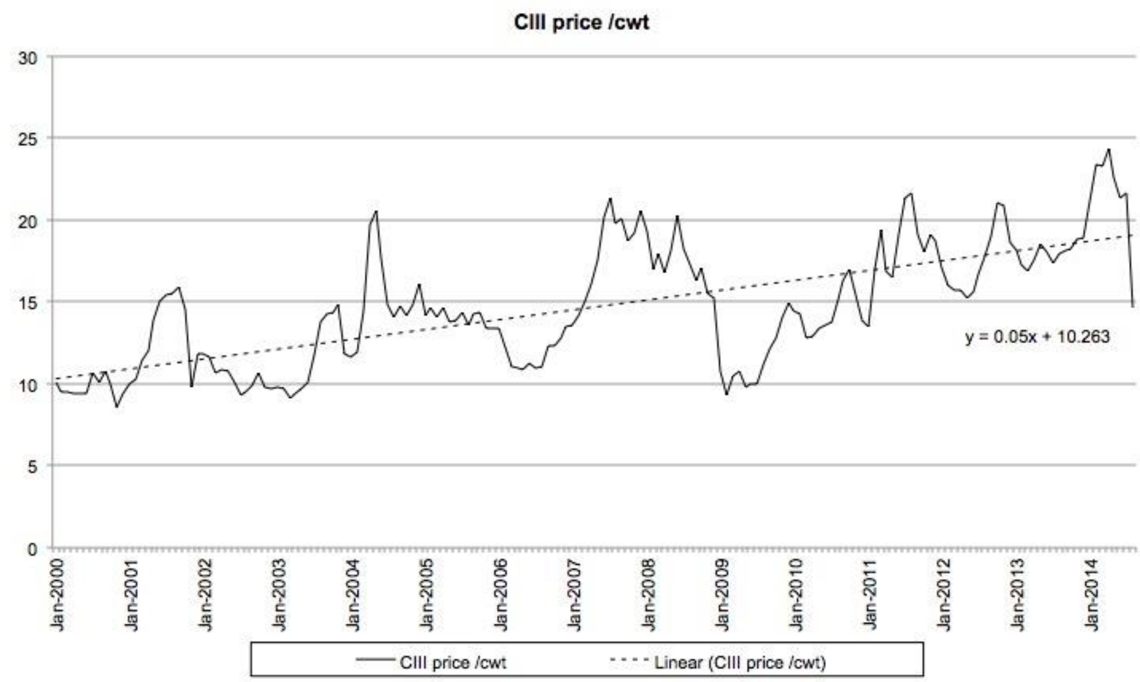

Figure 27. Class III Price

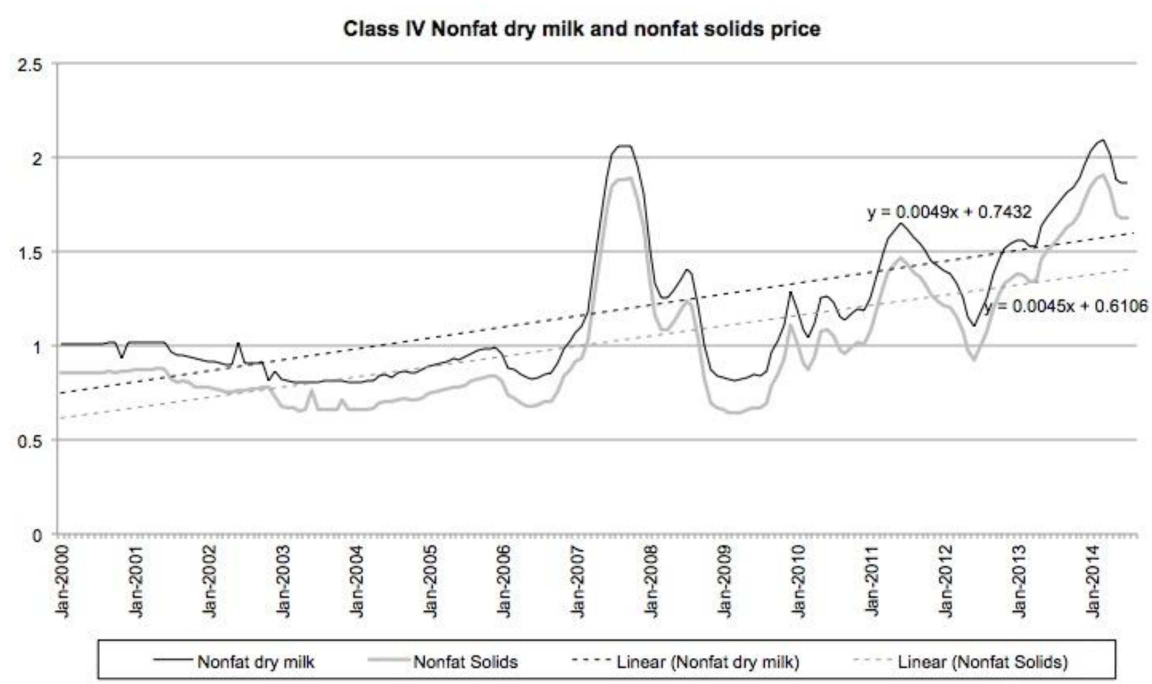

Figure 28. Class IV Nonfat Dry Milk and Nonfat Solids Price

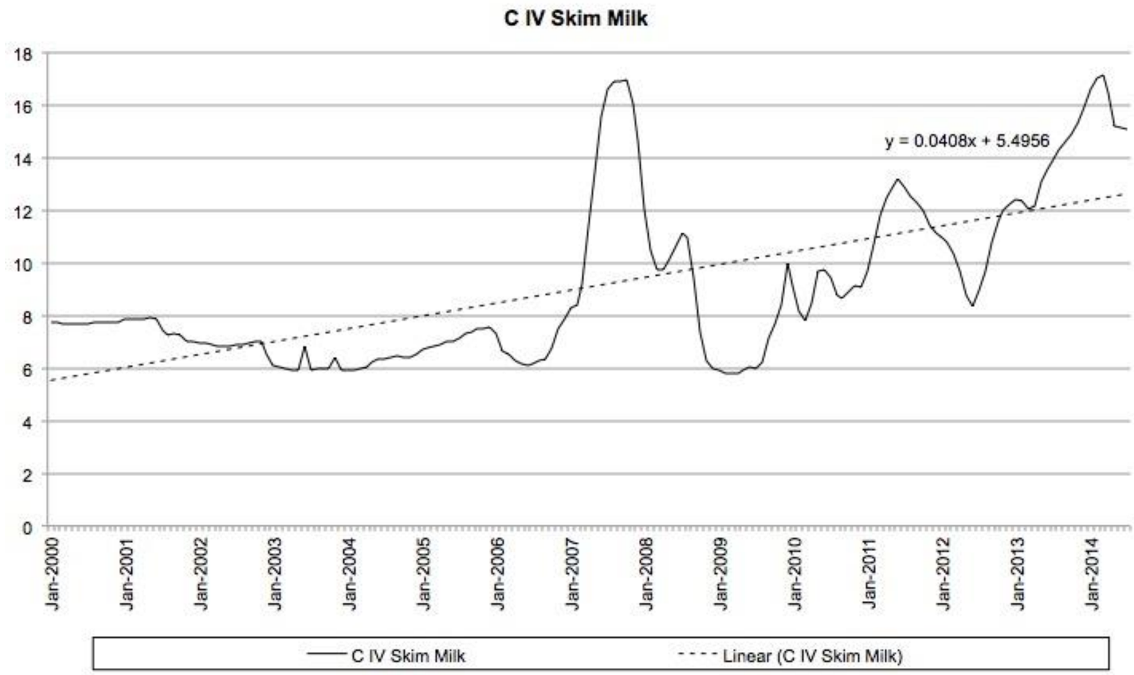

Figure 29. Class IV Skim Milk

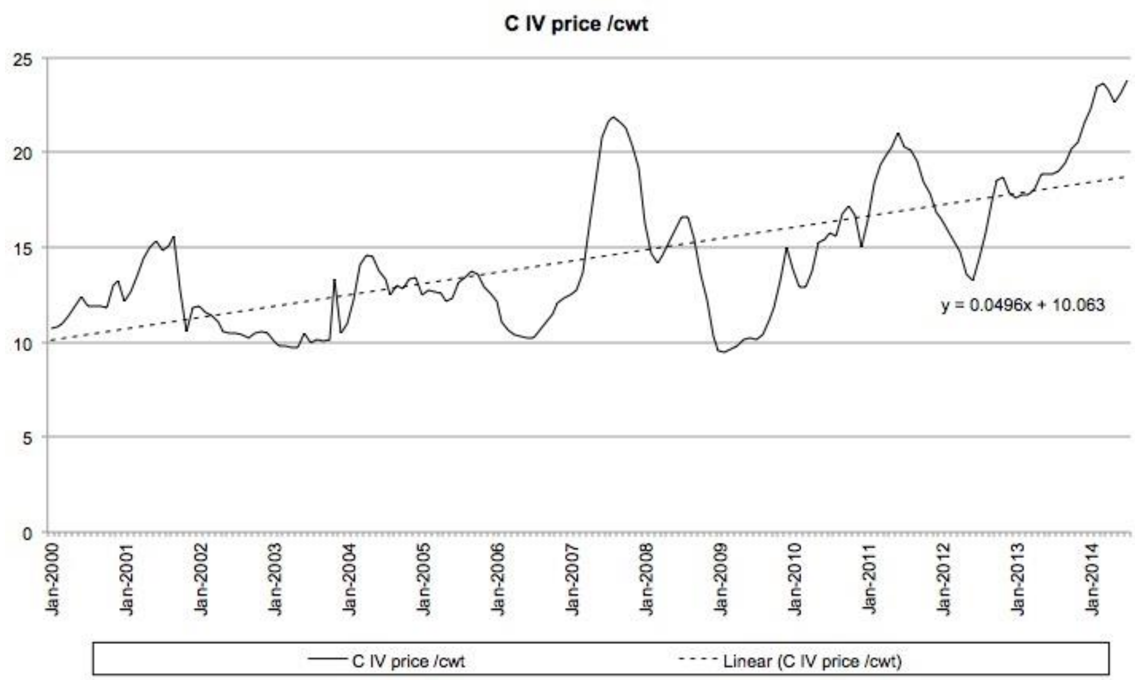

Figure 30. Class IV Price

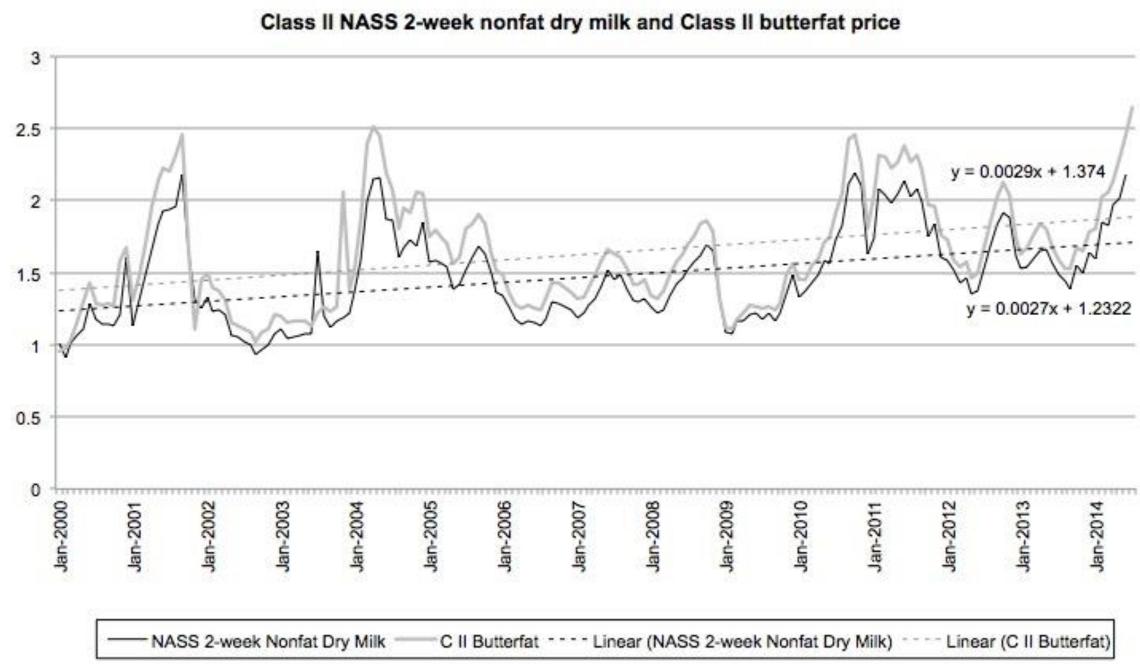

Figure 31. Class II NASS 2-week Nonfat Dry Milk And Class II Butterfat Price

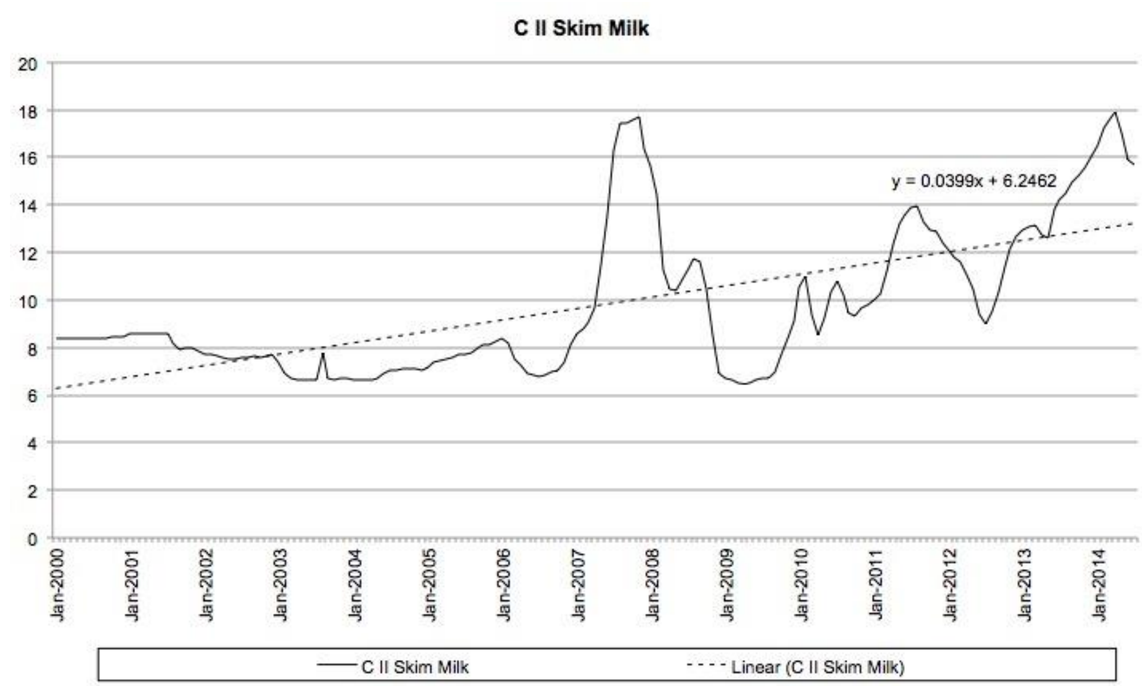

Figure 32. Class II Skim Milk Price

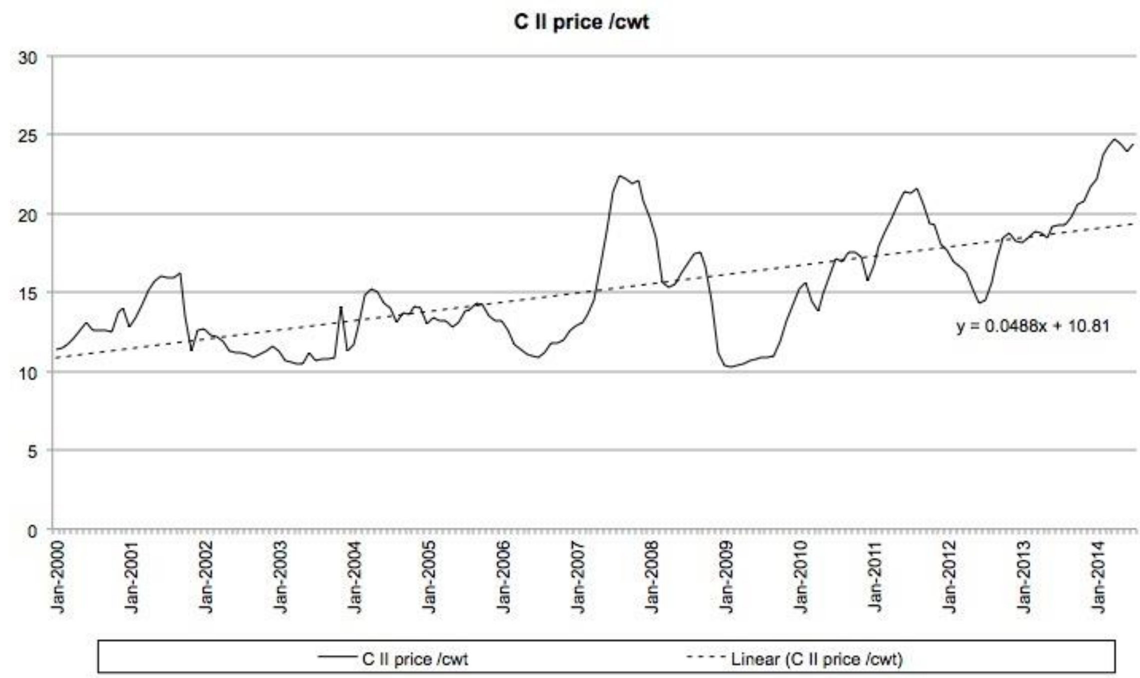

Figure 33. Class II Price

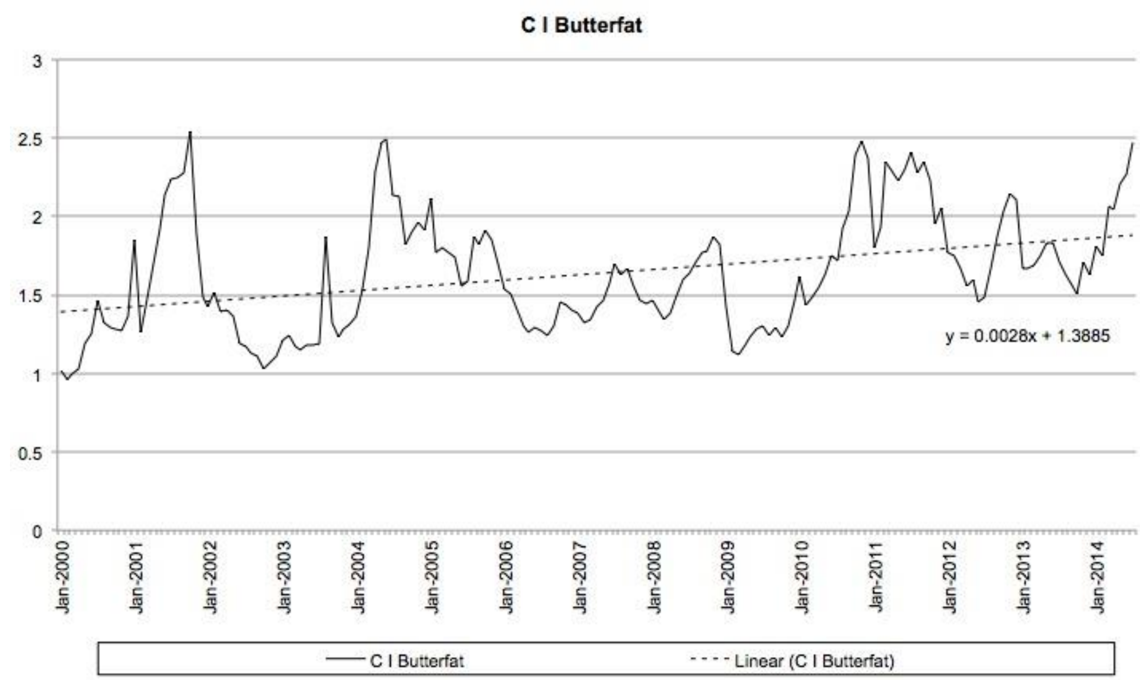

Figure 34. Class I Butterfat Price

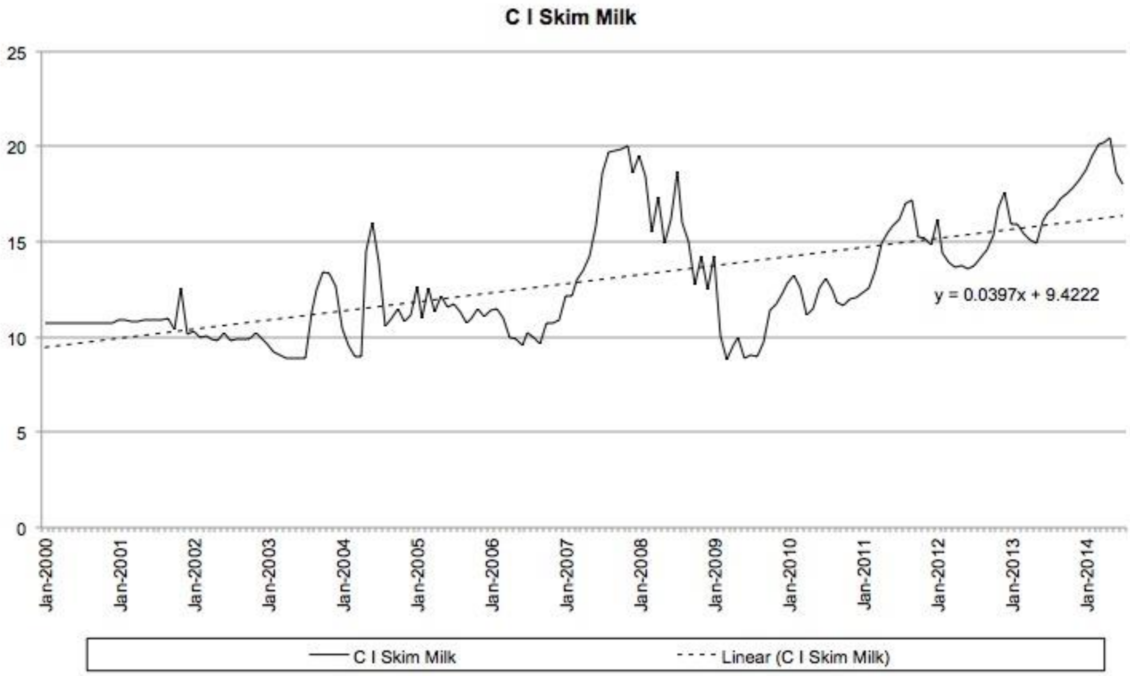

Figure 35. Class I Skim Milk Price

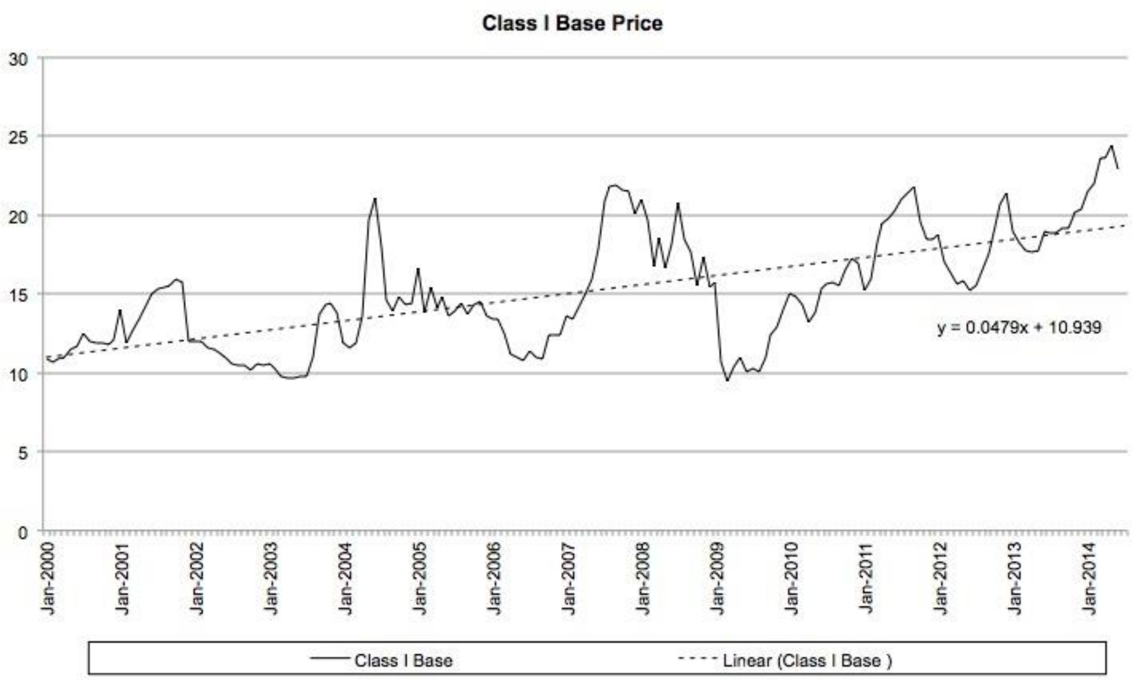

Figure 36. Class I Base Price

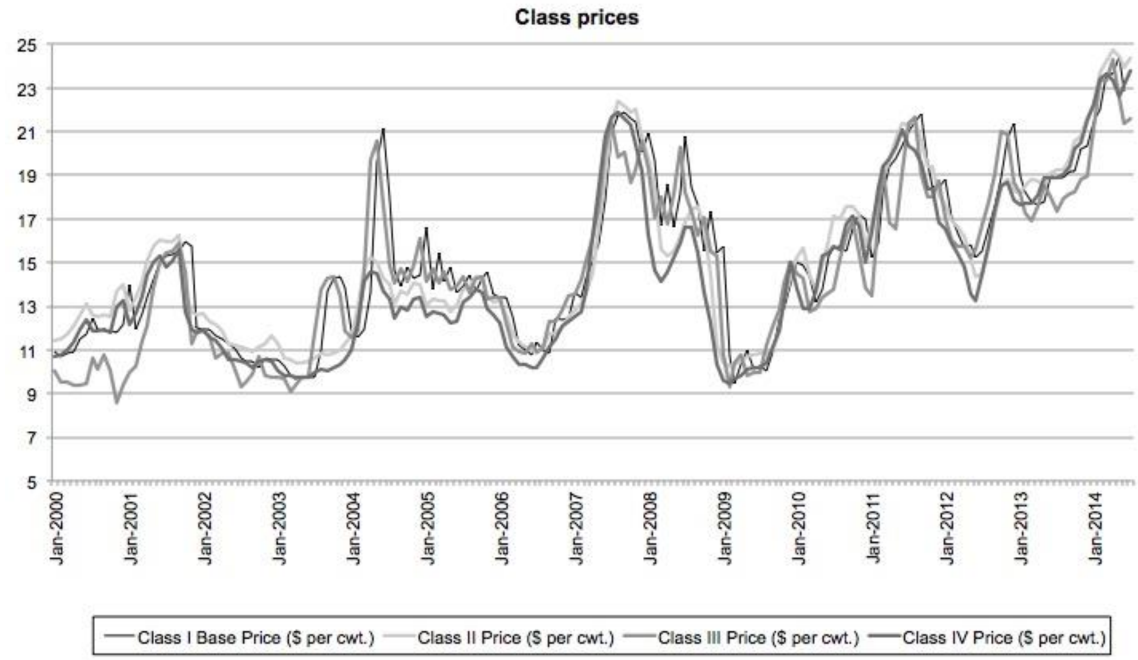

Figure 37. Class Prices

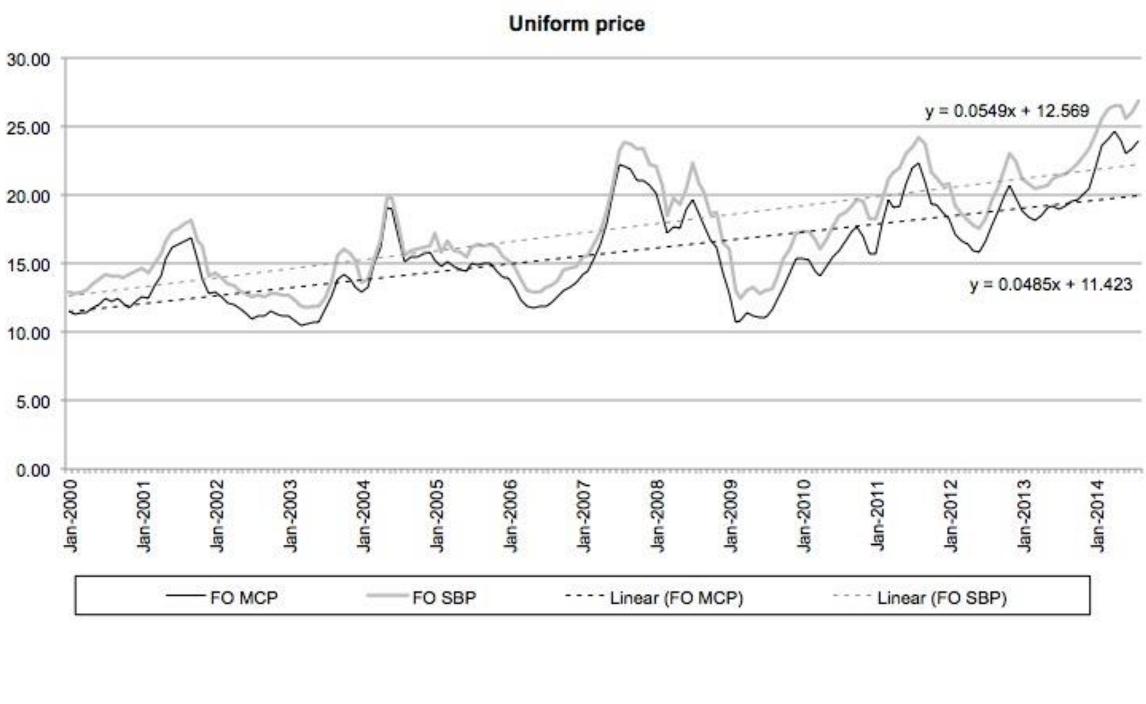

Figure 38. Uniform Price

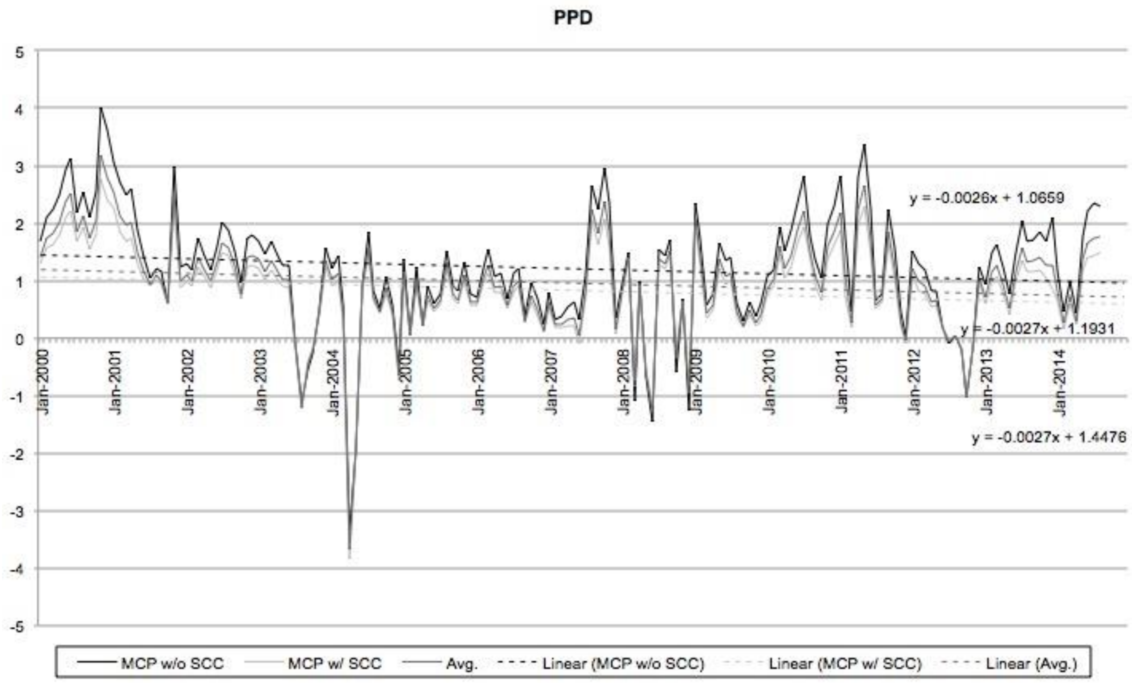

Figure 39. Producer Price Differential (PPD)

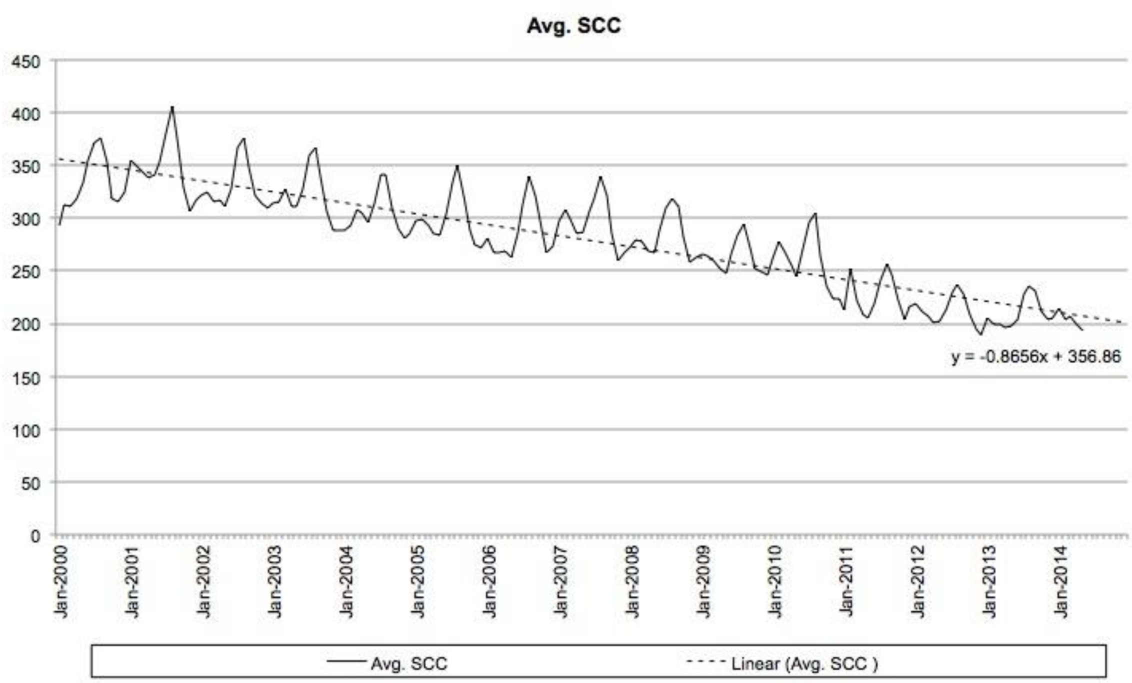

Figure 40. Average Somatic Cell Count

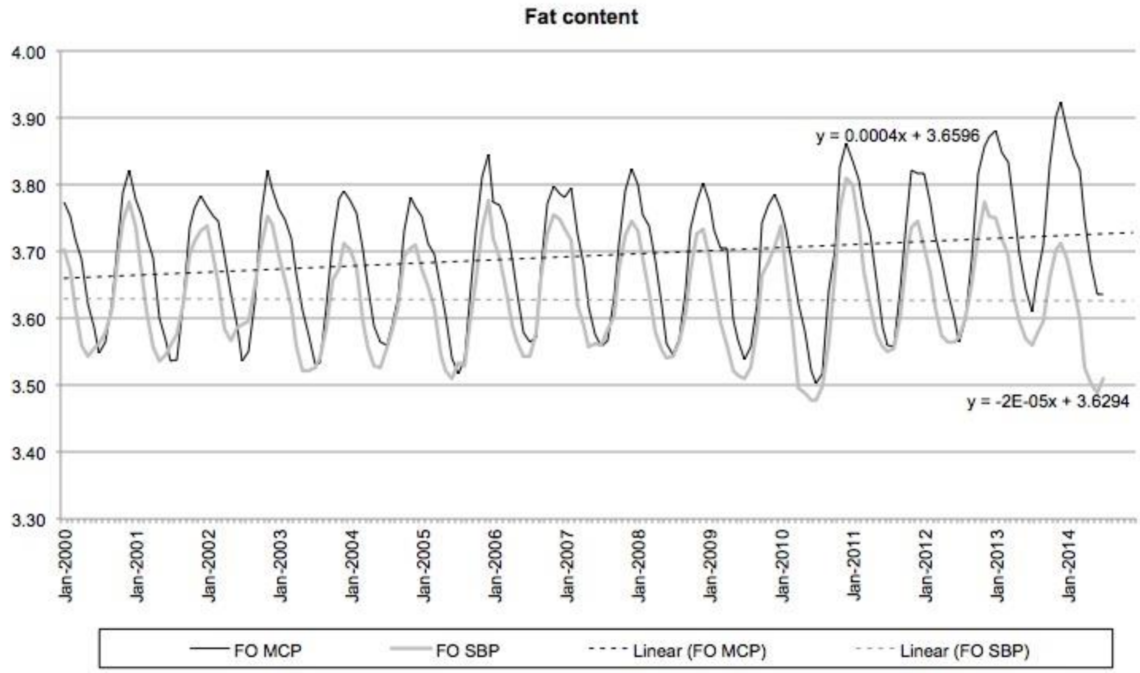

Figure 41. Average Fat Content of MCP and SFP Orders

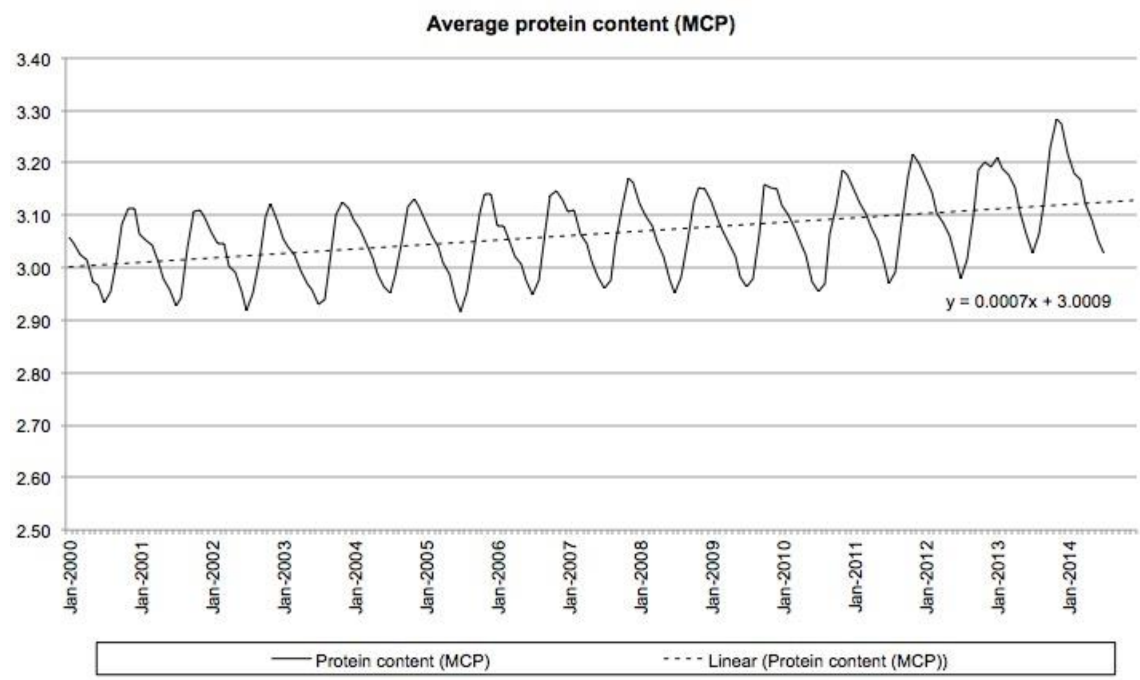

Figure 42. Average Protein Content of MCP Orders

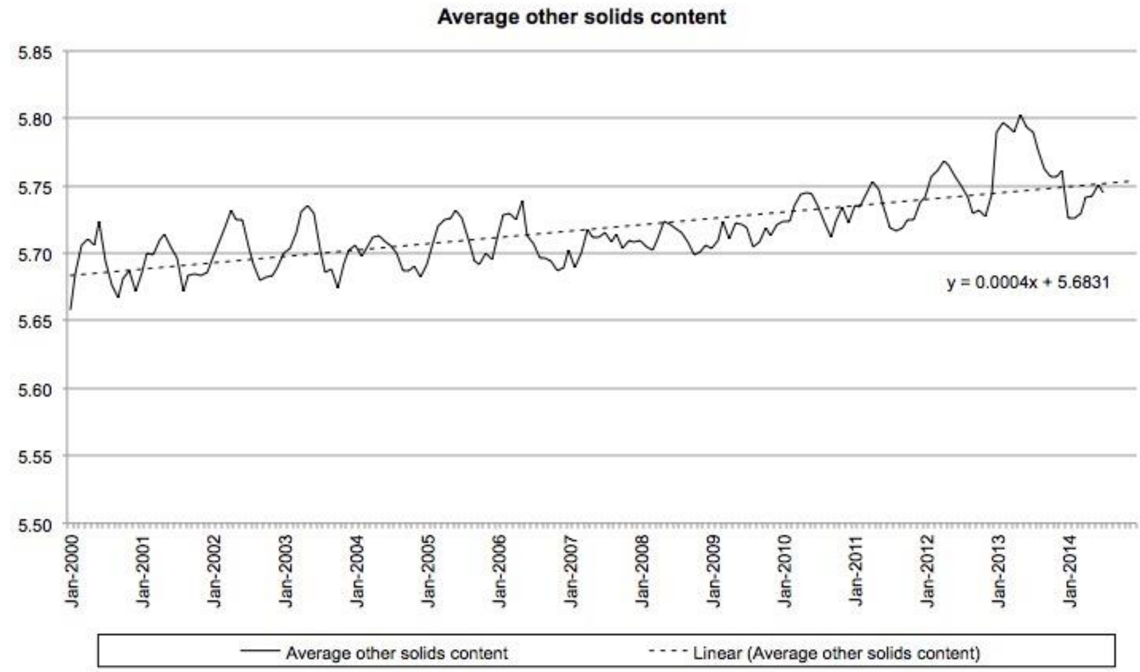

Figure 43. Average Other Solids Contents of MCP Orders

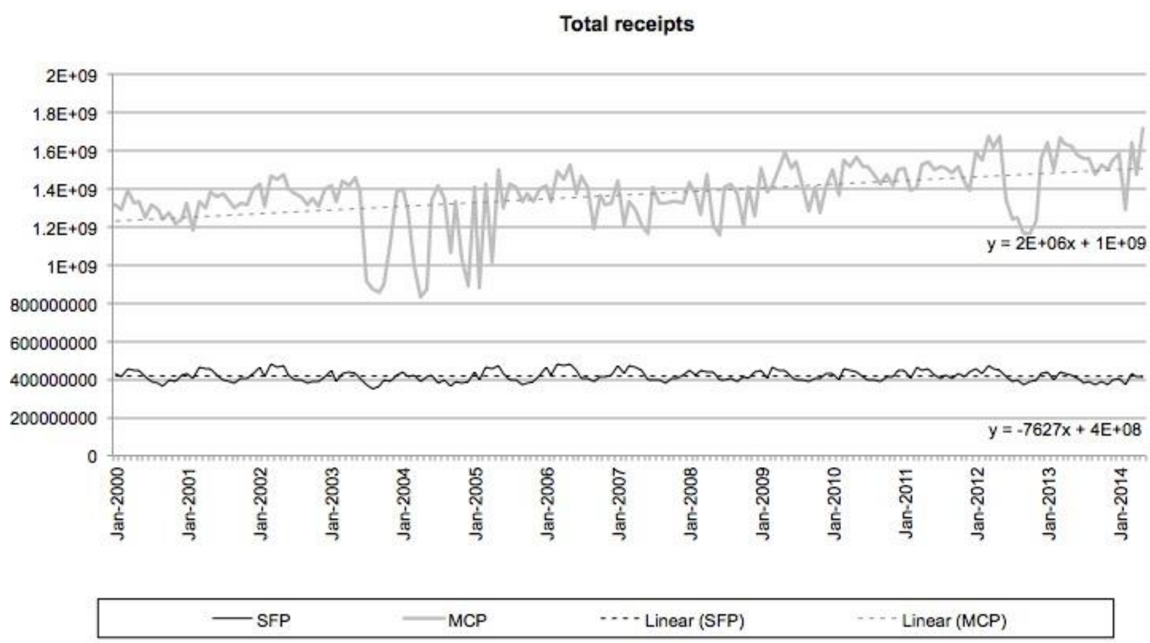

Figure 44. Total Receipts

APPENDIX B

TABLES

Table 1. Formula of Class IV Price

Formula	#
Class IV Price = (Class IV Skim Milk Price * 0.965) + (Butterfat Price * 3.5)	1
Butterfat Price = (NASS Monthly AA Butter Price - 0.1715) * 1.211	2
Butter Price = $\frac{\sum_{j=1}^{4\ or\ 5}((\text{Weekly Butter Price})_j \cdot (\text{Weekly Butter Sales})_j)}{\sum_{j=1}^{4\ or\ 5}(\text{Weekly Butter Sales})_j}$	3
Class IV Skim Milk Price = Nonfat Solids Price * 9	4
Nonfat Solids Price = (Nonfat Dry Milk Price – 0.1678) * 0.99	5
Nonfat Dry Milk (NFDM) Price = $\frac{\sum_{j=1}^{4\ or\ 5}((\text{Weekly NFDM Price})_j \cdot (\text{Weekly NFDM Sales})_j)}{\sum_{j=1}^{4\ or\ 5}(\text{Weekly NFDM Sales})_j}$	6

Table 2. Formula of Class III Price

Formula	#
Class III Price = (Class III Skim Milk Price * 0.965) + (Butterfat Price * 3.5)	7
Class III Skim Milk Price = (Protein Price * 3.1) + (Other Solids Price * 5.9)	8
Protein Price = ((Cheese Price – 0.2003) * 1.383) + ((((Cheese Price – 0.2003) * 1.572) – Butterfat Price * 0.9) * 1.17)	9
Cheese Price = $\frac{\sum_{j=1}^{4\ or\ 5}(((\text{Barrel Price})_j \cdot (\text{Barrel Sales})_j)+((\text{Block Price})_j \cdot (\text{Block Sales})_j))}{\sum_{j=1}^{4\ or\ 5}(\text{Barrel Sales})_j + (\text{Block Sales})_j}$	11
Other Solids Price = (Dry Whey Price – 0.1991) * 1.03	12
Dry Whey Price = $\frac{\sum_{j=1}^{4\ or\ 5}((\text{Weekly Dry Whey Price})_j \cdot (\text{Weekly Dry Whey Sales})_j)}{\sum_{j=1}^{4\ or\ 5}(\text{Weekly Dry Whey Sales})_j}$	13

Table 3. Formula of Class II Price

Formula	#
Class II Price = (Class II Skim Milk Price * 0.965) + (Class II Butterfat Price * 3.5)	14
Class II Butterfat Price = Butterfat Price + 0.007	15
Class II Skim Milk Price = Advanced Class IV Skim Milk Price Factor + 0.70	16
Advanced Class IV Skim Milk Price Factor = Advanced Nonfat Solid Price * 9.0	17
Advanced Nonfat Solids Price = (NASS 2-week Nonfat Dry Milk Price – 0.14) * 0.99	18

Table 4. Formula of Class I Price

Formula	#
Class I Price = (Class I Skim Milk Price * 0.965) + (Class I Butterfat Price * 3.5)	19
Class I Butterfat Price = Advanced Butterfat Price + (Class I Differential /100)	20
Advanced Butterfat Price = (NASS 2-week AA Butter Price – 0.115) * 1.20	21
Class I Skim Milk Price = Higher of: (Advanced Class IV Skim Milk Price Factor) or (Advanced Class III Skim Milk Price Factor) + Class I Differential	22
Advanced Class III Skim Milk Price Factor = (Advanced Protein Price * 3.1) + (Advanced Other Solids Price * 5.9)	23
Advanced Protein Price = (NASS 2-week Cheese Price – 0.165) * 1.383 + {[(NASS 2-week Cheese Price – 0.165) * 1.572] – 0.9 * Advanced Butterfat Price} * 1.17	24
Advanced Other Solids Price = (NASS 2-week Dry Whey Price – 0.159) * 1.03	25

Table 5. Slopes of CPI and PPI

	CPI	PPI
Dairy and related products	0.3773	0.3950
Whole milk	0.3763	0.5490
Butter	0.3209	0.1628
Cheese and related products	0.4030	0.3042
Food at home	0.4273	-

Table 6. Class I Differential Each Federal Order's Major City

Federal order (#)	Major city	Differential
Northeast (1)	Boston	$3.25
Upper Midwest (30)	Chicago	$1.80
Central (32)	Kansas City	$2.00
Mideast (33)	Cleveland	$2.00
Pacific Northwest (124)	Seattle	$1.90
Southwest (126)	Dallas	$3.00
Appalachian (5)	Charlotte	$3.40
Florida (6)	Tampa	$5.40
Southeast (7)	Atlanta	$3.80
Arizona (131)	Phoenix	$2.35

Table 7. Summary of Utilization

	Amount	
	MCP	SFP
Class I	Slight fluctuation, decrease, Produced mainly in FO 1	Slight fluctuation, decrease
Class II	Slight fluctuation, increase, Produced mainly in FO 1	Slight fluctuation, almost stable
Class III	Large fluctuation, almost stable, Produced mainly in FO 30	Slight fluctuation, decrease
Class IV	Large fluctuation, increase, Produced mainly in FO 1	Slight fluctuation, increase
Total production	Large amount, increase	Small amount, slight decrease
	Percentage	
	MCP	SFP
C1	About 40%, decrease	About 63%, slight decrease
C2	13~15%, increase	11~14%, almost stable
C3	About 30%, decrease	11~14%, slight decrease
C4	13~15%, increase	11~14%, almost stable
Total percentage	Large fluctuation	Stable