Disorderly Markets: Milk Price Regulations Alter U.S. Inter-Regional Trade in Milk and Increase U.S. Production of Internationally Tradable Dairy Products

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OVERVIEW

Milk supply and demand in most regions of the United States are affected by Federal Milk Marketing Order regulations, where buyers of farm milk must pay minimum prices based on the products manufactured from that milk. Milk processors use farm milk from outside their region despite relatively high transportation costs.

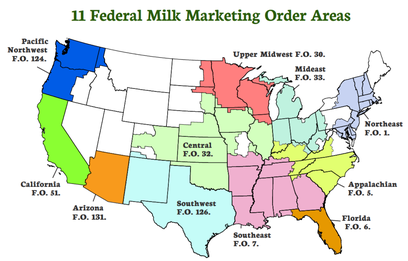
We examine the movement of milk between regions and sales of dairy products across the United States using a model of inter-regional trade. The export market is included to evaluate the increase in U.S. dairy product exports. Simulations using this model examine the effects of federal milk pricing policies, with results showing an increase in shipments of milk between regions and increased dairy product exports.

DAIRY POLICY

U.S. dairy policy supports farmers by increasing the price received for farm milk through classified pricing and revenue pooling.

Federal Milk Marketing Orders (FMMOs) regulate milk pricing in 11 milk producing regions. Milk buyers in FMMO regions face minimum prices, set according to regulated formulas, depending on the intended end use of the purchased milk.

Classified pricing results in price discrimination for milk used in beverage products. Revenue is pooled at the regional level and the additional revenue generated from price discrimination is distributed to producers as a "blend price".



Source: National Milk Producers Federation

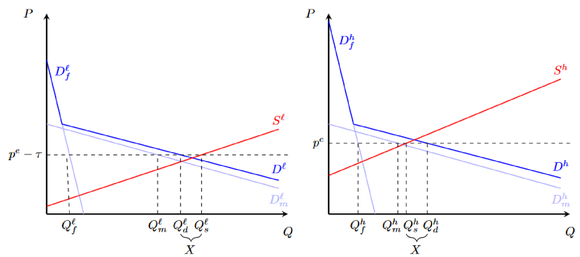
The effects of classified pricing and revenue pooling were explored by Kessel (1967) and Ippolito and Masson (1978), both identifying increased milk production and inefficiencies due to the marketing order policies. Through price discrimination and revenue pooling within regional orders, U.S. milk pricing regulations alter regional milk supplies by increasing milk production within high-cost regions and increasing raw milk shipments into high-price regions.

WHAT CAUSES TRADE BETWEEN REGIONS?

Milk producers ship farm milk between regions despite high transportation costs to take advantage of price differences.

The cost to produce milk and the demand for milk and other dairy products differ across regions. Suppose there are two regions, one with low cost of milk production and reduced demand for beverage milk products and another with high cost of production and higher demand for beverage milk. Depending on the cost of transportation between the two regions, the low-cost region will ship milk to the high-cost region to meet demand (Figure 1).

Figure 1: Trade Between Milk-Producing Regions

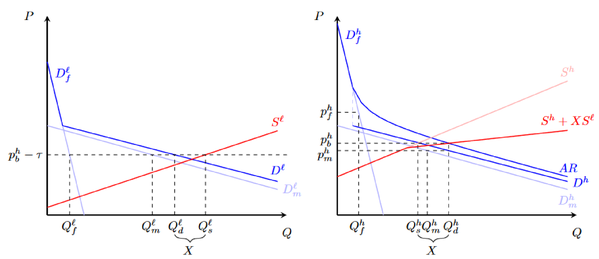


Suppose now that the high-cost region implements classified pricing and revenue pooling policies. A fixed price differential is added to the price paid by buyers for milk used in beverage products. The price paid for milk used in manufactured products is determined by the market.

The price received by milk producers is a weighted average of the beverage milk and manufacturing milk prices. The equilibrium blend price is determined where the average revenue function, AR, meets the total supply of milk. The price paid for manufacturing milk is determined using the total demand function and the quantity available in the region.

Given the higher price received, more milk is shipped from the low-cost region to the high-cost region (Figure 2).

Figure 2: Milk Shipments Increase under FMMO Policies



MODELING INTER-REGIONAL TRADE

Consumer Preferences: A representative consumer purchases dairy products, n, from regions across the U.S. and imported products.

$$C_{ij}^n = \beta_j \beta_j^n \beta_{ij}^n \left(P_j\right)^{\kappa-\epsilon} \left(P_j^n\right)^{\sigma^n-\kappa} \left(\tau_{ij}^n p_i^n\right)^{-\sigma^n}$$

Where P_j and P_j^n are price indices, $\tau_{ij}^n p_i^n$ is the price of product n after delivery from i to j.

Product Manufacturing: Dairy products are manufactured from milk components in each region according to a fixed proportions production function, $Q_i^n = \min(Z_i^n, N_i^n/\nu_i^n)$, where Z_i^n is an aggregate of milk components used in manufacturing product n and N_i^n is other inputs.

There are three milk components, indexed by k, that may be used in dairy product manufacturing: fat, protein, and other solids. The derived demand for each component is given by:

$$Z_i^{nk} = Q_i^n \gamma_i^{nk} (V_i^n)^{\varsigma^n} \left(\delta_i^{nk} v_i^k\right)^{-\varsigma^n}$$

Where V_i^n is a price index, v_i^k is the price of component k in region i, and $\delta_i^{nk} \geq 1$ is a policy parameter that increases the minimum price for component k when used in product n.

Given demand for dairy products from all regions, market clearing requires that:

$$Q_i^n = \sum_{j \geq 0} \tau_{ij}^n C_{ij}^n$$

Milk Production: Milk is produced in each region using feed crops and other inputs, $M_i = \min(F_i, N_i/\nu_i)$, where F_i is an aggregate of feed crops. Crop production and trade is modeled using an approach based on Costinot, Donaldson, and Smith (2016) and Gouel and Laborde (2021). This ensures an upward-sloping supply of milk in each region.

Milk may be shipped between regions to meet demand for milk components. The share of each component in a quantity of milk is fixed, therefore the component availability is determined by the total quantity of milk delivered to a region. The quantities of components used must balance with the total quantity of milk delivered, resulting in the following market clearing condition:

$$\sum_{n \geq 1} Z_i^{nk} = \zeta^k \sum_{j \geq 1} M_{ji}$$

Where ζ^k is the share of component k in milk and M_{ji} is the quantity of milk used in region i that was produced in region j.

CALIBRATION AND PRELIMINARY RESULTS

Milk marketing orders have existed for nearly 100 years, with the dairy industry changing significantly during that time. Therefore, no data exist that adequately represent the dairy industry in the absence of the marketing orders, and it is not reasonable to compare the present to a time before these policies existed.

The model of inter-regional trade is expressed in relative equilibrium, following the work of Gouel and Laborde (2021). Each variable is expressed as the value in the counterfactual scenario relative to the baseline. This allows the model to be calibrated using a set of share parameters, such as the trade share between regions, consumer budget shares, and the cost shares at each level of production.

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