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Analysis of Multiple Component Pricing in the Appalachian, Southeast, and Florida Federal Milk Marketing Orders

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ABSTRACT

The rising value of milk proteins combined with two separate milk pricing regimes has led to a renewed interest in the Southeast U.S. to consider abandoning the existing skim and fat milk pricing system in favor of adopting multiple component pricing. Using USDA data, multiple component pricing pools were estimated for the Appalachian, Southeast, and Florida marketing areas for 2006 to 2013. Results of the analysis demonstrate that component pricing could simplify the terms of trade between milk buyers and sellers by creating a uniform pricing system for milk and may facilitate the orderly marketing of milk by helping to guide milk to its highest value and best use. The value of producer milk in the pool would increase; however, the distribution of pool revenue will shift from producers with below average component levels to producers with above average component levels. Economic incentives to increase component productivity would exist, but increases in the farm-level milk price due to the adoption of component pricing must come from improvements in market efficiency, higher prices paid by consumers, reduced processor operating margins, or reduced premium payments to dairy farmers.

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INTRODUCTION

In recent years milk proteins have become a major nutritional and value-added product in both domestic and international markets and have helped to drive the price of milk to record highs (US Dairy Export Council, 2014; USDA National Agricultural Statistics Service, 2014). However, across portions of the U.S. the milk pricing regulations are not designed to separately price all of the milk components that give milk its functional and economic value – specifically butterfat, protein, other solids, and somatic cell count. Instead, in the Appalachian, Arizona, Florida, and Southeast Federal Milk Marketing Orders (FMMO) the milk pricing regulations are based solely on butterfat and skim pricing and do not formally reward dairy farmers for producing milk proteins. The rising value of milk protein combined with the alternative milk pricing schemes is believed to have contributed to challenges in the Southeast U.S. related to farm equity and milk procurement. For example, the southeast marketing areas draw a large portion of the milk supply from adjacent marketing areas to the north and west. With overlapping milksheds, the two pricing systems often result in milk moving in spite of regulations (e.g. south to north and east to west) to exploit price advantages created by the non-uniform pricing provisions (Newton, 2012). In light of these realities, there has been a renewed interest in the Southeast U.S. to consider abandoning the existing skim and fat milk pricing and pooling system in favor of adopting multiple component pricing.

The purpose of this article is to examine the potential financial impact and policy implications of adopting multiple component pricing in the Appalachian, Southeast, and Florida FMMO marketing areas.[1] This work builds on the work of Kirkland and Mittelhammer (1986), Schmidt and Pritchard (1988), Elbehri et al. (1994), Jesse (1994), Jesse and Cropp (1994), and Bailey, Jones, and Heinrichs (2005) to determine the market- and farm-level economic implications of multiple component pricing as it relates to the Southeastern marketing areas during 2006 to 2013. This analysis is non-dynamic as both the supply and demand sides are treated as exogenous. It is likely that any changes in the farm-level regulated milk prices over the extended period of 2006 to 2013 would have impacts on milk production and utilization. As a result, the empirical results are presented as a static approximation of the financial impacts. Factors such as increased milk supply, changes in milk component levels, or reduced demand would alter the financial results presented in this analysis.

The article proceeds with a brief discussion of USDA FMMO multiple component and skim-fat pricing regulations. The rationale for adopting multiple component pricing is explored using anecdotal evidence of milk procurement challenges resulting from the two pricing schemes. Next, the FMMO revenue pool is simulated for each month during 2006 to 2013 under both a skim-fat and multiple component pricing regime. Using milk component level distributions farm-level milk prices per hundredweight are estimated under skim-fat and multiple component pricing to identify potential financial returns and distributional effects of multiple component pricing. Then, to evaluate the effect of pricing incentives on component production practices, trends in component productivity are estimated and compared for skim-fact and multiple component marketing areas. Finally, the results are used to identify potential challenges and policy considerations associated with the adoption of multiple component pricing.

MILK PRICING IN FEDERAL MILK MARKETING ORDERS

Across the U.S., with California as a major exception, USDA regulates milk and dairy product prices using the FMMO.[2] Marketing orders were established under the Agricultural Marketing

Agreement Act of 1937 to help ensure that participating dairy farmers receive a minimum price for milk sold to milk processors and manufacturers (Blayney and Normile, 2004). This is accomplished through the use of end-product price formulas, formal discriminatory pricing based on milk utilization, and revenue sharing pools. The classified pricing system assigns monthly minimum milk prices based on the utilization of milk in each of four product classes: class I (beverage milk), class II (soft manufactured products), class III (cheese), and class IV (butter and milk powder). FMMO minimum milk prices for each class are calculated using pricing formulas that incorporate wholesale dairy product prices for cheddar cheese, butter, nonfat dry milk, and dry whey. The minimum price paid to producers pooling on a FMMO reflects the weighted average value of all uses at the classified values.[3] Through the revenue pooling process all farmers delivering pooled milk share in the total revenue generated by all uses of milk regardless of how the milk of an individual dairy farmer is used.[4] Currently there are two alternative types of revenue pooling processes: multiple component pricing and skim-fat pricing. [5]

Major shifts in consumer demand for low-fat beverage milk and protein-based manufactured dairy products in the late 80's and early 90's led to modifications in the FMMO milk pricing system to recognize value-added milk components such as protein, butterfat, other milk solids, and somatic cell counts (Elbehri et al., 1994; Jesse, 1994; Jesse and Cropp, 1994; Thraen, 2002; Blayney and Normile, 2004). With the exception of Arizona, in FMMO marketing areas where the production of butter and protein-based manufactured milk products dominates beverage milk use the milk pricing regulations are based on multiple component pricing.[6] Multiple component pricing is a classified pricing system that establishes a monthly minimum milk price based on the value of the three milk components, a return from the FMMO revenue sharing pool called the producer price differential (PPD), and FMMO-imposed premiums and deductions for milk quality measured by the somatic cell count (Jesse and Cropp, 1994; Thraen, 2002).[7] The formula for the minimum multiple component milk price per hundredweight is given by:

(1) $$p_{MCP} = \left(p_{BF} \times BF + p_{PRO} \times PRO + p_{OS} \times OS \right) + p_{PPD} + p_{SCC}(350 - SCC)$$

where p_{BF} is the butterfat price, p_{PRO} is the protein price, and p_{OS} is the other solids price, all in dollars per pound. The butterfat, protein, and other solids prices are announced by the USDA prior to the monthly revenue pooling process and are determined using the end-product pricing formulas which reflect the wholesale dairy commodity prices listed above. p_{PPD} is the PPD and p_{SCC} is the somatic cell count adjustment rate, both in dollars per hundredweight. The PPD is announced after the monthly pooling process and reflects the market-wide utilization of milk in each of the four classes minus the value of milk components. *BF*, *PRO*, and *OS* are the butterfat, protein, and pounds of other solids per 100 pounds of milk, respectively. Finally, *SCC* is the somatic cell count of the milk. As apparent in equation (1), under multiple component pricing producers with higher (lower) levels of butterfat and solids-non-fat have higher (lower) regulated minimum pay prices per hundredweight of milk than producers with lower (higher) component levels such that: $\frac{\partial p_{MCP}}{\partial BF}, \frac{\partial p_{MCP}}{\partial PRO}, \frac{\partial p_{MCP}}{\partial OS} > 0$. Higher (lower) somatic cell counts decrease (increase) the minimum pay price such that $\frac{\partial p_{MCP}}{\partial SCC} < 0$.

In marketing areas where beverage milk use dominates manufacturing use the milk pricing regulations are based on skim-fat pricing. These skim-fat marketing areas include the

Appalachian, Southeast, and Florida FMMOs (USDA Agricultural Marketing Service, 2014).[8] Skim-fat regulations price milk based on the butterfat and skim content alone and have been the primary method of milk price referencing in these areas for more than 70 years. Under skim-fat pricing FMMO regulated minimum prices are determined based on the fat content in the milk. The price of butterfat is announced after the monthly pooling process and is the weighted average value of butterfat used to produce class I, II, III, and IV milk products. The market price for skim is also announced after the monthly pooling process and is based on the remaining value in the producer revenue pool after accounting for the value of butterfat. The formula for the skim-fat milk price is given by:

$$(2) \qquad p_{SF} = \overline{p}_{BF} BF + \overline{p}_{SKIM} (100 - BF)$$

where $\overline{p}_{BF}$ is the weighted average butterfat price per pound, $\overline{p}_{SKIM}$ is the weighted average skim price per hundredweight, and BF is as defined in equation (1). As demonstrated in equation (2) the regulated minimum prices under a skim-fat order and do not formally reward dairy farmers for producing milk proteins or for reducing the somatic cell count. Thus, by pricing on the fat content of the milk and categorizing all else as skim, water in the skim portion of the milk returns the same price per pound to producers as the solids-non-fat.

RATIONALE FOR COMPONENT PRICING

While there are two regulated milk pricing systems, recent data from USDA demonstrates a milkshed in common. The southeastern skim-fat milksheds overlap with milk supplies in the northern (Mideast, Northeast, and Upper Midwest) and western (Southwest) component pricing orders. For example, during May 2013 both the Appalachian and Southeastern milksheds extended west into Texas and New Mexico and north into New York and Wisconsin (USDA AMS FMMO 5 & 7, 2014). The presence of one milkshed and two regulated milk pricing systems creates the potential for disorderly marketing of milk in both the Southeast and adjacent marketing areas. Examples of disorderly marketing conditions include but are not limited to milk moving in spite of regulations south to north or east to west to exploit the pricing regulations and maximize the regulated value of milk. Disorderly marketing of milk impacts milk buyers, sellers, and consumers by unnecessarily increasing the transportation and marketing costs of supplying dairy products to consumers.

By not pricing the individual milk components, skim-fat pricing creates a financial disincentive for high component milk to serve as the reserve milk supply for the seasonally deficit Southeast milkshed. Transportation credits help to offset the cost of delivering milk into the deficit market but do not address differences in the milk pricing regulations. Due to the different regulating pricing system it may be difficult for fluid plants to attract nearby milk from high component producers if the value of class I milk does not outweigh the component value. As a result, fluid milk plants in the Southern markets often have to reach farther north or west in order to secure low component supplemental milk supplies. Consequently, to attract the nearby milk it's possible for a milk buyer to pay premiums above FMMO minimum prices based on component levels yet sell the finished product at market prevailing skim-fat prices. Such a pricing scenario has the potential to increase procurement costs if the additional costs cannot be recovered in the wholesale or retail channels. Additionally, a buyer paying component prices for supplemental milk in a skim-fat market is unable receive credit from the FMMO pool that reflects the plant's payment obligation to dairy farmers. Component pricing would provide uniform pricing provisions and prevent this shuffling of milk supplies.

With respect to milk diversions, when milk is diverted from a skim-fat order to a manufacturing plant outside the marketing area the pooling plant only needs to account to the FMMO skim-fat pool based on the skim and butterfat prices. If the diverted milk has high milk component levels the receiving manufacturing plant could potentially get the milk at a discount compared to the regulated value of the diverted milk at solids-non-fat prices. Since high milk solids improve manufacturing product yields, the manufacturing plant receiving the diverted milk from the skim-fat order may gain a pricing advantage over similarly located manufacturing plants paying higher component prices for milk. Component pricing could provide solutions to these milk procurement and marketing challenges by regulating plants based on components they use or divert.

Continuing to the sell-side, a dairy farmer has a choice between delivering milk to a processing plant in a multiple component pricing order and receiving a milk price based on milk components; and delivering milk to a processing plant in the southeast and receiving a minimum milk price based on the butterfat and skim alone. For farm managers who have invested in raising their milk solids levels, shipping milk to the skim-fat order has the potential to reduce net farm revenue in the absence of compensating premium payments. Alternatively, for producers with below average solids-non-fat, shipping milk to the skim-fat order has the potential to increase net farm revenue compared to component pricing. As a result, disorderly marketing conditions such as milk moving south to north or east to west, in spite of pricing regulations, is common for producers seeking to maximize their regulated milk price conditional on the milk pricing provisions. Empirical evidence of such milk flows were observed by Newton (2012) such that high component or low somatic cell count milk in portions of Kentucky, North Carolina, and Virginia (Appalachian marketing area) was pooled to the north on the Mideast component pricing order. Component pricing would facilitate this milk remaining available to supply the seasonally deficit Southern marketing areas instead of seeking pool status on the northern Mideast marketing area.

By placing value on higher milk components and milk quality, multiple component pricing facilitates the orderly marketing of milk by improving market signals and helping to guide milk to its highest value and best use. As a result, nearby high component milk may become available to supply the seasonally deficit Southeastern market and the incentive to shuffle milk into and out of component pricing and skim-fat markets in search of the highest regulated price is diminished. These improvements in milk marketing have the potential to result in more efficient milk deliveries and may reduce market-wide transportation costs.

COMPUTATION OF A MULTIPLE COMPONENT PRICING POOL

In order to determine how regulated minimum milk prices may change if multiple component pricing is adopted it is first necessary to simulate a FMMO revenue pool. The return from the FMMO pool is used to compute the PPD and the weighted average butterfat and skim prices necessary to determine the FMMO regulated minimum price. The FMMO revenue pool calculates the total value of producer milk pooled in the marketing area and then it calculates the milk processors' payment obligation to dairy farmers. The difference between the value of all producer milk in the pool and the gross processor payment obligation represents the amount of revenue shared among all producers pooling milk in the marketing area.

The primary difference between skim-fat and multiple component pricing in determining the producer milk value is the method by which solids-non-fat are priced in classes II through IV and the somatic cell count adjustment rate. The value of milk in class I is exactly the same under both pricing alternatives and butterfat is priced exactly the same in all four classes. However, under multiple component pricing the value of producer milk is determined by the value of solids-not-fat in class II and class IV, the amount of protein and other solids in class III, and the somatic cell count in classes II through IV. Using the USDA Agricultural Marketing Service end-product pricing formulas the change in the market-wide producer milk value from adopting multiple component pricing can be simplified as:

$$(3) \qquad \Delta_{PMV} = \left(\tfrac{1}{100}\right)\left[\begin{array}{l}\left(S_{II}\,p_{SNF,II} + S_{IV}\,p_{SNF,IV}\right)(SNF-9) + \\ S_{III}\left(p_{PRO}(PRO-3.1) + p_{OS}(OS-5.9)\right) + p_{SCC}(350-SCC)M \times \sum_i U_i\end{array}\right]$$

where Δ_{PMV} is the change in producer milk value, S_i for $i = II, III, IV$ is the pounds of skim in classes II, III, and IV, $p_{SNF,j}$ is the price of solids-non-fat in classes $j = II$ and IV, PRO and OS are as defined above but as represented in skim pounds, and SNF is the pounds of solids-non-fat in skim ($SNF = PR + OS$). The last expression on the right-hand-side of equation (3) represents the market-wide somatic cell adjustment for classes II through IV where M is the pounds of milk pooled, SCC is the somatic cell adjustment, and U_i is the utilization of milk in class II, III, and IV.

The simplification of multiple component pricing in equation (3) reflects the fact that skim and fat pricing implicitly treats all dairy producers as if they have the following attributes in solids-non-fat and somatic cell count: 3.1% protein, 5.9% other solids, and 350 somatic cell count. This is obviously not the case, and multiple component pricing changes the price of milk based on these solids-non-fat and somatic cell count attributes such that the value of producer milk in the pool increases as the somatic cell count decreases or as any of the solids-non-fat levels increase $\frac{\partial \Delta_{PMV}}{\partial SCC} < 0,\ \frac{\partial \Delta_{PMV}}{\partial SNF} > 0.$ Additionally, with respect to market utilization, the change in producer milk value increases as utilization in manufacturing classes increases and decreases as class I utilization increases: $\frac{\partial \Delta_{PMV}}{\partial S_i} > 0,\ \frac{\partial \Delta_{PMV}}{\partial U_i} > 0$ for $i = II, III, IV$. As a result, marketing areas with high levels of class I utilization may see smaller, and potentially negative, changes in producer milk value as a result of adopting multiple component pricing.

In order to approximate the change in producer milk value as a result of adopting multiple component prices, empirical data on milk component levels, somatic cell counts, milk utilization, and milk prices were collected from USDA Agricultural Marketing Service for all months during 2006 to 2013 (USDA AMS 2014).[9] During the 2006 to 2013 period analyzed over 128 billion pounds of milk was pooled on the Appalachian, Southeast, and Florida FMMO marketing areas combined. The total value of producer milk under skim-fat pricing was approximately $24.17 billion dollars. Average class I utilization was the highest in the Florida order at 84%, while the Southeast order had the lowest average class I utilization at 66%. The average milk component levels were highest in the Southeast marketing area and lowest in the Florida marketing area. Table 1 presents annualized descriptive statistics of the USDA data.

[Table 1 About Here]

USDA data was used to simulate the monthly FMMO revenue pool to determine the total producer milk value in the revenue sharing pool under multiple component pricing. In order to calibrate the simulation model the producer milk value under a skim-fat order was also estimated and verified using USDA published values (USDA AMS, 2014). After calibrating the model, comparisons of the producer milk value and farm-level milk prices calculated under multiple component and skim-fat pricing regulations were used to form the basis for evaluations of multiple component pricing.

[Figure 1 About Here]

Simulation results indicate that the value added under multiple component pricing is highly variable, Figure 1. West (2003), Newton (2010, 2012), Freije (2013), Mykrantz (2013), and Espe (2014) observed that milk solids are higher in the fall and winter and lower during the spring-flush and summer months with the general feature that somatic cell counts follow an opposite seasonal pattern. As is apparent in Figure 1, the value added under multiple component pricing follows a similar seasonal pattern as milk components. The added value under multiple component pricing is the highest in the fall and winter months (when milk solids are the highest) and lowest during the spring flush and summer months. Additionally, as the utilization of milk in manufacturing classes increases so too does the value added under multiple component pricing.

During the 2006 to 2013 period multiple component pricing would have increased the value of producer milk in the pool by $25 million ($0.053/hundredweight) and $44 million ($0.078/hundredweight) in the Appalachian and Southeast marketing area, respectively. The adoption of multiple component pricing in the Florida order would have resulted in a decline of producer milk value by approximately $1 million dollars (-$0.004/hundredweight). The total change in producer milk value among the three marketing areas was an increase of $68 million dollars, holding all else constant. Table 2 identifies the change in producer milk value in aggregate, per hundredweight, and the average PPD return from the FMMO revenue sharing pool.

[Table 2 About Here]

Another critical component of multiple component pricing is the PPD. The PPD represents the individual producers return from the revenue sharing pool. During the 2006 to 2013 period the average producer prices differentials averaged $2.57, $2.68, and $4.59 for the Appalachian, Southeast, and Florida Marketing areas respectively.[10] A common occurrence in other component pricing markets is a negative PPDs. Negative PPDs occur when the gross handler obligation to dairy farmers exceeds the producer milk value in the pool. During the analysis period none of the three Southeast marketing areas experienced a negative PPD when evaluated at the principle pricing points of Charlotte, Atlanta, and Tampa.[11]

These results reflect the milk value at average market levels tests. It is possible for the farm-level returns of an individual producer to be higher (lower) than these values if the producer had higher (lower) component levels and lower (higher) somatic cell counts. The difference among marketing areas can be tied back to the range in observed component levels and utilization of milk in manufacturing classes (e.g. Table 1).[12] For example, the change in producer milk value for the Florida order was lower than adjacent marketing areas due to higher class I utilization percentages and lower average milk component tests.

By changing the pricing regulations the total value of producer milk in all three marketing areas was approximately $24.25 billion dollars, ceteris paribus. At the aggregate level, the change in producer milk value from a skim-fat regime to a multiple component pricing regime of $68 million dollars would have represented less than a one percent increase in the total value of milk in the pool. Although the magnitude of the change in producer milk value appears immaterial at less than one percent; due to heterogonous farm profiles the benefits of multiple component pricing would not apply uniformly to producers pooling and delivering milk within a marketing area (e.g. Elbehri et al., 1993). As a result, multiple component pricing may change the distribution of pool revenues received among producers serving the marking area.

FARM-LEVEL IMPACT OF MULTIPLE COMPONENT PRICING

A comparison of the two pricing systems reveals that the skim-fat method may undercompensate producers with high solids-non-fat and overcompensate dairy farmers who produce fewer solids-non-fat per hundredweight relative to component pricing.[13] To evaluate potential changes in the farm-level regulated milk price as a result of multiple component pricing, representative farms with below-average, average, above-average, and Jersey herd (i.e. high component breed of dairy cow) milk component tests were created. These four productivity categories capture variations in farm management (e.g. stage of lactation, culling decisions, average herd age, nutritional factors, and animal genetics) and were evaluated by shifting the milk protein content up or down by 0.20. For example, if an average protein test was observed at 3.12% then the below-average test would be 2.92% and the above-average test would be 3.32%. The change in protein tests of 0.20 corresponds to empirical estimates of protein standard deviations $\sigma = 0.20$ observed in the Mideast, Upper Midwest, and Pacific Northwest marketing orders (Newton, 2010; Freije, 2013; and Espe, 2014).[14] [15] The associated effects on butterfat and other solids were derived using component relationships from Newton (2010).[16] The farm-level productivity categories are as follows:

- Below-Average – Farm-level protein level was reduced by one standard deviation (-0.20) relative to the marketing area average. Empirical component relationships were used to then adjust butterfat and other solids levels.
- Average – Farm-level butterfat and solids-non-fat were equal to marketing area averages.
- Above-Average – Farm-level protein level was increased by one standard deviation (+0.20) relative to the marketing area average. Empirical component relationships were used to then adjust butterfat and other solids levels.
- Jersey Herd – Farm-level butterfat and protein were increased based on a Holstein-Jersey component productivity ratio estimated from Heinrichs, Jones, and Bailey (2005).[17]

Results of the farm-level analysis indicate that farms with average or above average component tests (relative to the marketing area average) would have a non-negative benefit from the adoption of multiple component pricing. However, as apparent in Table 3 the increase in producer milk value from adopting multiple component pricing will not affect all dairy farmers uniformly. Farms who have invested in increasing their milk solids may experience greater returns from component pricing; while farmers with below-average milk components will likely receive less. For example, comparing skim-fat and component pricing, the decrease in the milk value at test for a producer with below-average milk components in the Southeast FMMO averaged $0.07 per hundredweight over the analysis period, $0.15 less than farms with market average milk components. Meanwhile, the increase in milk value at test for a producer with above-average milk components in the Southeast FMMO was $0.23 per hundredweight for 2006 to 2013, $0.15 higher than farms with market average component levels. For Jersey breeds the average change in milk value at test was $1.78 per hundredweight in the Southeast FMMO. Thus, the data demonstrates that farms with higher milk components will see greater improvements in the regulated milk price relative to a skim-fat environment. Results of similar magnitude were observed in the Appalachian and Florida FMMOs such that only farms with average, above-average, or Jersey milk components experienced higher (or non-negative) regulated milk prices as a result of multiple component pricing.

[Table 3 About Here]

Results indicate that multiple component pricing would make some dairy farmers better off at the expense of other dairy producers. Dairy farm operations with average and above-average milk components are likely to receive positive, or non-negative, returns from multiple component pricing; while farmers with below average milk components are likely to be worse off under multiple component pricing. Operations which stand to benefit most from multiple component pricing are farms, who through improved management or herd genetics, have higher milk solids levels. As a result, multiple component pricing would shift the distribution of pool revenue from producers with below average component levels to producers with above average component levels. Confirming these results, Schmidt and Pritchard (1988) found that skim-fat pricing undercompensates producers with high milk component levels and overcompensated dairy farmers with lower milk solids.

Since dairy farmers, and hence milk component levels are non-homogeneous, farm management factors will drive variability in potential benefits under multiple component pricing. Farm management factors may include culling decisions, stage of lactation, average herd age, nutritional factors, and animal genetics. While it is possible to improve milk component production in the short-run with increased efficiency in feed and farm management, long-run attempts to maximize the return under multiple component pricing would require structural changes such as alternative breeds of cows or genetic selection based on production traits. The adoption of multiple component pricing may help to drive these short- and long-run changes by altering the market price signals received at the farm. However, as production practices evolve to respond to new economic incentives so too will the costs of production. Bailey, Jones, and Heinrichs (2005) recognized the effect of input and output prices on the production decision and noted that for both Jersey and Holstein animals multiple component pricing could improve the income-over-feed-cost margin by as much as 10%. The following section will evaluate the production response in milk components since the adoption of component pricing in FMMO marketing areas.

IS THERE A PRODUCTION RESPONSE TO COMPONENT PRICING?

As indicated in equations (2) and (3), and in previous sections, multiple component pricing sends price signals through the pool for dairy farmers to increase component productivity. Early literature by Kirkland and Mittelhammer (1986) suggested that the production response of milk components to economic pricing incentives was inflexible. However, since the findings of Kirkland and Mittelhammer, nearly three decades ago, multiple component pricing regulations have been adopted across large portions of the U.S. It's worth considering then if milk components and somatic cell counts remain inflexible to component pricing signals or if producers have responded to the economic incentives by improving component productivity. To test this hypothesis, empirical data on milk component levels and somatic cell counts were collected from USDA Agricultural Marketing Service for all months and all marketing areas during 2000 to 2013 (USDA AMS 2014).[18 19]

The most common method to identify trends in time series data is to estimate a linear trend. However, estimating a linear trend without accounting for seasonal variation in component levels may overestimate the trend component. To test how component levels may have responded following the adoption of multiple component pricing, trends and periodic cycles in milk component production in skim-fat and component pricing markets were estimated using the following time series model:

(4) $$y_{tk} = \beta_0 + \beta_1 t + \alpha_1 \sin(2\pi t) + \alpha_2 \cos(2\pi t) + \varepsilon_t$$

where y_{tk} is the component test at time t and marketing area k for butterfat , protein, and somatic cell count; β_0 and β_1 represent coefficient estimates for the intercept and the time trend respectively; and α_i for $i = 1, 2$ captures the amplitude of the seasonality effects.[20 21]

[Table 4 About Here]

As apparent in Table 4, positive and statistically significant trends in butterfat levels were observed in most marketing areas. For milk protein tests, among the skim-fat orders, only the Southeast marketing area had a statistically positive trend; while all component pricing orders had statistically positive trends in milk protein tests. The Florida marketing area had a statistically negative trend on milk protein test. Finally, statistically negative trends on somatic cell counts were observed in all FMMO marketing areas. These results are generally consistent in sign as observed in previous literature. Newton (2012) observed a positive slope coefficient on trend for butterfat and milk protein tests, and a negative trend on somatic cell counts under a multiple component pricing order. However, comparing the magnitude of slope coefficients, the following general conclusion is reached: the trend on milk protein test is higher in the component pricing markets than in the skim-fat markets. Moreover, confirming the results, tests of statistical difference indicated that the trends on protein were significantly higher in orders with component pricing regulations relative to skim-fat orders. There results suggest producers respond to economic signals. While other factors likely contribute to component productivity (i.e. climate and farm management), it reasonable to expect that that component productivity is not as inflexible to pricing incentives as previously estimated and that price signals from adopting component pricing could lead to increased productivity in the production of value-added milk proteins.

CONSIDERATIONS UNDER MULTIPLE COMPONENT PRICING

As demonstrated, the adoption of multiple component pricing has the potential to simplify the terms of trade between buyers and sellers of milk in the not only the Southeastern FMMO marketing areas but also in the adjacent marketing areas who share a milkshed in common. Additionally, component pricing would provide economic incentives to increase component productivity and improve milk quality. However, before moving to adopt component pricing several factors are worth considering.

First, location-specific class I location differentials have long been the primary method for addressing the spatial relationship between milk supply and demand. Location differentials on class I beverage milk are designed to encourage movement of milk from surplus milk markets into deficit milk markets such as the Southeast (Blayney and Normile, 2004). The county-specific value of the differentials are set using a spatial transshipment model of the dairy industry based on the supply and demand for milk and milk components (i.e. prices are not an input variable in the model). The class I location differentials are part of the model solution and represent the shadow value of milk at U.S. processing locations (Pratt et al. 1996).[22] If multiple component pricing changes the supply and demand of milk or milk components substantially then the current location differentials could be distorted relative to market conditions. For example, if the spatial value of milk changes such that milk prices in the Southeast increase (decrease) relative to adjacent marketing areas then the class I locations differentials may be too high (low). A short-run solution would be a market correction through the adjustment in premium payments; but if the problem were to persist, a long-run solution would involve reevaluating the value of class I location differentials in the Southeastern FMMO areas.

Second, the primary purpose of multiple component pricing is a tool to redistribute the pool dollars among dairy producers based on the farm-level production of milk components. Depending on perspective this redistribution of revenue may be more equitable as it more accurately reflects the functional and economic value of milk components in the national manufacturing market. Dairy farm operations with average and above-average milk components are likely to receive greater returns from multiple component pricing; while farmers with below average milk components are likely to be worse off under multiple component pricing. However, as evidenced by Newton (2012), and in this analysis, multiple component pricing sends a market price signal to produce value-added milk components and to reduce the somatic cell count of the milk. Any dairy farmer can respond by investing in increasing milk component levels and improving milk quality by reducing somatic cell count to increase their share of the FMMO revenue pool. This may increase the variable costs of production; however, as evidenced by Bailey, Jones, and Heinrichs (2005) the income-over-feed-cost margin could also increase, justifying the investment in component productivity.

Finally, while the empirical results represent an increase of $68 million over the analysis period, it's unlikely that all price benefits will flow directly to dairy farmers. The model results are based on highly simplified and static assumptions and may not reflect the real world economic impacts of an alternative milk pricing regime. It's possible that the gains in marketing efficiency could reduce the market-wide transportation costs and producer pay prices would increase as a result of not only the pricing regulations but also through the efficiency gains. It's also possible that the regulated milk prices could replace the current premium prices. The extent to which regulated prices replace premium prices will determine the net effect on the farm-level milk price. Premiums paid to dairy producers represent the difference between the market equilibrium price (based on supply and demand conditions) and the regulated market price established by FMMOs. FMMOs are designed to set the regulated milk price below the market equilibrium price such that the sum of over-order premiums, market deductions, and the FMMO minimum price represent the market-clearing price for milk.[23] Absent reductions in system-wide transportation costs or adjustments to the premiums paid to dairy farmers, alternative cost recovery measures may include higher prices to the consumer or reduced plant operating margins. As a result, the net effect of the market finding a new equilibrium price on an individual farmer's mailbox milk price is ambiguous – and may be higher or lower than projected in the article.[24]

SUMMARY

Results of the empirical analysis indicate that over the 2006 to 2013 period analyzed multiple component pricing would have increased the value of producer milk in the Southeastern FMMO revenue pools by $68 million dollars, holding all else constant. However, milk pricing is not exogenous and had multiple component pricing been in effect the milk supply and utilization in these marketing areas would have been different – increasing or decreasing these results.

With the rise in prominence of milk proteins, overlapping milksheds, and challenges in milk procurement it's worth considering if the framework defining the minimum value of milk in the Southeast should also include solids-non-fat and somatic cell counts. If adopted, multiple component pricing has the potential to enhance regulated milk prices, drive milk to its highest valued and best use, improve transportation efficiency, and create financial incentives to increase milk component productivity.

The benefit of multiple component pricing over skim-fat pricing going forward will be driven by solids-non-fat production and utilization of milk in manufacturing classes. During months with higher solids-non-fat production the value of producer milk under multiple component pricing will be greater than that under a skim-fat order. During months with lower solids-non-fat production the value of producer milk under multiple component pricing will be near breakeven or less than the value under skim-fat pricing. At the farm-level the benefits of multiple component pricing will depend primarily farm management factors with the general feature that regulated milk prices will favor high component producers over farms with below-average milk tests.

When considering adopting changes to the milk pricing and regulatory structure it is important to consider that the farm-level milk price is not independent of retail prices or plant operating margins. Any additional revenue paid to dairy farmers must come from efficiency improvements, consumers, farmers, processors, or some combination of the four. As a result, the farm-level market clearing equilibrium price for milk under a component pricing regime may be higher or lower than anticipated.

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1 *Information on milk component levels in the Arizona FMMO was not publically available by USDA at the time of this analysis.*

2 *There are presently ten FMMO marketing areas in the U.S. Information on FMMOs can be found online at:* www.ams.usda.gov/dairy

3 *The minimum price is not a traditional price support program that establishes a price floor for milk; if the prices for wholesale dairy commodities were equal to zero the FMMO minimum price would equal zero plus the location differential.*

4 *The FMMO weighted average price is the minimum price and dairy farmers often negotiate premiums over and above FMMO minimums.*

5 *FMMO areas pricing under multiple component pricing include the Northeast, Mideast, Central, Upper Midwest, Southwest, and Pacific Northwest. FMMO areas pricing under skim-fat include Arizona, Appalachian, Southeast, and Florida.*

6 *California also employs a multiple component pricing regulations in the State marketing order program: http://www.cdfa.ca.gov/dairy/.*

7 *The Northeast and Pacific Northwest marketing areas do not include price adjustments based on somatic cell count.*

8 *Arizona is also a skim and fat pricing order but has a higher utilization of milk in manufacturing classes than the three marketings orders in this analysis. Arizona was excluded from this analysis as detailed milk component statistics were unavailable.*

[9] *For the Appalachian marketing order the component data represents greater than 70% of the producer milk pooled during the analysis period. For the Southeast marketing order the component data represents approximately 50% to 87% of the producer milk pooled during the analysis period. For the Florida marketing order the component data represents approximately 70% to 95% of the producer milk pooled during the analysis period.*

[10] *Average PPDs are based on the principle pricing points of Charlotte, NC (Appalachian); Atlanta, GA (Southeast); and Tampa, FL (Florida).*

[11] *PPDs are re-zoned based on the actual farm location. As a result, it's possible for negative PPDs to lower the producer pay price depending on farm location. Under skim-fat pricing the equivalent of negative PPDs is captured in the skim value of the product.*

[12] *Due to the higher milk utilization for class I beverage milk and lower levels of milk solids the change in producer milk value for the Florida marketing area was negative for 64% of the monthly observations. Accordingly, higher milk solids levels and higher manufacturing milk utilization lead to positive changes in the producer milk value for the Appalachian and Southeast FMMO areas. Approximately 85% of the monthly observations for the Southeast and Appalachian marketing areas resulted in an increase in the producer milk value.*

[13] *FMMOs do not prevent plants from paying more for high quality or high component milk. Instead FMMOs act as a regulatory intermediary between milk buyers and sellers by establishing and enforcing only a minimum price of milk that must be paid to dairy farmers. Milk prices above FMMO minimum prices are often negotiated by dairy farmers on the basis of balancing services, milk quality, and milk components.*

[14] *Assuming a normal distribution approximately 68% of observations are within one standard deviation from the mean.*

[15] *Of the six multiple component pricing orders, these marketing orders release an annual summary of milk component statistics.*

[16] *Newton (2010) estimated a butterfat-protein production response of 0.53 and other-solids-protein production response of 0.001. For example, a 1% increase in the milk protein test would result in a 0.53% increase in the butterfat test. No adjustment was made to somatic cell count as production response between protein and somatic cell counts were not estimated.*

[17] *Estimations based on ratio of Holstein average component levels 3.65 butterfat and 3.06 protein and Jersey average component levels of 4.60 butterfat and 3.59 protein (Heinrichs, Jones, and Bailey, 2005). Ratios result in a 27% increase in butterfat and an 18% increase in protein.*

[18] *The Southeast marketing areas only had solids-non-fat and somatic cell count data for 2006 to 2013.*

[19] *Data prior to 2000 was unavailable.*

[20] *The estimates of trend may vary based on the time period analyzed. For example, data from 2006 to 2013 was used to estimate the trends in protein and somatic cell count for the Southeast marketing areas, while 2000 to 2013 was used to estimate trends in other marketing areas.*

[21] *Trends and seasonal patterns were not estimated for other solids.*

[22] *The transshipment model does not include FMMO regulations as a constraint. As a result the model solution represents the optimal milk transportation notwithstanding the farm-level incentive to maximize the regulated milk price.*

[23] *It's possible for premiums to be negative as distressed loads of milk during periods of excess supply may be sold at prices below FMMO minimum prices.*

[24] *In 2013 USDA suspended the monthly publication of the Over-Order Price Report. This report contained information on the premiums above Federal order minimum prices paid by dairy processors.*

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Table 1. Annual milk utilization and pooling descriptive statistics by marketing area, 2006-2013

Year	Producer Milk Mil. Lbs.	Value of Producer Milk Mil. $	Butterfat %	Protein %	Other Milk Solids %	Somatic Cell Count (000)	Class I %	Class II %	Class III %	Class IV %
					Appalachian Marketing Area					
2006	6,243	863	3.67	3.05	5.69	328	67	16	5	12
2007	5,865	1,186	3.67	3.05	5.69	324	70	17	5	8
2008	5,882	1,166	3.69	3.05	5.71	303	70	17	4	8
2009	5,950	826	3.68	3.04	5.69	294	70	16	6	8
2010	6,042	1,079	3.65	3.05	5.70	286	68	16	7	9
2011	6,128	1,333	3.69	3.06	5.72	272	69	15	9	8
2012	5,863	1,153	3.69	3.05	5.73	261	68	15	8	10
2013	5,729	1,222	3.71	3.06	5.73	262	67	15	8	10
Total	**47,702**	**8,827**								
					Southeast Marketing Area					
2006	8,055	1,109	3.67	3.06	5.66	330	60	12	20	8
2007	7,521	1,503	3.66	3.08	5.67	343	64	12	19	5
2008	6,923	1,376	3.67	3.07	5.69	321	68	11	13	8
2009	7,169	989	3.66	3.07	5.68	315	67	11	16	7
2010	7,001	1,239	3.66	3.09	5.69	315	67	9	18	5
2011	7,057	1,516	3.71	3.11	5.70	281	65	9	19	7
2012	6,794	1,337	3.70	3.10	5.68	253	66	10	16	7
2013	6,129	1,310	3.72	3.08	5.66	250	68	12	13	7
Total	**56,649**	**10,378**								
					Florida Marketing Area					
2006	3,126	484	3.66	3.01	5.64	379	84	8	3	5
2007	3,206	688	3.63	3.02	5.62	384	81	9	5	5
2008	3,130	690	3.60	3.01	5.63	361	83	8	3	6
2009	3,027	495	3.58	2.99	5.61	352	86	8	2	5
2010	2,902	592	3.59	3.00	5.64	330	87	8	3	3
2011	2,919	704	3.67	2.99	5.66	321	84	9	3	4
2012	2,890	645	3.66	2.95	5.64	293	84	9	2	5
2013	2,833	676	3.64	2.95	5.54	265	86	8	3	3
Total	**24,034**	**4,973**								

Table 2. Change in producer milk value and producer price differential under multiple component pricing

Year	Change in Producer Milk Value Mil $	Avg. Change in Producer Milk Value $/cwt.	Producer Price Differential $/cwt.
	Appalachian Marketing Area		
2006	1.73	0.03	1.98
2007	2.51	0.04	2.24
2008	2.75	0.05	2.23
2009	1.90	0.03	2.48
2010	2.60	0.04	3.38
2011	4.24	0.07	3.10
2012	4.23	0.07	2.02
2013	5.26	0.09	3.12
Total	**25.22**		
Average		**0.05**	**2.57**
	Southeast Marketing Area		
2006	3.63	0.05	1.88
2007	6.01	0.08	2.10
2008	5.33	0.08	2.45
2009	3.50	0.05	2.70
2010	4.61	0.07	3.46
2011	8.28	0.12	3.10
2012	7.20	0.11	2.31
2013	5.23	0.09	3.46
Total	**43.80**		
Average		**0.08**	**2.68**
	Florida Marketing Area		
2006	-0.15	-0.00	3.30
2007	-0.26	-0.01	3.37
2008	-0.24	-0.01	4.35
2009	-0.16	-0.01	4.74
2010	-0.02	-0.00	5.66
2011	0.07	0.00	5.33
2012	0.08	0.00	4.40
2013	-0.36	-0.01	5.55
Total	**-1.05**		
Average		**-0.00**	**4.59**

Table 3. Effect of component productivity on distribution of pool revenue under multiple component pricing

Component Productivity	Average Milk Value Under Multiple Component Pricing	Average Milk Value Under Skim-Fat Pricing	Difference
		$/cwt	
	Appalachian Marketing Area		
Below-Average	18.49	18.54	-0.05
Market Average	19.09	19.04	0.05
Above-Average	19.69	19.53	0.16
Jersey Components	22.21	20.48	1.73
	Southeast Marketing Area		
Below-Average	18.66	18.73	-0.07
Market Average	19.30	19.22	0.08
Above-Average	19.94	19.71	0.23
Jersey Components	22.44	20.67	1.77
	Florida Marketing Area		
Below-Average	20.28	20.34	-0.06
Market Average	20.83	20.84	-0.01
Above-Average	21.38	21.33	0.05
Jersey Components	23.93	22.26	1.67

Table 4. OLS regression results for the component trends in the FMMO marketing areas

	Arizona *Skim-Fat*	Appalachian *Skim-Fat*	Florida *Skim-Fat*	Southeast *Skim-Fat*	Central *Component*	Mideast *Component*	Northeast *Component*	Pacific Northwest *Component*	Southwest *Component*	Upper Midwest *Component*
					Butterfat Model					
Intercept	3.645*	3.635*	3.603*	3.619*	3.669*	3.678*	3.673*	3.601*	3.621*	3.697*
	(0.007)	(0.006)	(0.007)	(0.006)	(0.008)	(0.007)	(0.006)	(0.008)	(0.007)	(0.008)
Trend	**-0.010***	**0.004***	**0.002**	**0.006***	**-0.001**	**0.002***	**0.004***	**0.014***	**0.002***	**0.004***
	(0.001)	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**
R^2	0.78	0.87	0.59	0.88	0.81	0.86	0.86	0.82	0.86	0.79
N	168	168	168	168	168	168	168	168	168	168
					Protein Model					
Intercept	1/	3.042*	3.033*	3.062*	3.008*	3.003*	2.984*	2.984*	3.017*	2.990*
		(0.006)	(0.006)	(0.008)	(0.006)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)
Trend	1/	**0.002**	**-0.006***	**0.004***	**0.007***	**0.006***	**0.007***	**0.014***	**0.007***	**0.006***
		(0.001)	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**	**(0.001)**
R^2		0.87	0.85	0.81	0.84	0.85	0.83	0.84	0.84	0.81
N		98	98	98	168	168	168	168	168	168
					Somatic Cell Count Model					
Intercept	1/	343.561*	418.731	367.500*	350.702*	400.826*	2/	2/	358.842*	357.164*
		(4.151)	(4.428)	(5.687)	(3.384)	(5.565)			(4.554)	(2.730)
Trend	1/	**-10.461***	**-16.730**	**-13.352***	**-8.871***	**-12.244***	2/	2/	**-11.306***	**-9.300***
		(0.746)	**(0.796)**	**(1.022)**	**(0.379)**	**(0.624)**			**(0.511)**	**(0.306)**
R^2		0.76	0.89	0.71	0.795	0.73			0.76	0.87
N		98	98	98	168	168			168	168

*Approximated standard errors in parenthesis; *p-value < 0.01; 1/ Data unavailable as pricing regulations in Arizona are based on skim-fat; 2/ Data unavailable as pricing regulations in these orders do not include adjustments for somatic cell counts.*

Figure 1. Value Added Under Multiple Component Pricing, 2006-2013