DMaP
Dairy Markets and Policy

Information Letter Series

The Impact of US Dairy Component Exports on the All-Milk Price

Information Letter 19-01
March 2019

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The impact of the dairy components exported on the All-milk price is positive, but likely only about $0.10/cwt for each additional 1% of components produced that are exported. The likely reason for this relatively small price impact is that as component exports have grown, milk supply growth has maintained an approximate supply-demand balance.

Introduction

It seems to have become an article of faith that US dairy product exports have a large impact on farm milk prices. This is reflected in the attention paid to export data, ongoing trade negotiations or disputes (for example with China, Mexico, Japan), and the reaction of the futures markets when the trade dispute with China arose in 2018. The value of exports is often discussed in terms of the proportion of solids exported—sometimes differentiated between the fat and non-fat solids—but also in terms of the total value of dairy product exports. The pattern of US dairy exports from 2000 to 2018 is similar whether expressed in the total volume of components or the proportion of components in US farm milk that is exported (Figure 1). Both have grown substantially, especially since 2005, and the percentage exported of combined fat and nonfat components has exceeded 15% in recent years. A goal of 20% of total US milk components exported has been promoted by some organizations.

Despite the growth in the importance of exports for the US dairy industry, there has been limited empirical analysis to date of the price impacts of exports. The patterns of behavior over time for the All-milk price and US dairy component exports might suggest that

the price impact of exports is less than often imagined. After all, if dairy component exports have such a large impact on price, why is it the case that while dairy exports have grown rapidly since 2004, there is no notable trend in the All-milk price during this time[1] (Figure 2)?

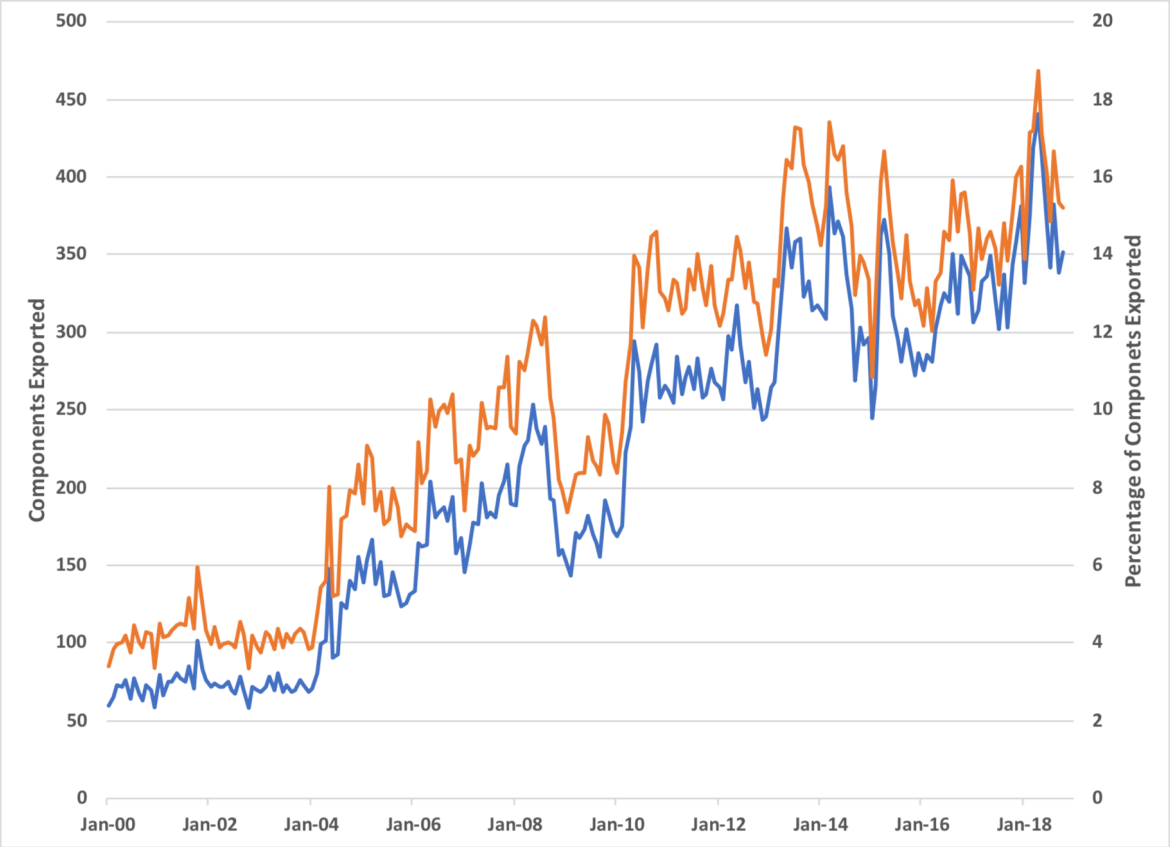

Figure 1. Total Components Exported and Components Exported as a Proportion of Components in US Farm Milk, Monthly 2000 to 2018

With this as background, this Information Letter assesses the impact of component exports on the US All-milk price using an econometric model that combines structural variables (the cost of feed and components exported) with time series variables (trend, seasonal effects and cycles).

Methods

An econometric model using monthly data from 2000 to 2018 on the All-milk price, the cost of a 16% protein dairy ration, alternative measures of dairy component exports, and underlying time series components (trend, seasonal effects and cycles). Data for the All-milk price and ration value are those reported by NASS (or calculated based on NASS data). Data

[1] Of course, it can be misleading to look only at a graph of the two series without controlling for other factors, and it is at least logically possible that milk prices would have declined without the impact of increasing exports. However, this is a hypothesis that can be tested using actual data.

on the components exported are from the Economic Research Service of USDA. Graphically, these series suggest a relationship between the three variables (Figure 3), and this is the sort of evidence that is presented to indicate a strong link between component exports and US milk prices. The time series components are determined by the econometric model.

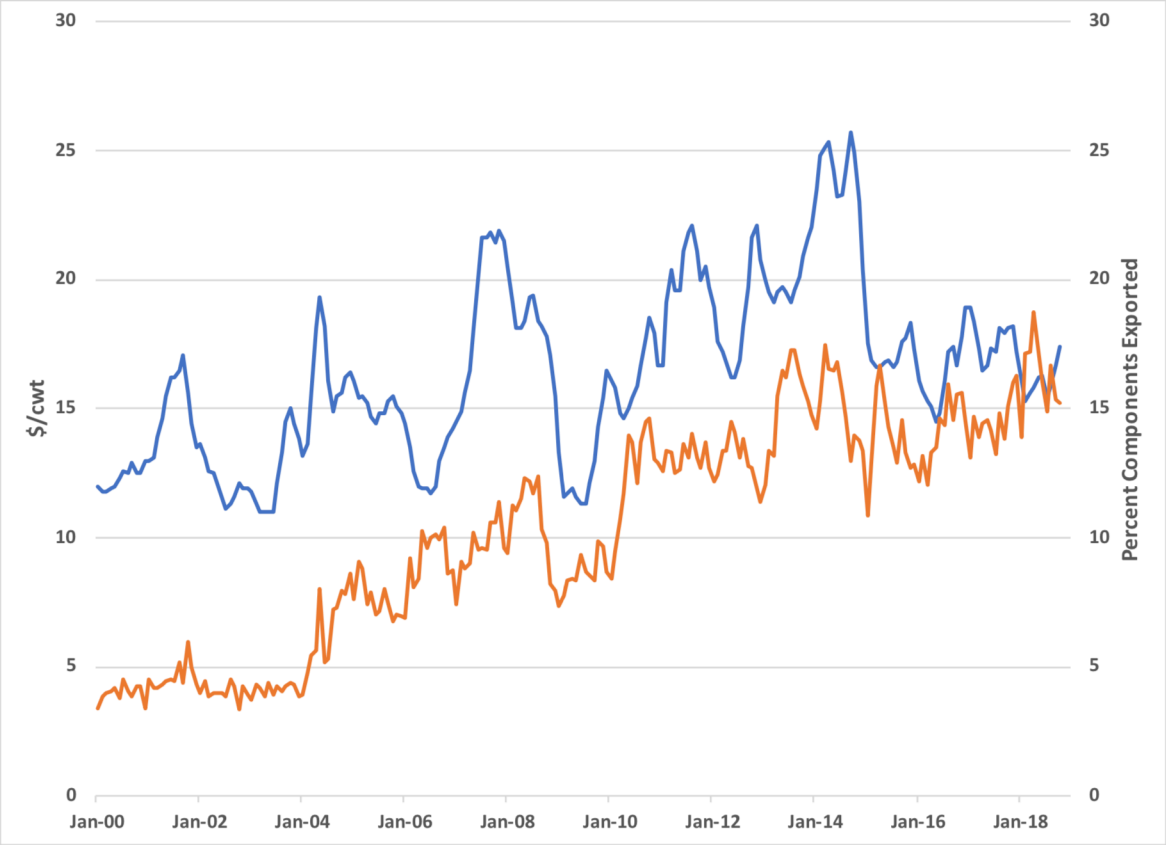

Figure 2. US All-Milk Price and Proportion of Farm Milk Components Exported, Monthly 2000 to 2018

Binary variables are included for each of the months January to November to account for seasonal effects. The model attempts to combine specific variables hypothesized to affect milk prices with an underlying patterns of milk price behavior (trend, cycles, seasonality) for which causes are not analyzed. This model is similar to one used by Nicholson and Stephenson (2015), who analyzed cyclical behavior in US milk prices. In that analysis, the total value of US exports and the quantity of key export categories (milk, whey and cheese) were initially included but were later dropped when they did not have statistically significant effects on the US All-milk price.

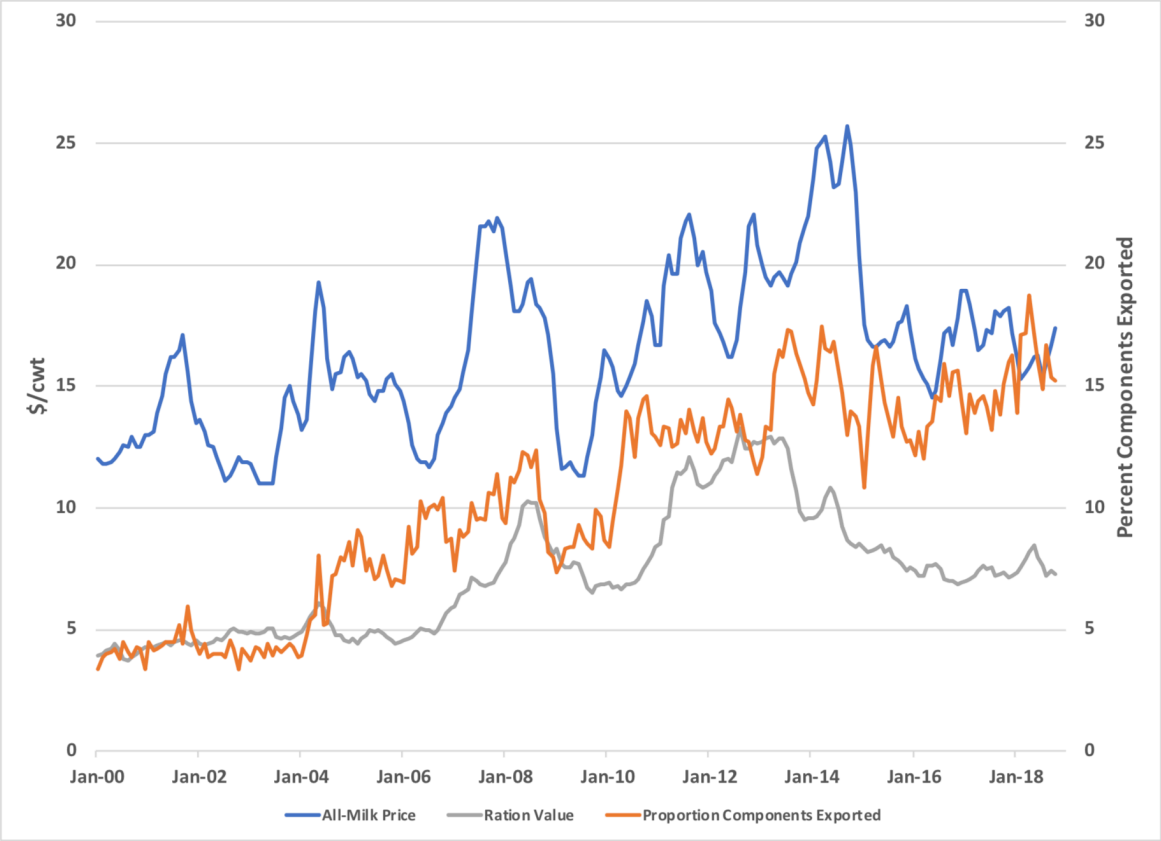

Figure 3. The US All-Milk Price, NASS Ration Value and Proportion of Components Exported, Monthly 2000 to 2018

A number of alternative variables representing components exported were assessed in developing this analysis, as were different time periods. Neither the total amount of exported components (both fat and nonfat solids) nor the proportion of farm milk components exported in the same month as the milk price had a statistically significant effect. A rolling 12-month average of the proportion of components exported was statistically significant but the model had difficulty solving with different algorithms and the properties of the model residuals were undesirable. (It is also a bit challenging to imagine that logic by which current milk prices would be affected by a rolling average value, although this calculation does smooth out the rather large variation in export values month to month that is shown in the figures above.) At the suggestion of Mark Stephenson, a model was run to account for the delays in compiling and reporting export information. The variable ultimately used was a 6-month lag of the proportion of components exported. When models were run with this using monthly data from 2000 to 2018, the effect was not statistically significant. A similar result occurred in using monthly data from 2005 to 2018. The final model for which results are reported herein includes the six-month lag of the proportion of components exported and data from January 2008 to October 2018.

The model was estimated using the "unobserved components model" (UCM) computational methods available in Stata (version 15.1). A "random walk" was assumed as the form of the underlying time series model after accounting for the ration value, proportion exported and monthly binary variables. Based on previous work (Nicholson and Stephenson, 2015), we included two cycles to account for that underlying behavioral component. The solution process allowed for changing of the optimization technique to facilitate the model solution and used that standard Stata UCM value for convergence tolerances.

Results

The model solved in a limited number of iterations using the above formulation and data period. This model suggests that the ration value and many of the seasonal factors are statistically significant, as are the two cyclical components (Figure 4). Similar to previous work, the higher-amplitude of the two cycles has a period of about 36 months. For the model formulation and data period, the impact of the lagged proportion of components exports is statistically significantly different than zero, with a mean estimated effect of $0.12/cwt and a 95% confidence interval of half a cent per cwt to $0.24/cwt. The model predicts one-step-ahead forecasts with a low degree of error (Figure 5), and the residuals are normally distributed and not serially correlated.

Discussion

The UCM analysis suggests that the impact of dairy component exports is statistically significant, at least for this way of measuring the impact and for this time period. However, a number of points merit further discussion. First is that finding no impact for other time periods or measures of components tends to suggest a less strong relationship than might be commonly assumed—it is only for a very specific way of measuring components and for one assumed time period (albeit the most recent 11 years) that the effect of component exports is statistically significant. Second, the estimated impact appears relatively small, given that a 1% increase in total component exports (i.e., a relatively large volume of exported product) would result in a price increase of $0.12/cwt. Measured as an elasticity at the mean of the data for the All-milk price and proportion exported during 2008 to 2018, the value is 0.09, suggesting that the sensitivity of the milk price to exports—although positive—is relatively low. Finally, component exports should not be considered a "cause" of cycles in the milk price. The analysis controls for the proportion of exports and indicates a high-amplitude cycle that occurs due to other factors—which Nicholson and Stephenson (2015) hypothesized to the nature of producer supply response behavior.

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Unobserved-components model
Components: random walk, 2 cycles of order 1

Sample: 2008m1 - 2018m10                        Number of obs      =       130
                                                Wald chi2(17)      =   4445.57
Log likelihood = -130.42462                     Prob > chi2        =    0.0000
------------------------------------------------------------------------------
             |                 OIM
     Allmilk |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
cycle1       |
   frequency |   .9660868   .0779107    12.40   0.000     .8133847    1.118789
     damping |   .8349155   .0508846    16.41   0.000     .7351834    .9346476
-------------+----------------------------------------------------------------
cycle2       |
   frequency |    .177468    .024985     7.10   0.000     .1284983    .2264378
     damping |   .9717283   .0161225    60.27   0.000     .9401287    1.003328
-------------+----------------------------------------------------------------
Allmilk      |
      Ration |   .6206017   .1762749     3.52   0.000     .2751091    .9660942
   pcexplag6 |   .1210864   .0596829     2.03   0.042       .00411    .2380627
      JanDum |  -.7572922   .2366438    -3.20   0.001    -1.221106   -.293479
      FebDum |  -1.222631    .362689    -3.37   0.001    -1.933489   -.511774
      MarDum |  -1.459502   .4251124    -3.43   0.001    -2.292707  -.6262966
      AprDum |  -1.729188   .4224706    -4.09   0.000    -2.557215  -.9011609
      MayDum |   -1.89535   .3956763    -4.79   0.000    -2.670861  -1.119839
      JunDum |  -1.495561   .3718389    -4.02   0.000    -2.224352  -.7667701
      JulDum |   .3251086   .2327746     1.40   0.163    -.1311213   .7813384
      AugDum |  -.6344388   .4244188    -1.49   0.135    -1.466284   .1974067
      SepDum |   .0249533   .4268247     0.06   0.953    -.8116076   .8615143
      OctDum |   .3701568   .3691824     1.00   0.316    -.3534275   1.093741
      NovDum |   .6349817   .2327993     2.73   0.006     .1787035    1.09126
-------------+----------------------------------------------------------------
  var(level) |   .0179967   .0414352     0.43   0.332            0    .0992082
 var(cycle1) |    .110897   .0360396     3.08   0.001     .0402606    .1815334
 var(cycle2) |   .1889463    .064554     2.93   0.002     .0624229    .3154698
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Figure 4. Results of the UCM Model Assessing the Impacts of Dairy Component Exports

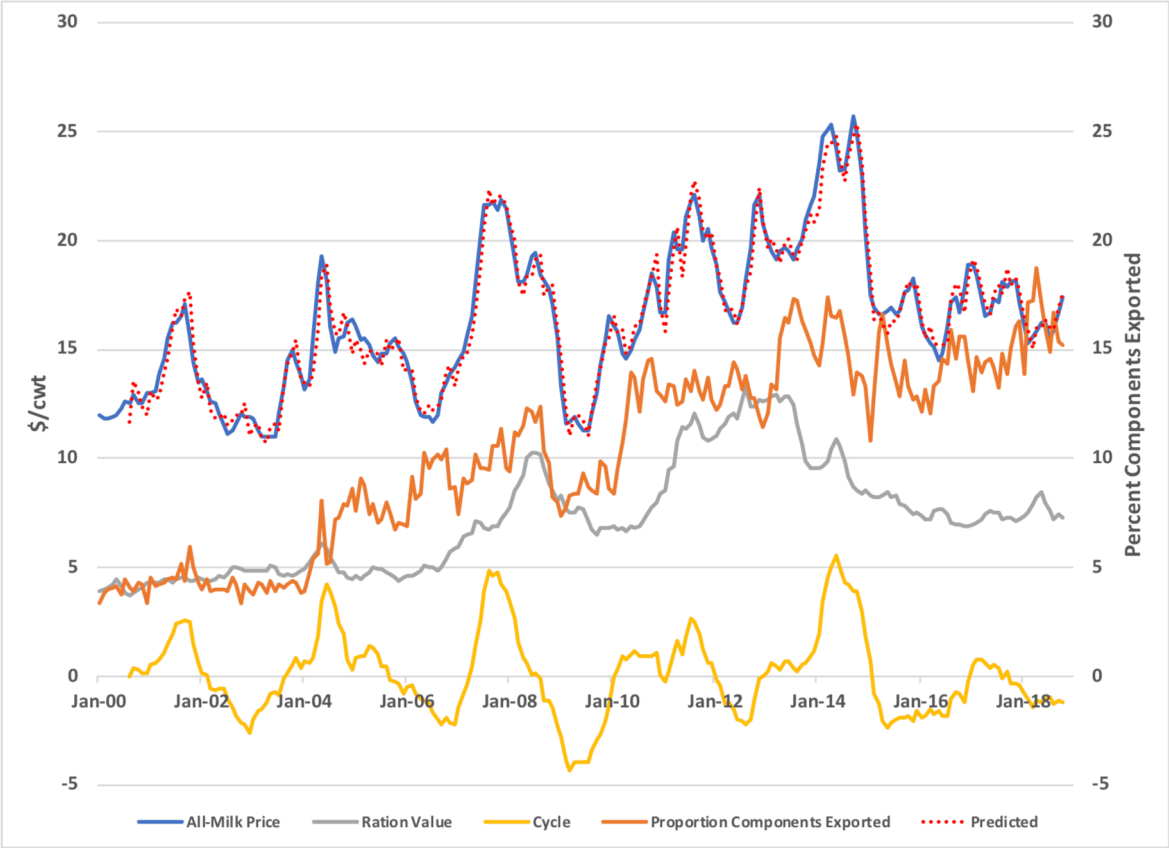

Figure 5. UCM Model Prediction (One-Step Ahead), the High-Amplitude Cyclical Component, the NASS Ration Value and the Proportion of Components Exported, 2000 to 2018

Why might the price impact of exports be small when estimated with this approach? One explanation is that this analysis focuses on the longer-term, when the impact of steady growth in component exports can be accommodated with growth in milk production. This may maintain an approximate balance between milk supply and demand, mitigating to a large extent impact of the increase in the demand for components for export. Thus, this type of analysis may not be representative of the impacts of sudden large changes in components exported (e.g., rapid decreases in exports to China or Mexico). Large abrupt changes may result in larger impacts because they are more disruptive of the current supply-demand balance for milk. This analysis is thus more useful for the assessment of strategic initiatives to grow dairy exports. Moreover, price may not be the best metric for evaluating the impacts of growing trade. Our analysis of dairy markets with a global dairy supply chain model (Nicholson and Stephenson, 2019) suggests that the *price impacts* of steadily growing trade will be minimal (and is thus consistent with this econometric analysis) but that *aggregated industry revenues and earnings* are enhanced as more components are exported.

This analysis should be considered preliminary and could undoubtedly be refined but provides a relevant initial estimate of the size of the impact of dairy component exports on farm milk prices. Pending further evidence from additional analyses, it would be appropriate to be cautious in estimating the magnitude of price impacts from US dairy exports.

Reference

Nicholson, C. F. and M. W Stephenson. 2015. Price Cycles in the U.S. Dairy Supply Chain and their Management Implications. *Agribusiness: An International Journal*, 31:507-520. DOI: 10.1002/ agr.21416

Nicholson, C. F. and M. W. Stephenson. 2019. Analyses of Selected Dairy Programs Proposed to Reduce Variability in Milk Prices and Farm Income. Report to the Wisconsin Farmers Union, February.