An Analysis of Pricing in the United States Dairy Industry

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Motivation

The Federal Milk Marketing Orders (FMMOs) system of milk pricing
- Increased attention in dairy industry community, government and academia
- A dramatic increase in milk price volatility
  - Adverse effects on dairy farm profitability
- The effects of private Exchange spot cheese market on FMMOs milk pricing
  - National Cheese Exchange (NCE): 1975 – 1997
  - Chicago Mercantile Exchange (CME): 1997 - present
  - Concerns due to its susceptibility to price manipulations
- The interaction of Federal milk pricing system and private Exchange spot cheese market
  - Has evolved over the last several decades
  - Has become more complex during the current milk pricing regime
- The core of the FMMOs classified pricing system is manufacturing milk price
  - Class III milk price (BFP and M-W price)
  - A mover of the overall pricing structure within FMMOs
  - Changed from being based on unregulated manufacturing grade milk price to being calculated using price formulas
    - Cheese price is a major determinant

Objective

- To evaluate increasing interaction between FMMOs milk pricing system and Exchange spot cheese market during three milk pricing regimes
  - Minnesota-Wisconsin price series: 1960s-1995
  - Basic Formula Price: 1995-1999
  - Multiple Component Pricing: 2000 - present
- To provide basic empirical evidence on the market effects of this interaction

Private Exchange Spot Cheese Market: NCE and CME

- A price-discovery function
  - Exchange spot cheese prices are reference prices in cheese contracts
  - Contract market covers 90% of cheese production
- Since the 1980s, only cheddar cheese is traded
  - 40 pound blocks and 500 pound barrels
- A thin (low-volume) market and is concentrated, transactions are infrequent
- Periodically, concerns about market and price manipulations are raised
- In 1997, the spot cheese market was moved from NCE to CME
  - Increasing role of spot cheese price in FMMOs milk pricing
  - Improved regulatory oversight
- NCE: weekly trade and identities of traders are known
- CME: daily trade and identities of traders are not known
- Manipulations concerns: Traders' incentives to influence spot cheese prices
  - To benefit in contract cheese market
  - To influence milk prices within FMMOs

Federal Milk Marketing Orders, Milk Classes and Milk Grades

FMMOs set the minimum prices for *Grade A milk*
- Regulated milk handlers at the first level pay based on the final milk use
- Classified milk pricing principle
  - Class I milk price is tied (is higher) to the price of manufacturing milk
- Class I milk -> fluid (beverage) milk
- Class II milk -> yogurt, cottage cheese, ice-cream
- Class III milk -> cheese, cream cheese
- Class IV milk -> butter, dry milk
  - Grade A milk -> fluid and manufactured dairy products
  - Grade B milk -> only manufactured dairy products

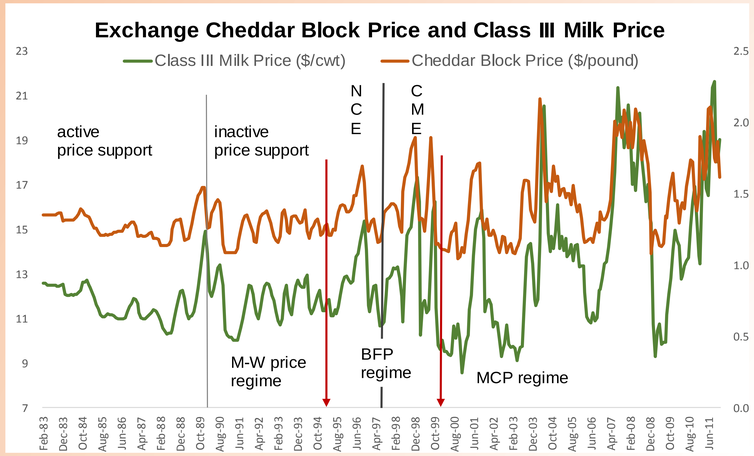
Methodology

- An analysis of the level and volatility of cheese and milk prices
- During five historical periods reflecting key changes in
  - FMMOs milk price determination procedure
  - Exchange spot cheese market institutional environment
- The average cheese and milk prices and the coefficients of variations are calculated for

1. M-W price regime - active Milk Price Support Program: 01/83-12/89
2. M-W price regime - inactive Milk Price Support Program: 01/90-05/95
3. Basic Formula Price regime and National Cheese Exchange: 06/95-04/97
4. Basic Formula Price regime and Chicago Mercantile Exchange: 05/97- 12/99
5. Multiple Component Pricing regime: 01/2000 – present

Data

- NCE and CME spot cheddar block and barrel prices (wholesale prices)
  - *Source:* USDA AMS Dairy Market Statistics Annual Summaries
- M-W price, BFP and Class III milk price
  - *Source:* USDA AMS Milk Marketing Order Statistics Public Database



FMMOs Milk Pricing Regimes: Class III Milk Price and Cheese Price

Minnesota-Wisconsin price regime (1960s – 1995): M-W price
- Was based on *Grade B milk* prices in Minnesota and Wisconsin
  - Paid by manufacturers of cheese, butter and non-fat dry milk
- Reflected value of milk under unregulated market environment
- Milk Price Support Program provided a price floor

Basic Formula Price regime (1995 – 1999): BFP
- Was a temporary alternative; the share of *Grade B milk* was declining
- M-W price plus an adjustment including
  - Wholesale prices of cheese, butter and NFDM
  - National Cheese Exchange spot price of cheddar sold in 40 pound blocks

Multiple Component Pricing regime (2000 – present): Class III milk price
- Is calculated using a series of price formulas
- Is based on value of key components: protein, other solids and butterfat
- Is a function of survey-based wholesale prices of cheese, butter and whey
  - Wholesale (contract) prices of cheddar block and cheddar barrel
- In 2009 the share of cheese value in Class III milk price was 86%

The Exchange Spot Cheddar Cheese Prices and Class III Milk Price: Averages and Coefficients of Variation: 1983-2011.

Cheddar barrel price ($/pound)	Cheddar block price ($/pound)	Class III milk price ($/cwt)
1. Minnesota-Wisconsin Price regime with active Price Support		
1.24 (0.07)	**1.28** (0.07)	**11.74** (0.07)
2. Minnesota-Wisconsin Price regime with inactive Price Support		
1.24 (0.08)	**1.27** (0.08)	**11.76** (0.08)
3. Basic Formula Price regime and National Cheese Exchange		
1.35 (0.10)	**1.40** (0.09)	**12.77** (0.09)
4. Basic Formula Price regime and Chicago Mercantile Exchange		
1.39 (0.15)	**1.44** (0.15)	**13.00** (0.17)
5. Multiple Component Pricing regime		
1.44 (0.20)	**1.47** (0.20)	**13.80** (0.24)

Coefficients of variation are in the parentheses

Results

General Pattern of Cheese and Milk Price Behavior over Five Periods
- The patterns of cheese and milk price behavior are similar
- Changes in the average prices are small
  - Cheese prices increased by 16%
  - Milk price increased by 18%
- Changes in the price volatility are dramatic
  - Cheese price volatility increased by 186%
  - Milk price volatility increased by 243%
- The average cost-price ratios remain the same
  - 0.95 for cheddar barrel and 0.92 for cheddar block
  - The volatility of these ratios has increased 4 times

Key Changes in Cheese and Milk Price Behavior during Five Periods
- The largest average price increases are in BFP-NCE period
  - NCE spot cheddar block price was included in price formula
  - Hypothesis: Traders benefiting from higher cheese and milk prices might have been able to use their market power to influence NCE cheese price -> Was reflected in a higher BFP level
- The first largest magnitude increase in price volatility is in BFP-CME period
  - Hypothesis: Due to the increase in trade frequency
  - A shift from NCE weekly trade to CME daily trade
- The second largest magnitude increase in price volatility is in MCP regime
  - Hypothesis: The current design of Class III milk price formula intensifies the effects of spot cheese market on FMMOs pricing

Conclusion

- The interaction between Exchange cheese market and FMMOs milk pricing
  - Has increased over time and has become most complex in MCP regime
  - Each consequent change in the design of Class III milk pricing and the Exchange institutional environment coincides with increases in the volatility of milk and cheese prices
- The Class III milk price determination procedure evolved from this price
  - Being based on unregulated manufacturing grade milk price to being determined using price formulas
    - Wholesale cheese price is a major determinant
- The current Class III milk price reflects the revenue side of cheese manufacturing
  - Does not have much connection with the cost of dairy farm operations
  - Does not reflect increasing level and volatility of milk production costs
  - Affects the performance of FMMOs pricing and dairy farm profitability

Other factors that might have contributed to the observed effects
- Increasing level and volatility of agricultural input prices
- Increasing consolidation and concentration in dairy processing and retailing
- Diminishing level of government price support
- Increasing exposure of domestic dairy industry to international markets

An Analysis of Pricing in the United States Dairy Industry

Yuliya Bolotova[1] and Andrew Novakovic[2]

The performance of the system of milk pricing within Federal Milk Marketing Orders (FMMOs) has recently attracted increased attention in the dairy industry community, government and academia (GAO Report 2007; DOJ and USDA Workshops 2010; USDA DIAC 2011**)**. First, a dramatic increase in the volatility of milk prices received by dairy farmers observed during the recent decade has adversely affected dairy farm profitability. Second, the effects that the private Exchange spot cheese market (currently Chicago Mercantile Exchange spot cheese market) has on FMMOs milk pricing have raised concerns because of the susceptibility of this market to price manipulations. The design of the Federal milk pricing system as well as its interaction with the private Exchange spot cheese market has evolved over the last several decades, and this interaction has become more complex during the current milk pricing regime.

The core of the FMMOs classified pricing system is manufacturing milk price (currently Class III milk price; BFP and M-W price in the past). In addition to being used to price a large share of raw milk used in manufactured dairy products (currently cheese), this price has been a mover of the overall pricing structure within FMMOs. The procedure of Class III milk price determination changed from this price being based on an unregulated manufacturing grade milk price to this price being calculated using a series of price formulas, in which the wholesale cheese price is the major determinant.

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The objective of this paper is to provide an overview of the private Exchange spot cheese market and the major changes that took place in the design of Class III milk pricing during the three milk pricing regimes (Minnesota-Wisconsin price series, Basic Formula Price, and Multiple Component Pricing) in order to highlight increasing interaction between the FMMOs milk pricing system and the Exchange spot cheese market. A basic empirical evidence on the market effects of this interaction is discussed.

Private Exchange Spot Cheese Market (NCE and CME)

Cheese industry participants have historically used the organized Exchange spot cheese prices as reference prices in cheese contracts used to transact more than 90% of cheese produced in the country. Since the beginning of the last century, the spot cheese market took place at the Wisconsin Cheese Exchange (Plymouth, WI), which in 1975 was renamed as the National Cheese Exchange (NCE) and was moved to Green Bay, WI. Due to concerns relating to the susceptibility of the NCE market to price manipulations and due to increasing role of NCE spot cheese prices in FMMOs milk pricing system, in May 1997 the spot cheese market was moved from NCE to the Chicago Mercantile Exchange (CME) (Mueller et al 1996).

The type of market participants, the nature of trading rules, and the role of the Exchange spot market as a price-discovery mechanism in the cheese industry have not changed much throughout the history. A number of the most important changes in some of the trading rules took place when the spot cheese market was moved from NCE to CME. The NCE trade took place on a weekly basis, and the identities of traders were known; actually, their representatives were required to be present during each trading session. The CME trade takes place on a daily basis, and the identities of traders are not known; the traders are represented by professional brokers.

Since the early 1980s, only cheddar cheese has been traded at the Exchange. It is a standardized product, and is currently represented by two styles: cheddar cheese sold in 500 barrels (used in further processing to manufacture processed cheeses, cheese spreads and similar products) and cheddar cheese sold in 40 pound blocks (used to make cut and wrapped natural cheese). The Exchange spot cheese market is a thin (low volume) market, where typically less than one percent of all cheese produced in the country is traded. This market is concentrated, and transactions are infrequent. Although there are only 30-40 members, only a few buyers and a few sellers actively trade on the Exchange (GAO report 2007). These are large cheese processors/manufacturers and large agricultural cooperatives. The Exchange buyers and sellers are also active participants in the contract cheese market.

The Exchange spot cheese market/price manipulations concerns arise due to two reasons. First, because the Exchange spot cheese price is a reference price in cheese contracts, the Exchange spot market participants may have incentives to influence the Exchange spot cheese prices with the purpose of influencing contract cheese prices. Second, some of the Exchange spot market participants may have incentives to influence the Exchange spot cheese prices in order to influence pricing of milk within FMMOs. As it is discussed further in the paper, FMMOs have used wholesale cheese prices in the milk price determination procedures.

FMMOs Milk Pricing Regimes

The FMMOs classified milk pricing system determines the minimum prices for Grade A milk that regulated milk handlers at the first level (i.e. processors and manufacturers) have to pay based on the final (end) use of milk represented by a number of milk classes. Milk pricing within FMMOs has historically been based on a classified pricing principle. The price of milk used to produce fluid milk products (i.e. Class I milk) has been tied to the price of milk used for manufacturing

purposes (i.e. currently Class III milk) and has been higher than this price. Milk classes are distinguished from milk grades. There have been two grades of milk: Grade A and Grade B. Only Grade A milk can be used to produce fluid milk products; it can also be used to produce manufactured dairy products. Grade B milk can only be used in manufactured dairy products. Originally, Grade B milk had to meet somewhat lower sanitary standards than Grade A milk, and consequently Grade B milk had lower production costs. Pricing of Grade B milk has never been regulated, and this price was a result of the interaction of supply and demand conditions.

Minnesota-Wisconsin (M-W) price regime (1960s-1995)

In early 1960s, the Minnesota-Wisconsin (M-W) price was introduced as a base price for Class III milk within FMMOs. The M-W price was the average price calculated based on prices paid for Grade B milk by manufacturers of cheese, butter and non-fat dry milk in Minnesota and Wisconsin, which represented a region of surplus production of manufacturing grade milk. The M-W milk price represented the value of milk under an unregulated competitive environment. The M-W price was based on prices collected through systematic surveys conducted by the USDA National Agricultural Statistics Service (NASS) on a monthly basis (Dairy Outlook 1996), and was announced on a monthly basis. During this period of time another federal program, Milk Price Support Program affected dairy industry pricing; it established price floors (price supports) for manufactured dairy products. When the M-W price was below the milk price support level, the latter was used as a base price for Class III milk price within FMMOs. During the period of 1960-1990, the quantity of Grade B milk produced and the number of plants processing Grade B milk began to decrease (GAO Report 1989). This situation posed a question of the value of using M-W milk price series for the purpose of milk pricing in FMMOs, and consequently it was replaced with the Basic Formula Price (BFP).

Basic Formula Price (BFP) regime (1995-1999)

The BFP was introduced in June 1995, and it was a temporary alternative because the share of Grade B milk was projected to decline. The BFP still reflected the value of unregulated Grade B milk in Minnesota and Wisconsin. There was a novelty in the adjustment (change) to this price, which was calculated as the difference in the value of milk used for manufacturing purposes between the base and previous month. The value of milk was calculated using wholesale prices of selected dairy manufactured products, including cheddar cheese, and these products' yield rates. This approach is based on a multiple component principle, which is also referred to as price formula. The NCE spot price for cheddar cheese sold in 40 pound blocks was directly used in the price formulas. Beginning May 1997, when the spot cheese market was moved from NCE to CME, the USDA NASS survey-based wholesale price of cheddar cheese sold in 40 pound blocks replaced the NCE spot cheese price in milk price formulas.

Multiple Component Pricing Regime (2000-present)

As a result of the Federal Order reform, a completely new milk pricing system was introduced in January 2000. The BFP was replaced with a set of formulas conceptually similar to the adjustment used in BFP calculation. Class III milk price is calculated using a series of price formulas, which include the values of key components (protein, other solids and butterfat) of the final products manufactured from raw milk (cheese, butter and whey). The Class III milk price is a function of wholesale prices of these products, the average yield rates and estimates of plant processing costs. The cheese value is a major determinant of Class III milk price. For example, in 2009, the share of cheese value in Class III milk price was in the range of 83.14-89.57%, with the average of 86.12% (Bolotova and Novakovic 2011). The cheese price used in Class III milk price formulas is

determined by the USDA Agricultural Marketing Service (AMS) using the USDA NASS survey-based wholesale prices for cheddar cheese sold in 500 pound barrels and 40 pound blocks.

Private Exchange Spot Cheese Market and FMMOs Milk Pricing:

Empirical Evidence on the Interaction Effects

This section presents empirical evidence that may be used to characterize market effects of the interaction between private Exchange spot cheese market and FMMOs Class III milk pricing over three milk pricing regimes. Using descriptive statistical analysis, we analyze the level and volatility of the Exchange spot cheddar cheese prices, Class III milk price and cost-price ratios. The cost-price ratio is the ratio of the cost of milk, which is required to produce one pound of cheese, to the price of cheese ($/pound). To capture the effects of the key changes in the dairy industry institutional environment, the M-W regime is split into two periods: the first one is associated with active milk price support, and another one is associated with inactive milk price support. The BFP regime is divided into two periods: the first one is associated with NCE, and the second one is associated with CME. The average prices and cost-price ratios and the coefficients of variations are calculated for each of the analyzed periods (Table 1). The monthly cheddar cheese prices and Class III milk prices are obtained from the USDA AMS Dairy Market Statistics Annual Summaries and Milk Marketing Order Statistics public database.

The changes in the average level of cheddar cheese and milk prices are rather small in magnitude, but the changes in the volatility of these prices are dramatic across the analyzed milk pricing regimes. The average cheddar cheese barrel (block) price increased from $1.24/pound ($1.28/pound) in M-W regime (active milk price support) to $1.44/pound ($1.47/pound) in MCP regime or by 16% (15%). The average milk price increased from $11.74/cwt to $13.80/cwt or by 17.6% during the same period of time. The cheddar cheese price volatility increased by 186%, and

the milk price volatility increased by 243% between M-W and MCP regimes. While the magnitude of the cost-price ratios, 0.95 for cheddar barrel and 0.92 for cheddar block, remains the same on average, the volatility of these ratios increased 4 times between M-W regime (active milk price support) and MCP regime.

There were no any significant changes in the level and volatility of cheese and milk prices between two sub-periods of M-W regime (active and inactive Milk Price Support Program). The level of cheese and milk price remains practically the same, and there is only a 14% increase in the volatility of these prices during M-W regime with inactive milk price support. The milk price volatility is exactly the same as the cheese price volatility.

A shift from M-W regime to BFP/NCE period is characterized by a noticeable increase in the level and volatility of milk and cheese prices. The average cheddar barrel (block) price increased by 9% (10%), and the average milk price increased by 8.6%. These are the largest magnitude price increases among all analyzed regimes/periods. The BFP/NCE period is the one when the NCE spot cheddar cheese block price was included in milk price calculation procedure. This may have created incentives for some of the Exchange participants to influence the spot cheese prices in order to influence milk prices. The fact that there was an increase in the average level of milk/cheese price may reflect the fact that traders benefiting from a higher level of milk and cheese prices were able to use their market power to influence the spot cheese price level, which was reflected in a correspondingly higher average milk price level (Bolotova 2011). As compared to M-W regime (inactive milk price support), the cheddar barrel (block) price volatility increased by 25% (12.5%), and the milk price volatility increased by 12.5%.

A shift from BFP/NCE period to BFP/CME period is characterized by the most dramatic increase in the volatility of cheese and milk prices, and by a rather minor increase in the average

level of these prices. The average cheddar cheese prices increased by 3%, and the average milk price increased by almost 2%. The volatility of cheddar barrel (block) price increased by 50% (67%), and the volatility of milk price increased by almost 90%. The move of the spot cheese market from NCE to CME was accompanied by a change in some of the trading rules, including daily trade on CME, as opposed to weekly trade on NCE, and anonymous trade in the former case. A daily trading, as compared to a weekly trading, contributes to the observed increase in the cheese price volatility, and consequently in the milk price volatility. While spot cheese prices were determined 4 times a month on average under weekly trading, spot cheese prices can be determined at least 20 times a month under daily trading. During the BFP/NCE period, the milk price volatility began to exceed the cheese price volatility, which may reflect the fact that the USDA survey-based 40 pound cheddar block price instead of NCE spot cheddar block price started being used in milk price determination procedure.

A shift from BFP/CME period to MCP regime is characterized by a rather small increase in the level of cheese and milk prices and by a substantial increase in their volatility. The average cheddar barrel (block) price increased by 3.6% (2.1%), and the average milk price increased by 6%. The cheese price volatility increased by 33%, and the milk price volatility increased by 41%. Given that under current MCP regime Class III milk price is determined using a series of price formulas, this design of the milk price determination procedure might have contributed to the observed increase in the volatility of milk price in MCP regime, as compared to BFP regime. Furthermore, the use of a survey-based wholesale prices of three different manufactured dairy products (cheese, butter and whey) in milk price formulas is likely to contribute to the observed increase in the volatility of milk price relative to the volatility of cheese price.

Conclusion

The analysis presented in the paper indicates that the interaction between the private Exchange spot cheese market and FMMOs milk pricing system has increased over time and has become most complex in the current MCP regime. Each consequent change in both the design of Class III milk pricing and the Exchange institutional environment as well as the interaction of these changes coincide with the observed increases in the volatility of Class III milk price and the Exchange spot cheese price. Given that the Class III milk price has historically been a mover of the overall pricing structure within FMMOs, the analyzed interaction affects the performance of the overall FMMOs pricing system and consequently dairy farm profitability.

During M-W price regime, Class III milk price was tied to an unregulated Grade B milk price, which reflected milk production cost. In addition, active Milk Price Support Program ensured that dairy farmers avoided losses. During the current MCP regime, Class III milk price is formula-based; it is a function of a survey-based wholesale prices of manufactured dairy products. The current Class III milk price reflects the revenue side of cheese manufacturing industry and does not have much connection with the cost of dairy farm operations. While the level and volatility of milk production costs have been increasing over last decade, they have not been reflected in the level of Class III milk price and consequently in the level of milk prices received by dairy farmers within FMMOs.

Finally, there are other factors of the dairy industry institutional environment that may have contributed to the observed behavior of spot cheese prices and milk prices over the analyzed period of time. The most important of them include a diminishing level of domestic government price support and increasing exposure of dairy industry to the fluctuations taking place in international

markets, increasing concentration and consolidation at the processing and retail level, and increasing level and volatility of agricultural input prices.

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Table 1: The Level and Volatility of the Exchange Spot Cheddar Cheese Prices,
Class III Milk Price and Cost-Price Index over Three Milk Pricing Regimes (1983-2011).

	Cheddar barrel price	Cheddar block price	Class III milk price	Cost-price index* (barrel)	Cost-price index* (block)
	$/pound	$/pound	$/cwt**		
Minnesota-Wisconsin Price regime with active milk price support: 01/83-12/89					
Average	1.24	1.28	11.74	0.95	0.92
CV***	0.07	0.07	0.07	0.02	0.02
Minnesota-Wisconsin Price regime with inactive milk price support: 01/90-05/95					
Average	1.24	1.27	11.76	0.95	0.92
CV	0.08	0.08	0.08	0.03	0.02
Basic Formula Price regime and National Cheese Exchange: 06/95-04/97					
Average	1.35	1.40	12.77	0.95	0.91
CV	0.10	0.09	0.09	0.02	0.02
Basic Formula Price regime and Chicago Mercantile Exchange: 05/97-12/99					
Average	1.39	1.44	13.00	0.94	0.90
CV	0.15	0.15	0.17	0.07	0.06
Multiple Component Pricing regime: 01/00-12/11					
Average	1.44	1.47	13.80	0.95	0.93
CV	0.20	0.20	0.24	0.08	0.08

*Cost-price index is the share (ratio) of the cost of milk required to produce 1 pound of cheese in the wholesale cheese price. It is typically required 10 pounds of milk to produce 1 pound of cheese.
** Cwt = 100 pounds.
*** CV is the coefficient of variation used to measure price volatility; it is a ratio of the standard deviation to the mean.
Class III milk price is M-W price and BFP in M-W and BFP regimes, respectively.