Case Study

Market Power in the U.S. Dairy Industry

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Abstract
The motivations for this case study are developments in the U.S. dairy industry involving implementation of a herd retirement (HR) program by the National Milk Producers Federation (NMPF) and the Cooperatives Working Together (CWT) in the period from 2003 to 2010. This program was part of a broader private supply management initiative, which aimed to balance milk supply and milk demand and to stabilize and strengthen milk prices received by dairy farmers. The HR program, which intended to decrease milk supply, raised legal issues leading to antitrust lawsuits filed by buyers of manufactured dairy products against dairy cooperatives. These buyers argued that the HR program was a form of illegal conspiracy aiming to increase prices for raw milk and manufactured dairy products. The lawsuits resulted in large settlements. This case study introduces economic, business, and legal issues related to implementation of the HR program. The case study presents a theoretical framework that may explain market and price effects of the HR program using the perspectives of dairy farmers and buyers of raw milk and manufactured dairy products. In addition, the case study presents a basic market and price analysis based on publicly available data reported by the U.S. Department of Agriculture. The case study is suitable for a variety of undergraduate and graduate courses taught in agricultural economics and agribusiness programs, as well as extension and outreach audiences. A teaching note includes teaching guidance, as well as answers to discussion and multiple-choice questions.

1 Introduction

The motivations for this case study are developments in the U.S. dairy industry involving implementation of a herd retirement (HR) program by the National Milk Producers Federation (NMPF) and the Cooperatives Working Together (CWT) in the period from 2003 to 2010. This program was part of a broader private supply management initiative (CWT program), which aimed to balance milk supply and milk demand and to stabilize and strengthen milk prices received by dairy farmers. The CWT program, in addition to the HR program, included an export assistance program (2003–present). The HR program was used to control milk supply by removing from production the entire milking herds of selected dairy farmers. The export assistance program has been used to help dairy farmers expand foreign markets for manufactured dairy products by allocating subsidies to participating dairy cooperatives on export of selected products (cheese, butter, etc.).

In 2011, buyers of fluid milk and other fresh milk products[1] at the retail level (indirect purchasers) and in 2015 buyers of raw milk, cheese, and butter at the wholesale level, who purchased these products directly from dairy cooperatives (direct purchasers), filed class action antitrust lawsuits against NMPF, CWT, and a group of dairy cooperatives: Agri-Mark, Inc., Dairy Farmers of America, Inc., Dairylea Cooperative Inc., and Land O'Lakes, Inc. In their complaints filed in the court, these buyers alleged that by implementing the HR program the cooperatives engaged in an unlawful conspiracy to

[1] Fluid milk products include "beverage" milk (whole milk, reduced fat milk, one percent milk, etc.). Other fresh milk products include cottage cheese, cream cheese, cream, half-and-half, sour cream, and yogurt.

limit the production of raw milk to achieve short-run and long-run increases in the wholesale prices of raw milk, cheese, and butter and in the retail prices of fluid milk and other fresh milk products.[2]

The buyers argued that the HR program was not within the scope of Capper-Volstead Act (1922) immunity and consequently violated Section 1 of the Sherman Act (1890) and the state antitrust laws.[3] The cooperatives settled the lawsuit with indirect buyers in 2016 for $52 million (Hagens Berman 2018; Fresh Milk Products Antitrust Litigation 2022). The cooperatives settled the lawsuit with direct buyers of cheese and butter in 2019 for $220 million (Fu 2019; Butter and Cheese Class Action 2022). In their settlement agreements, the cooperatives did not admit to any wrongdoing.

This case study introduces economic, business, and legal issues related to implementation of the HR program. The case study presents a theoretical framework that may explain market and price effects of the HR program (conduct and performance of the dairy industry) using the perspectives of dairy farmers and buyers of raw milk and manufactured dairy products. In addition, the case study presents a basic market and price analysis based on publicly available data reported by the U.S. Department of Agriculture.

The case study is suitable for a variety of undergraduate and graduate courses taught in agricultural economics and agribusiness programs, including agricultural marketing, agricultural markets and prices, and applied industrial organization. Table 1 summarizes student learning objectives.

Table 1. Student Learning Objectives.

Student Learning Objective (SLO)	
SLO #1	Students should be able to discuss the U.S. dairy industry's institutional environment at the end of the last century that might have led to an idea of a private supply management program (HR program).
SLO #2	Students should be able to explain the objectives and implementation procedure of the HR program, as well as the role of dairy cooperatives in implementing this program.
SLO #3	Using a graphical analysis, students should be able to explain two variations of the theoretical framework that may explain market and price effects of the HR program using the perspective of dairy farmers and the perspective of buyers of raw milk and manufactured dairy products.
SLO #4	Students should be able to conduct a basic market and price analysis, as well as a dairy farm profitability analysis using the U.S. Department of Agriculture data for the period of the HR program and the periods before and after the program to evaluate possible effects of this program.
SLO #5	Students should be able to discuss the role of the Capper-Volstead Act, as a limited antitrust immunity to the Sherman Act, in regulating collective agricultural marketing activities of dairy farmers in the analyzed situation.

[2] Figure A1.1 presented in Appendix 1depicts the dairy product supply chain.

[3] The Clayton Act (1914), a Federal law, allows direct purchasers of cartelized products to recover treble damages for violations of the Sherman Act. Indirect purchasers of cartelized products are allowed to recover damages under the state antitrust statues in the states where these statutes exist (Hovenkamp 2005). The state antitrust statutes exist in approximately half of the states. The state "antitrust statutes" may include antitrust laws, restraint of trade laws, and consumer protection laws.

2 The U.S. Dairy Industry Institutional Environment and Economic Forces Leading to a Private Supply Management Initiative

The competitiveness of the U.S. dairy industry depends on the economically viable domestic production and profitability of individual dairy farmers. During the last two decades of the last century, the institutional environment of the U.S. dairy industry changed, which affected milk prices received by dairy farmers and dairy farm profitability. Changes in the institutional environment affected strategic decisions of the dairy industry, in particular programs implemented by dairy cooperatives. Dairy cooperatives representing individual dairy farmers have historically been involved in milk marketing and dairy product manufacturing in the United States (Ling 2011, 2012, 2014).

During the last century, there was a significant degree of Federal government intervention in dairy industry pricing and marketing, mostly in terms of price supports and associated government purchases of manufactured dairy products (Manchester and Blayney 1997, 2001; Shields 2010). The milk price support provided a price floor on the level of milk prices received by dairy farmers, which guaranteed a satisfactory milk price level and milk price stability, which consequently ensured a viable profitability level for dairy farmers. Dairy product prices in international markets were below the U.S. dairy product prices, which limited export opportunities for the U.S. dairy industry during that period.

In the 1980s, the Federal government intervention in the dairy industry pricing began to decrease (Manchester and Blayney 1997, 2001; Brown et al. 2010). In particular, the level of dairy (milk) price support declined. Milk oversupply problem became obvious, when the government purchases of manufactured dairy products were substantially decreased as a result of a decline in the dairy (milk) price support level. At the same time, milk productivity per cow continued increasing due to the improvements in animal genetics and production management practices.

In the 1980s, two Federal government-sponsored voluntary supply management programs were implemented in the U.S. dairy industry. The overall objective of these programs was to strengthen and stabilize farm-level milk prices by controlling milk supply (Gale 1990; Dixon, Susanto, and Berry 1991; Brown et al. 2010). The Milk Diversion Program was implemented in 1984, and the Dairy Termination Program (herd buyout) was implemented in 1986 and 1987. The U.S. Congress authorized these programs, and they were funded partially through the dairy producer assessments and partially through the government funds. Under the Milk Diversion Program, dairy farmers who committed to decrease their milk quantity marketed by 5 to 30 percent were paid $10 per hundredweight (cwt)[4] of milk on the reduced milk quantity. Under the Dairy Termination Program, the U.S. Department of Agriculture accepted bids from dairy farmers who committed to slaughter or export all female dairy cattle and not to re-enter the dairy industry for at least 5 years. After the implementation of both programs, the milk supply continued to increase.

Increased globalization and reduced trade barriers in the early 1990s created export opportunities for the U.S. dairy cooperatives (Liebrand and Spatz 1993; Seipel and Heffernan 1997; Kennedy 2006). As a result of the international trade liberalization (WTO/GATT Uruguay Round) affecting many agricultural markets, the U.S. dairy product prices came closer to international prices for these products, which created incentives for the U.S. dairy industry to explore export opportunities. At the same time, the U.S. dairy industry began being affected by price fluctuations taking place in international dairy markets.

This complex interaction of economic and policy forces affected the level and volatility of milk prices received by dairy farmers. The milk price volatility began to increase when milk prices started rising above the milk price support level beginning in the 1990s (Figure 1). Coupled with the increasing level and volatility of prices for agricultural inputs used in milk production (in particular, feed and energy), the increasing milk price volatility adversely affected the profitability of many dairy farmers.

[4] "Cwt" is one hundredweight (100 pounds).

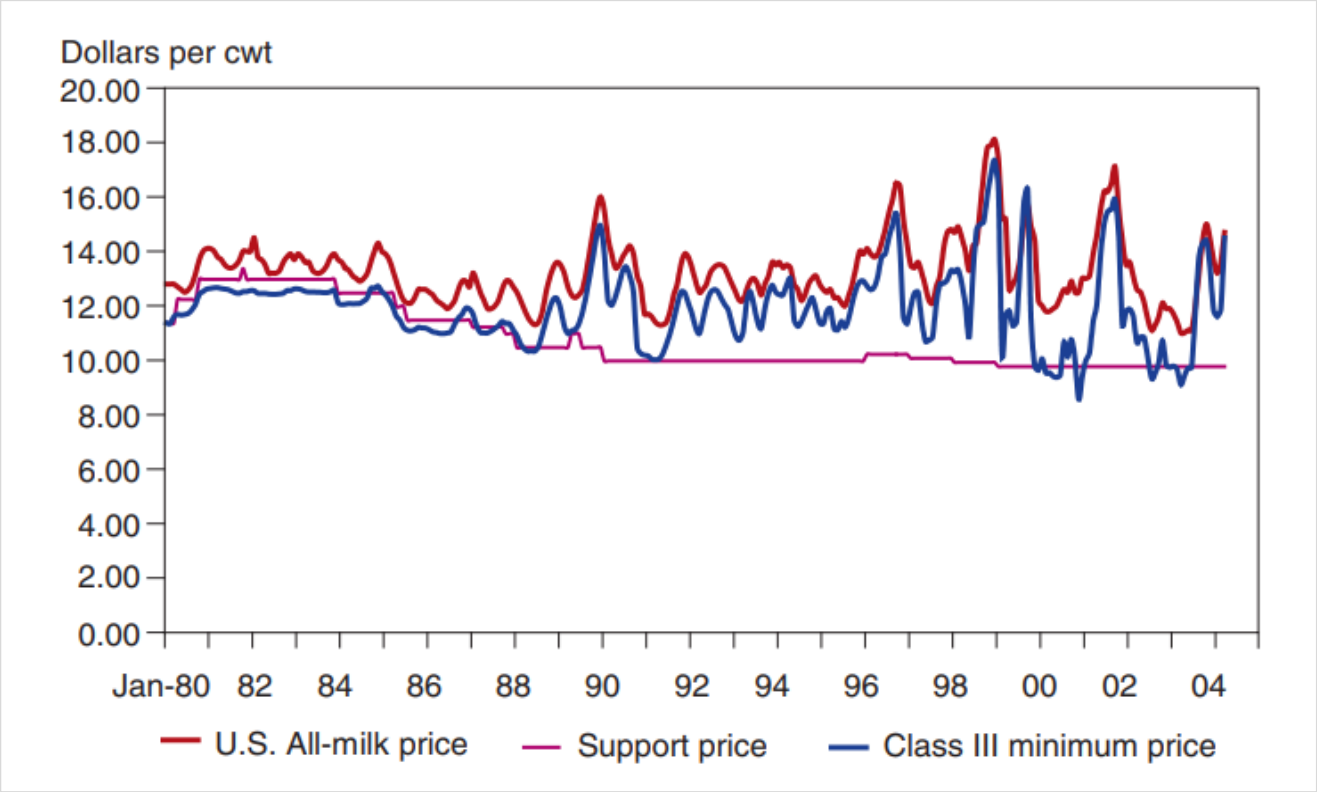

Figure 1. U.S. All-Milk, Class III Milk, and Support Prices, 1980–2004

Source: This figure is from U.S. Department of Agriculture, Economic Research Service (2004).

The problem that the U.S. dairy industry was faced with at the beginning of this century was to determine the strategies that would help effectively balance milk supply and demand, to achieve a satisfactory level of milk prices and milk price stability. In 2003, the NMPF and CWT developed and began implementing a private supply management program.

3 CWT and HR Program

CWT is a voluntary, marketing-focused program that is managed by the NMPF, a trade association of dairy cooperatives (Brown et al. 2010; CWT 2022). The CWT program is funded by assessments paid by participating dairy cooperatives and individual dairy farmers. The CWT program operates in accordance with the Capper-Volstead Act. There has not been any government participation or assistance involved in this program.

The CWT supply management program, originally developed in 2003, included the HR program (2003–2010) and an export assistance program (2003–present; Siebert and Lyford 2009; Brown et al. 2010). The participation of dairy farmers is on a voluntary basis. Dairy farmers participating in the CWT program have marketed on average 67 to 74 percent of the national milk supply (Brown et al. 2010). The CWT program has been funded by assessments of participating dairy farmers. The assessment introduced in July 2003 was $0.05 per cwt of milk produced. The assessment was increased to $0.10 per cwt of milk produced in July 2006. Approximately 90 percent of all funds were allocated to the HR program.

The objective of the HR program was to control milk supply by removing from production the entire milking herds of selected dairy farmers.[5] The HR program was implemented in the period from 2003 to 2010. During this period, CWT held ten HR rounds. To decide on whether to conduct an HR round, CWT used guidelines, which included an analysis of economic indicators such as all-milk price, milk production costs, milk-feed price ratio, and milk cow inventories. During each HR round, participating dairy farmers had to submit their bids on how much money they were willing to accept to slaughter their entire milking herds. The dairy farmers, which bids were accepted by CWT, had to slaughter their milking herds within 15 days after the audit process of their production was completed.

The audit focused on comparing the current year's milk production to the previous year's milk production to verify that there were no significant changes in the milk production attributed to the herd retiring. After the audit was completed, cows were CWT tagged, and the dairy farmers were responsible for sending these cows to slaughter within 15 days. Once the tags were returned to CWT, the dairy farmers received their checks. Originally, dairy farmers who retired their milking herds were not prohibited from re-entering dairy farming. The requirement of not to re-enter dairy farming within 12 months to receive a full payment was introduced in 2009 (Brown et al. 2010). In particular, the dairy farmers received 90 percent of their bids when they were accepted. The dairy farmers received the remaining 10 percent of their bids and interest after 12 months, when it was verified that these farmers and their dairy operations stayed out of milk production.

Figure 2 summarizes data on the HR levels during the first nine rounds (2003–2009; Brown et al.

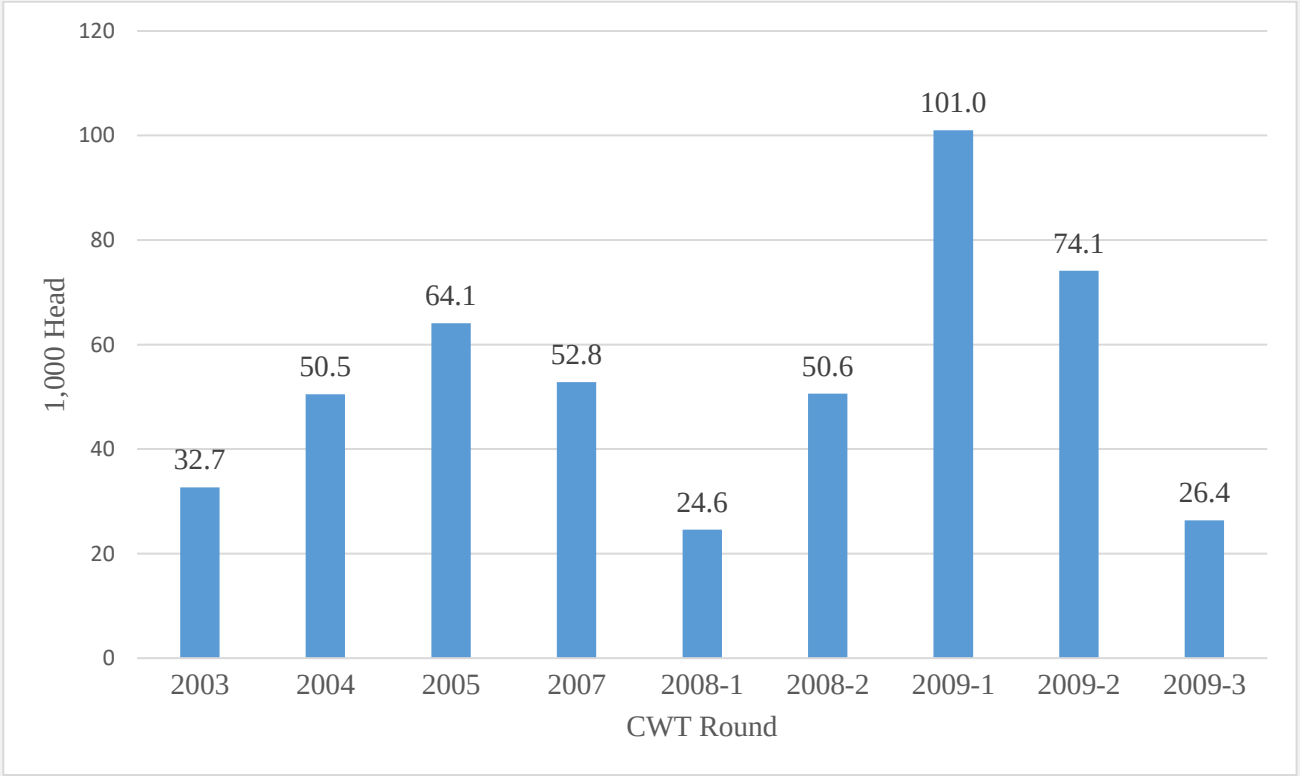

Figure 2. CWT HR Levels

Source: The data depicted in this figure are from Brown et al. (2010).

[5] A detailed discussion of the HR program is presented in the complaints filed by the buyers of raw milk and manufactured dairy products at the wholesale level: Edwards et al. v. National Milk Producers Federation et al. (2014) and by the buyers of fluid milk and fresh milk products at the retail level: First Impressions Salon, Inc., et al. v. National Milk Producers Federation, et al. (2015). The CWT program is also discussed in Siebert and Lyford (2009), Brown et al. (2010), and newsletters available on the webpage of the CWT (2022).

2010). One HR round was conducted in 2003, 2004, 2005, and 2007. Two HR rounds were conducted in 2008. Three HR rounds were conducted in 2009. The number of cows retired in each round ranged from 24,600 heads in the first round in 2008 to 101,000 heads in the first round in 2009. The smallest number of cows were retired in 2003 (32,700 heads during one round). The largest number of cows were retired in 2009 (201,500 heads during three rounds).

As a result of the nine rounds depicted in Figure 2, approximately 476,800 cows were removed from milk production. The combined effect of these HR rounds on the U.S. all-milk price in 2009 was over $1.50 per cwt of milk (Brown et al. 2010). Figure 3 summarizes the bids that selected dairy farmers accepted to retire their milking herds during the first six rounds of the HR program (2003–2008; Brown et al. 2010). The average bid per round ranged from $4.02 per cwt of milk in 2003 to $6.75 per cwt of milk in 2005.

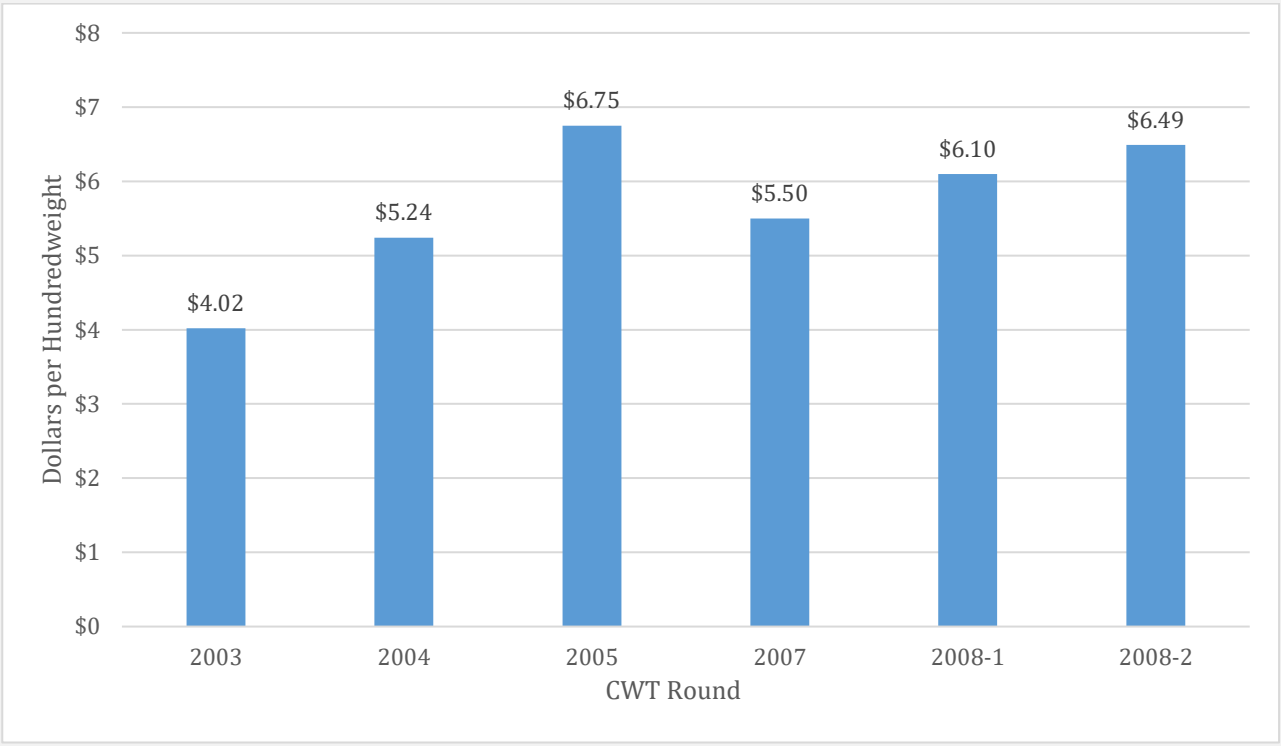

Figure 3. CWT HR Average Bids

Source: The data depicted in this figure are from Brown et al. (2010).

According to the complaint filed by the buyers of cheese and butter in the court,[6] as a result of ten HR rounds (2003–2010), 2,802 dairy farms retired their milking herds, 506,921 cows were removed from production, and milk supply was reduced by 9.672 billion pounds of milk. In addition, the effect of the HR program on the U.S. all-milk price was $0.05 per cwt in 2003, $0.16 per cwt in 2004, $0.44 per cwt in 2005, $0.55 per cwt in 2006, $0.62 per cwt in 2007, and $0.57 per cwt in 2008.

Since 2011, the entire focus of the CWT program has shifted to export assistance. The objective of the export assistance program is to help dairy farmers expand foreign markets for manufactured dairy products by allocating subsidies to participating dairy cooperatives on export of selected products. In the period from 2003 to 2009, butter and cheese were the products subject to CWT export assistance. Beginning in 2010, the product list was expanded to include whole milk powder.

[6] First Impressions Salon, Inc., et al. v. National Milk Producers Federation, et al. (2015).

4 Market and Price Effects of the HR Program: Theoretical Framework

This section presents two variations of the same theoretical framework that may explain conduct and performance of the dairy industry (market and price effects of the HR program) using the perspective of dairy farmers and the perspective of buyers of raw milk and manufactured dairy products.

4.1 Perspective of Dairy Farmers

Figure 4 depicts a wholesale demand curve for raw farm milk (labeled as "P") and a constant marginal cost curve (labeled as "MC"). The wholesale demand curve is a graphical representation of a price-dependent (inverse) demand function for raw farm milk, and the MC curve is a graphical representation of a constant MC function. In addition, this figure depicts three market scenarios differing due to total milk quantity produced by all dairy farmers each year (Q), milk price received by dairy farmers (P), and industry profit measured using a Price-Cost Margin (PCM). These are a milk oversupply scenario (Qo and Po), a perfectly competitive industry scenario (Qc and Pc), and a small degree of seller market power scenario (Qs and Ps)[7]. The MC of producing milk is the same in the three scenarios. Table 2 compares milk price-quantity combinations and profit for these scenarios.[8] These three scenarios can be thought of as three different years.

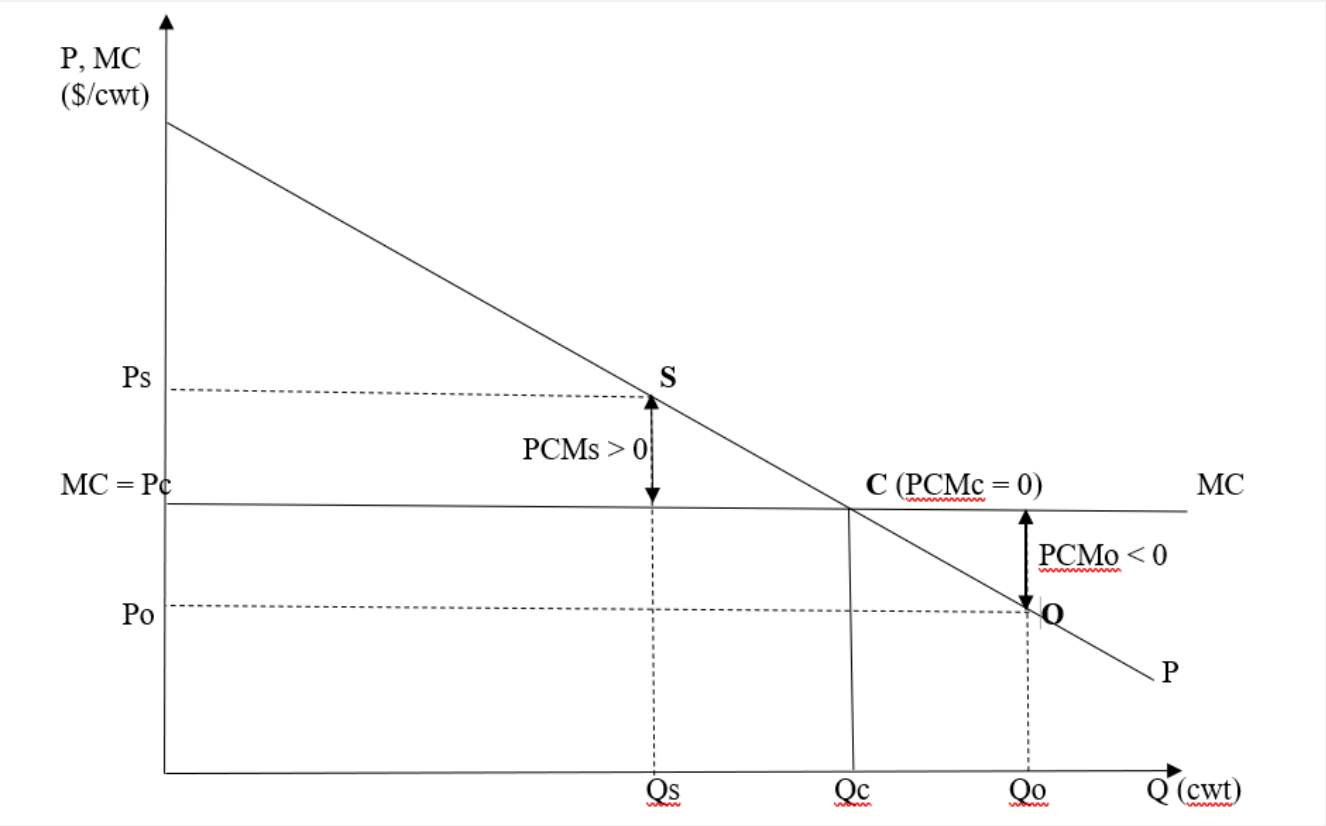

Figure 4. Alternative Market Scenarios for the U.S. Dairy Industry

Note: Point O at Qo and Po is a milk oversupply scenario. Point C at Qc and Pc is a perfectly competitive industry scenario. Point S at Qs and Ps is a small degree of seller market power scenario.

[7] This theoretical framework, as applied to all agricultural industries, is discussed in greater detail in Bolotova (2019).
[8] Marginal cost of producing milk is assumed to be the same in the three scenarios to isolate the effect of seller market power of the dairy industry due to a reduction in milk quantity, for example, due to the HR program. Theoretically, higher milk prices may be due to the seller market power and also due to higher milk production costs.

Table 2. Alternative Market Scenarios for the U.S. Dairy Industry.

Scenario	Price and quantity depicted in Figure 4[a]	Comparison of scenarios' prices and quantities	Profit
Perfect competition	Scenario C: Qc and Pc	Pc = MC	PCMc = Pc – MC = 0 Zero profit for the industry and firms.
Milk oversupply	Scenario O: Qo and Po	Qo > Qc Po < MC	PCMo = Po – MC < 0 PCMo < PCMc Loss for the industry and firms.
A small degree of seller market power	Scenario S: Qs and Ps	Qs < Qc Ps > MC	PCMs = Ps – MC > 0 PCMs > PCMc Profit for the industry and firms.

[a] Q (cwt), P ($ per cwt), MC ($ per cwt), and PCM ($ per cwt) are quantity, price, marginal cost, and price-cost margin, respectively. Subscripts "c," "o," and "s," denote a perfectly competitive industry scenario, a milk oversupply scenario, and a small degree of seller market power scenario.

In a perfectly competitive industry scenario, the dairy industry (all dairy farmers in the country) produces milk quantity (Qc) at which milk price received by dairy farmers (Pc) is equal to the MC of producing milk, and profit is equal to zero (PCMc = 0).[9] In the milk oversupply scenario, dairy farmers produce milk quantity (Qo), which is larger than milk quantity in a perfectly competitive industry scenario (Qc), as a result milk price (Po) is below MC, and the industry profit is negative (PCMo = Po – MC < 0): dairy farmers incur losses. In the scenario with a small degree of seller market power, dairy farmers produce milk quantity (Qs), which is smaller than milk quantity in a perfectly competitive industry scenario (Qc), as a result milk price (Ps) is above MC, and the industry profit is positive (PCMs = Ps – MC > 0).

According to this theoretical framework, a decrease in the total milk quantity produced increases milk price and industry profit. This theoretical framework illustrates the rationale for implementing the HR program and its market and price effects. In the period prior to the HR program (the pre-HR period), the dairy industry experienced a milk oversupply (overproduction). The expected effect of the HR program is for the total milk quantity produced to decrease due to a decrease in the milk cow inventory, which consequently would increase milk prices received by dairy farmers, decrease loss, and possibly allow to make profit. By implementing the HR program, the dairy industry exercises seller market power: a decrease in total milk quantity causes milk price and industry profit to increase.[10]

Theoretically, due to the HR program, the dairy industry may move from a milk oversupply scenario to a perfectly competitive industry scenario, and possibly to a small degree of seller market power scenario. However, depending on the actual reduction in milk quantity in the HR program period (HR period), the dairy industry may remain in the milk oversupply scenario where milk price, although

[9] In this case study, "profit" refers to economic profit, which is different from accounting profit. Accounting profit is equal to revenue minus costs associated with generating that revenue. Economic profit is equal to revenue minus costs associated with generating that revenue and minus opportunity cost. Opportunity cost is the forgone benefit of using capital in an alternative business venue. A simple example is earning interest on the money deposited in a savings account in a bank.

[10] A classic definition of seller market power is the industry's ability to increase output price above MC to earn a positive profit, as compared to a perfectly competitive industry. Lerner Index of market power is a classic measure of seller market power: L=[(P-MC)/P]*100% (Carlton and Perloff 2005; Besanko et al. 2006). The output quantity is typically decreased to achieve the output price increase. Seller market power of dairy cooperatives due to the HR program, as compared to seller market power of classic cartels organized in oligopolistic industries, is discussed in greater detail in Bolotova (2016).

higher than the one in the pre-HR period, is still below MC, and the industry incurs loss, although smaller than the one in the pre-HR period.

4.2 Perspective of Buyers of Raw Milk and Manufactured Dairy Products

Figure 5 depicts a wholesale demand curve for raw farm milk (this is the same demand curve labeled as "P" in Figure 4), a wholesale demand curve for manufactured dairy products (fluid milk, cheese, butter, etc.), and a retail demand curve for manufactured dairy products.[11] These demand curves are graphical representations of price-dependent (inverse) demand functions. Figure 5 also depicts price-quantity combinations for raw milk and manufactured dairy products for two market scenarios: a competitive industry scenario representing the industry situation prior to the HR program (Qc, FPc, WPc, and RPc), and a scenario where the dairy industry exercises seller market power by implementing the HR program (Qm, FPm, WPm, and RPm). Raw milk is the main input used to produce manufactured dairy products.[12] This is the reason the same Q is used to define raw milk quantity and quantities of manufactured dairy products in Figure 5. Note that the perspective of buyers of raw milk and manufactured dairy products does not take into consideration milk production costs and profitability of dairy farmers.

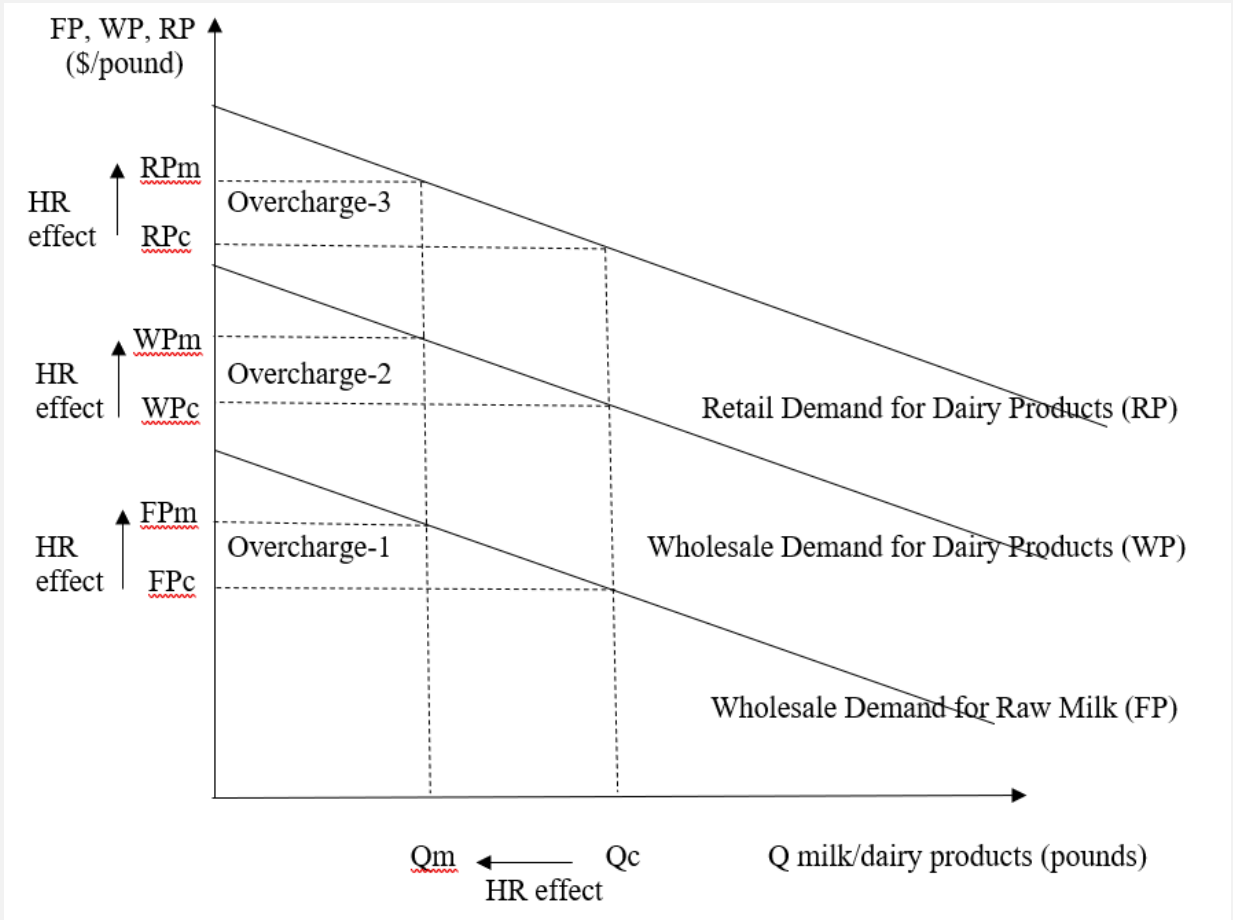

Figure 5. Seller Market Power in the U.S. Dairy Product Supply Chain: The Effects of the HR Program on Quantities and Prices

[11] Figure A1.2 presented in Appendix 1 depicts a simplified version of the dairy product supply chain directly matching Figure 5.

[12] For example, in manufacturing fluid (beverage) milk products, one unit (gallon) of raw milk is required to produce one unit (gallon) of fluid milk. In cheese manufacturing, ten units (pounds) of raw milk are typically required to produce one unit (pound) of cheese.

A decrease in milk cow inventory due to the HR program causes the raw milk quantity and consequently the quantity of manufactured dairy products at the wholesale and retail levels to decrease from Qc to Qm. As a result, raw milk price received by dairy farmers (this is the price paid by manufacturers of dairy products) increases from FPc to FPm, and the wholesale price of manufactured dairy products charged by manufacturers of these products (this is the price paid by food retailers) increases from WPc to WPm. The retail price of manufactured dairy products charged by food retailers (this is the price paid by final consumers) increases from RPc to RPm. In the market power scenario, buyers of raw milk and manufactured dairy products pay higher prices and are overcharged.

The overcharge (in $ per unit) is the output price increase due to the output quantity decrease due to the HR program in this case study. The overcharge attributed to direct buyers of raw milk (manufacturers of dairy products), who purchased raw milk directly from dairy farmers, is FPm - FPc in $ per pound of raw milk, and the total $ overcharge is (FPm - FPc) * Qm, which is the "Overcharge-1" rectangle in Figure 5. The overcharge attributed to direct buyers of manufactured dairy products (food retailers and food services), who purchased these products directly from dairy cooperatives, is WPm - WPc in $ per pound of these products, and the total $ overcharge is (WPm - WPc) * Qm, which is the "Overcharge-2" rectangle in Figure 5. The overcharge attributed to final consumers (indirect buyers), who purchased manufactured dairy products at the retail level is RPm - RPc in $ per pound, and the total $ overcharge is (RPm - RPc) * Qm, which is the "Overcharge-3" rectangle in Figure 5. The total overcharge is the basis for damages that direct buyers of raw milk and manufactured dairy products (cheese and butter) at the wholesale level and indirect buyers of fluid milk and other fresh milk products at the retail level aimed to recover during the antitrust litigations.[13]

5 Empirical Market and Price Analysis in the U.S. Dairy Industry

This section presents a basic market and price analysis in the U.S. dairy industry, as well as an analysis of the U.S. dairy farm profitability during the period of the HR program (HR period) and the periods before and after this program (the pre-HR period and the post-HR period, respectively). The purpose of this analysis is to evaluate possible effects of the HR program.

The market and price behavior in the HR period (2003–2010) reflects current effects of the HR program and to a smaller extent current effects of the export assistance program. Most of the funds were allocated to the HR program in this period. The market and price behavior in the post-HR period (2011–2014) reflects delayed effects of the HR program and current effects of the export assistance program. The HR program effects were likely to disappear during three to five years after each round (Brown et al. 2010).[14]

The yearly data on milk cow inventory, milk production per cow, total milk quantity produced (total milk production), and milk prices received by dairy farmers are collected from the U.S. Department of Agriculture, National Agricultural Statistics Service (2022). Total milk production is determined by milk cow inventory and milk production per cow. The yearly value of production, total operating costs, and total production costs are collected from the U.S. Department of Agriculture, Economic Research Service (2022)[15] to analyze dairy farm profitability. The monthly wholesale prices of cheddar cheese and butter are collected from the U.S. Department of Agriculture, Agricultural Marketing

[13] As a result of the antitrust litigation involving direct buyers, only direct buyers of cheese and butter were awarded damages (direct buyers of raw milk originally included as one of the plaintiffs were not awarded any damages). Buyers who purchased fluid milk and other fresh milk products at the retail level recovered damages in the states where antitrust laws allowing to recover these damages existed.

[14] The post-HR period in this case study includes four years after the last HR round conducted in 2010.

[15] Milk prices that dairy farmers receive in the United States are determined within the system of Federal and State Milk Marketing Orders. Milk prices are calculated on a monthly basis using a series of price formulas, which include wholesale prices of manufactured dairy products (cheddar cheese, butter, nonfat dry milk, and dry whey). Appendix 2 provides a brief description of the Federal Milk Marketing Orders pricing system.

Service (2022). The monthly retail prices of fluid whole milk are collected from the U.S. Bureau of Labor Statistics (2022a). The averages and coefficients of variation[16] are calculated for the analyzed economic variables for the three periods of interest. The changes in averages and coefficients of variation among the three periods are also calculated.[17]

5.1 Dairy Farm Level of the Dairy Product Supply Chain

5.1.1 Milk Cow Inventory, Production, and Prices

Table 3 presents yearly averages and coefficients of variation (CV) for milk cow inventory, milk production per cow, total milk production, and milk prices for the three analyzed periods, as well as changes in the averages and CVs among the three periods.[18] Figure 6 depicts the U.S. yearly milk production and prices for the three analyzed periods.

In the pre-HR period, the yearly average milk cow inventory is 9.25 million cows, the yearly average milk production per cow is 17,453 pounds, the yearly average total milk production is 161 billion pounds, and the yearly average milk price received by dairy farmers is $13.79 per cwt.[19]

Table 3. U.S. Dairy Industry: The Yearly Average Milk Cow Inventory, Production, and Price Prior, During, and After the HR Program, 1995–2014.

Period	Milk cow inventory	Milk production		Milk price
	Number of cows	Pounds per cow	Billion pounds	$ per cwt
	Average (coefficient of variation)			
Pre-HR period (1995–2002)	9,250,838 (0.02)	17,453 (0.05)	161.0 (0.04)	13.79 (0.09)
HR period (2003–2010)	9,132,175 (0.01)	19,934 (0.04)	182.2 (0.05)	15.47 (0.16)
Percentage change in HR period, relative to pre-HR period	____ (___)	___ (___)	___ (___)	____ (___)
Post-HR period (2011–2014)	9,204,975 (0.004)	21,783 (0.02)	201.0 (0.02)	20.75 (0.11)
Percentage change in post-HR period, relative to HR period	____ (___)	___ (___)	___ (___)	___ (___)

Source: U.S. Department of Agriculture, National Agricultural Statistics Service (2022). Descriptive statistics are calculated by the author.
Note: Students should calculate percentage changes in the analyzed economic variables among the three periods and record their answers in cells with missing answers in this table and in the text of the case study (Question 6.1).

[16] Coefficient of variation is chosen to measure the volatility of the analyzed variables in this case study. Although other measures of volatility are available, for example, standard deviation and variance, an advantage of the coefficient of variation is that it measures the standard deviation relative to the mean of the analyzed variable. The coefficient of variation can also be expressed in a percentage form.
[17] The teaching note includes an Excel file with all data and calculations.
[18] Students should calculate percentage changes in the analyzed economic variables among the analyzed periods, record them in Table 3 and in the text of the case study (Question 6.1).
[19] A descriptive statistical analysis of milk prices and prices of manufactured dairy products (cheese, butter, and fluid milk) presented in the case study uses nominal prices. Appendix 3explains the rationale for using nominal prices and presents a similar descriptive statistical analysis of real prices for the analyzed products.

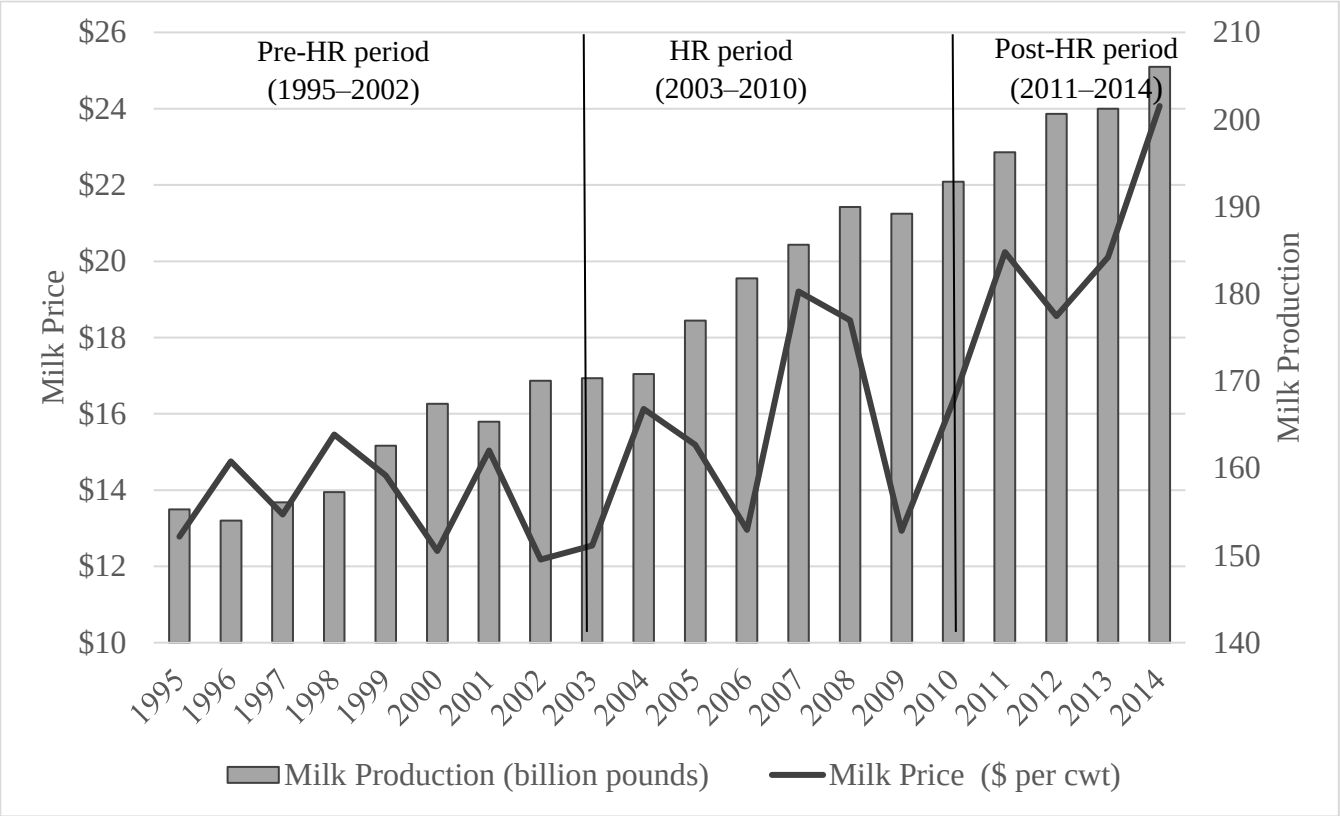

Figure 6. U.S. Yearly Milk Production and Prices Before, During, and After the HR Program, 2000–2014

Source: U.S. Department of Agriculture, National Agricultural Statistics Service (2022).
Note: Pre-HR period, HR period, and post-HR period are the pre-HR program, HR program, and post-HR program periods, respectively.

In the HR period, as compared with the pre-HR period,[20] the yearly average milk cow inventory decreases to 9.13 million cows (or by ___ percent), and the yearly average milk production per cow increases to 19,934 pounds (or by ___ percent). As a result, the yearly average total milk production increases to 182.2 billion pounds (or by ___ percent). The yearly average milk price increases to $15.47 per cwt (or by ___ percent). The volatility of milk cow inventory and milk production per cow decreases, and the volatility of total milk production and milk price increases in the HR period, as compared with the pre-HR period.

In the post-HR period, as compared with the HR period, the yearly average milk cow inventory increases to 9.2 million cows (or by ___ percent), and the yearly average milk production per cow increases to 21,783 pounds (or by ___ percent). As a result, the yearly average total milk production increases to 201 billion pounds (or by ___ percent). The yearly average milk price increases to $20.75 per cwt (or by ___ percent). The volatility of all analyzed economic variables decreases in the post-HR period, as compared with the HR period.

The following changes in the analyzed economic variables might reflect the current and delayed effects of the HR program. First, the yearly average milk cow inventory and the volatility of milk cow inventory decreased in the HR and post-HR periods, as compared with the pre-HR period. Second, the volatility of total milk production ("supply volatility") decreased in the post-HR period, as compared

[20] The pre-HR period is 1995–2002 in the analysis conducted in this section. The length of the pre-HR period (eight years) is equal to the length of the HR period (2003–2010).

with the pre-HR and HR periods. Third, the yearly average milk price received by dairy farmers increased in the HR and post-HR periods, as compared with the pre-HR period.

Despite a decrease in the yearly average milk cow inventory in the HR and post-HR periods, as compared with the pre-HR period, the yearly average total milk quantity produced increased over time, because the yearly average milk production per cow increased. In addition, given the fact that dairy farmers who did not participate in the HR program marketed about 30 percent of the national milk supply, some of these dairy farmers might have expanded their milking herds, thus contributing to the increases in total milk production in the analyzed periods. The latter likely decreased the effectiveness of the HR program. In summary, the HR program decreased the size of milk cow inventory and might have decreased the growth rate in the total milk production, which might have contributed to the observed increases in milk prices received by dairy farmers.

5.1.2 Dairy Farm Profitability

Table 4 presents yearly averages and CVs for Total Value of Production (TVP),[21] Total Operating Costs (TOC), Total Costs (TC), profit based on TOC, and profit based on TC for the three analyzed periods, as well as changes in the averages and CVs among the three periods.[22] Figure 7 depicts two dairy farm profitability measures for the three analyzed periods. Negative profitability measures indicate losses.

Table 4. U.S. Dairy Industry: The Yearly Average Total Value of Production, Production Costs, and Profit Prior, During, and After the HR Program, 2000–2014.

Period	Total value of production (TVP)	Total operating costs (TOC)	Total costs (TC)	Profit based on TOC [TVP-TOC]	Profit based on TC [TVP-TC]
	$ per cwt	$ per cwt	$ per cwt	$ per cwt	$ per cwt
	Average (coefficient of variation)				
Pre-HR period (2000–2002)	15.19 (0.12)	9.57 (0.02)	18.46 (0.02)	5.62 (0.31)	-3.27 (-0.55)
HR period (2003–2010)	17.51 (0.15)	12.42 (0.17)	20.57 (0.09)	5.09 (0.49)	-3.07 (-0.79)
Percentage change in HR period, relative to pre-HR period	___ (___)	___ (___)	___ (___)	___ (___)	___ (___)
Post-HR period (2011–2014)	23.09 (0.11)	18.71 (0.09)	26.78 (0.06)	4.38 (0.94)	-3.70 (-1.07)
Percentage change in post-HR period, relative to HR period	___ (___)	___ (___)	___ (___)	___ (___)	___ (___)

Source: U.S. Department of Agriculture, Economic Research Service (2022). The profit measures and descriptive statistics are calculated by the author.

Note: Students should calculate percentage changes in the analyzed economic variables among the three periods and record their answers in cells with missing answers in this table and in the text of the case study (Question 6.2).

[21] The TVP ($ per cwt of milk) is the sum of value of milk sold ($ per cwt of milk), value of dairy cattle sold ($ per cwt of milk), and other income ($ per cwt of milk; U.S. Department of Agriculture, Economic Research Service 2022). The value of milk ($ per cwt) can be thought of as the milk price received by dairy farmers in this case study. The share of value of milk in the TVP is typically more than 90 percent.

[22] Students should calculate percentage changes in the analyzed economic variables among the analyzed periods and record them in Table 4 and in the text of case study (Question 6.2).

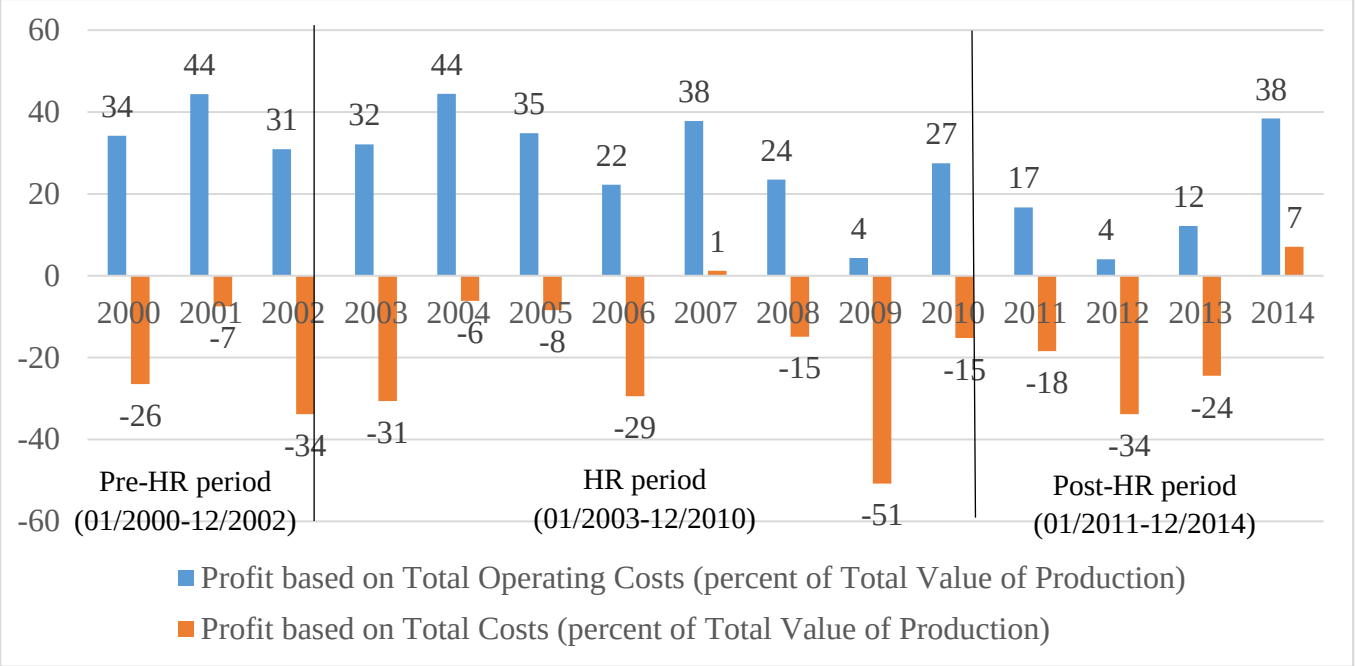

Figure 7. U.S. Dairy Industry Yearly Profit Before, During, and After the HR Program, 2000–2014

Source: U.S. Department of Agriculture, Economic Research Service (2022). The profit measures are calculated by the author.
Note: Pre-HR period, HR period, and post-HR period are the pre-HR program, HR program, and post-HR program periods, respectively.

In the pre-HR period,[23] the yearly average TVP is $15.19 per cwt of milk, the yearly average TOC are $9.57 per cwt of milk, and the yearly average TC are $18.46 per cwt of milk. In the same period, the yearly average profit based on TOC is $5.62 per cwt of milk, and the yearly average profit based on TC, which is a loss, is -$3.27 per cwt of milk.

In the HR period, as compared with the pre-HR period, the yearly average TVP increases to $17.51 per cwt (or by ___ percent), the yearly average TOC increase to $12.42 per cwt (or by ___ percent), and the yearly average TC increase to $20.57 per cwt (or by ___ percent). The yearly average profit based on TOC decreases to $5.09 per cwt (or by ___ percent), and the yearly average profit based on TC, which is a loss, decreases to -$3.07 per cwt (or by ___ percent). The volatility of all analyzed variables increases in the HR period, as compared with the pre-HR period.

In the post-HR period, as compared with the HR period, the yearly average TVP increases to $23.09 per cwt (or by ___ percent), the yearly average TOC increase to $18.71 per cwt (or by ___ percent), and the yearly average TC increase to $26.78 per cwt (or by ___ percent). The yearly average profit based on TOC decreases to $4.38 per cwt (or by ___ percent), and the yearly average profit based on TC, which is a loss, increases to -$3.70 per cwt (or by ___ percent). The volatility of TVP, TOC, and TC decreases, and the volatility of both profit measures increases in the post-HR period, as compared with the HR period.

The following changes in the analyzed economic variables might reflect some of the current effects of the HR program in the HR period, as compared with the pre-HR period. While the yearly average TVP increases by 15.3 percent in the HR period, the yearly average TC increase only by 11.4 percent. The observed increase in the TVP is mostly due to the increase in the TC. The remaining 3.9

[23] The pre-HR period is 2000–2002 in the analysis presented in this section. While historical costs and returns for milk are available (U.S. Department of Agriculture, Economic Research Service 2022), the reporting procedure somewhat changed in 2000. This impacted the pre-HR period length used in this section, as compared to the one used in the previous section.

percentage-point increase in the TVP is due to other factors, but the milk production costs. One of these factors may be seller market power of the dairy industry due to the effective implementation of the HR program. While the yearly average profit based on TOC decreases by 9.4 percent in the HR period, as compared with the pre-HR period, the yearly average profit based on TC, which is a loss, decreases by 6.4 percent. This is because the yearly average TOC increased faster than the yearly average TC in the HR period. Consequently, the yearly average loss in the HR period (-$3.07 per cwt) is smaller than the one in the pre-HR period (-$3.27 per cwt), or by 6.4 percent.

The following changes in the analyzed economic variables might reflect some of the delayed effects of the HR program in the post-HR period, as compared with the HR period. While the yearly average TVP increases by 31.9 percent in the post-HR period, the yearly average TC increase by 30.2 percent. The observed increase in the TVP practically reflects the increase in the TC. The remaining 1.7 percentage-point increase in the TVP is due to other factors, but the milk production costs. One of these factors may be seller market power of the dairy industry due to the delayed effects of the HR program and current effects of the export assistance program. The yearly average profit based on TOC decreases by 13.9 percent in the post-HR period, as compared with the HR period, and the yearly average profit based on TC, which is a loss, increases by 20.6 percent. The yearly average loss in the post-HR period (-$3.70 per cwt) is higher than the one in the HR period (-$3.07 per cwt), or by 20.6 percent.

In summary, the HR program might have been effective in helping the dairy industry to pass on milk cost increases on the buyers of raw milk and manufactured dairy products in the form of higher prices. Theoretically, to pass a cost increase on to the buyers, the industry has to decrease output quantity produced to increase output prices. If the dairy industry had not implemented the HR program to decrease total milk quantity produced, milk prices received by dairy farmers might have been lower, and the dairy industry and dairy farmers might have incurred greater financial losses.

5.2 Wholesale Level of the Dairy Product Supply Chain

Table 5 presents monthly averages and CVs for wholesale prices of cheddar cheese and butter for the three analyzed periods, as well as changes in the averages and CVs among the three periods.[24] The analyzed wholesale prices of cheddar cheese and butter correspond to the first handler-level of the cheese and butter supply chains. These are the prices charged by manufacturers of these products (dairy cooperatives and proprietary firms).[25] Figure 8 depicts wholesale prices of cheddar cheese and butter for the three analyzed periods.

In the pre-HR period,[26] the monthly average wholesale prices of cheddar cheese and butter are $1.23 per pound and $1.26 per pound, respectively. In the HR period, as compared with the pre-HR period, the monthly average wholesale prices of cheddar cheese and butter increase to $1.54 per pound and $1.45 per pound, respectively (or by ____ percent and ____ percent, respectively). The volatility of the wholesale cheddar cheese price increases and the volatility of the wholesale butter price decreases in the HR period, as compared with the pre-HR period.

In the post-HR period, as compared with the HR period, the monthly average wholesale prices of cheddar cheese and butter increase to $1.86 per pound and $1.81 per pound, respectively (or by ____ percent and ____ percent, respectively). The volatility of these prices decreases in the post-HR period, as compared with the HR period.

[24] Students should calculate percentage changes in the analyzed economic variables among the analyzed periods and record them in Table 5 and in the text of the case study (Question 6.3).

[25] These wholesale prices are survey-based prices that are collected by the U.S. Department of Agriculture and are used in milk price formulas to calculate Class milk prices within the system of Federal Milk Marketing Orders (Appendix2).

[26] The pre-HR period is January 2000–June 2003 in the analysis presented in this section. The wholesale prices of cheddar cheese and butter used in the analysis are reported beginning in January 2000 (U.S. Department of Agriculture, Agricultural Marketing Service 2022). This impacted the pre-HR period length used in this section, as compared to the one used in Section 5.1.1.

Table 5. U.S. Dairy Industry: The Monthly Average Wholesale Prices of Cheddar Cheese and Butter and Retail Prices of Fluid Whole Milk Prior, During, and After the HR Program, 2000–2014.

Period	Wholesale cheese price	Wholesale butter price	Retail fluid whole milk price
	$ per pound		$ per gallon
	Average (coefficient of variation)		
Pre-HR period (01/2000–06/2003)	1.23 (0.14)	1.26 (0.25)	2.79 (0.03)
HR period (07/2003–12/2010)	1.54 (0.17)	1.45 (0.19)	3.27 (0.10)
Percentage change in HR period relative to pre-HR period	____ (____)	____ (____)	____ (____)
Post-HR period (01/2011–12/2014)	1.86 (0.13)	1.81 (0.18)	3.55 (0.03)
Percentage change in post-HR period relative to HR period	____ (____)	____ (____)	____ (____)

Source: U.S. Department of Agriculture, Agricultural Marketing Service (2022) and U.S. Bureau of Labor Statistics (2022a). Descriptive statistics are calculated by the author.
Note: Students should calculate percentage changes in the analyzed economic variables among the three periods and record their answers in cells with missing answers in this table and in the text of the case study (Questions 6.3 and 6.4).

Higher wholesale prices of cheddar cheese and butter in the HR and post-HR periods, relative to the pre-HR period, might reflect current and delayed effects of the HR program. A decrease in raw milk supply due to the HR program would lead to higher raw milk prices that cheese and butter manufacturers have to pay for raw milk. Higher raw milk prices would increase the costs of cheese and butter manufacturing and consequently wholesale prices of these products.

At the same time, other factors might have contributed to higher wholesale prices of cheese and butter in the HR and post-HR periods, for example possibly increasing prices of other inputs used in cheese and butter manufacturing (labor, energy, packaging, equipment, etc.), output pricing strategies and seller market power of cheese and butter manufacturers,[27] and the CWT export assistance program directly affecting the quantities of cheese and butter available for the domestic market and consequently wholesale price of these products.

5.3 Retail Level of the Dairy Product Supply Chain

Table 5 presents monthly averages and CVs for the retail fluid whole milk price (U.S. city average) for the three analyzed periods, as well as changes in the averages and CVs among the three periods.[28] Figure 8 depicts retail fluid whole milk prices for the three analyzed periods.

In the pre-HR period,[29] the monthly average retail price of fluid whole milk is $2.79 per gallon. In the HR period, as compared with the pre-HR period, this price increases to $3.27 per gallon (or by ____ percent), and the volatility of this price increases as well. In the post-HR period, as compared with the

[27] There is empirical evidence suggesting that wholesale cheese pricing by cheese manufacturers (dairy cooperatives and proprietary firms) is consistent with oligopoly and monopoly pricing (Bolotova and Novakovic 2015; Bolotova 2020).
[28] Students should calculate percentage changes in the analyzed economic variable among the analyzed periods, record them in Table 5 and in the text of the case study (Question 6.4).
[29] The pre-HR period is January 2000–June 2003 in the analysis presented in this section. The pre-HR period has the same length as the one used to analyze wholesale prices of cheddar cheese and butter.

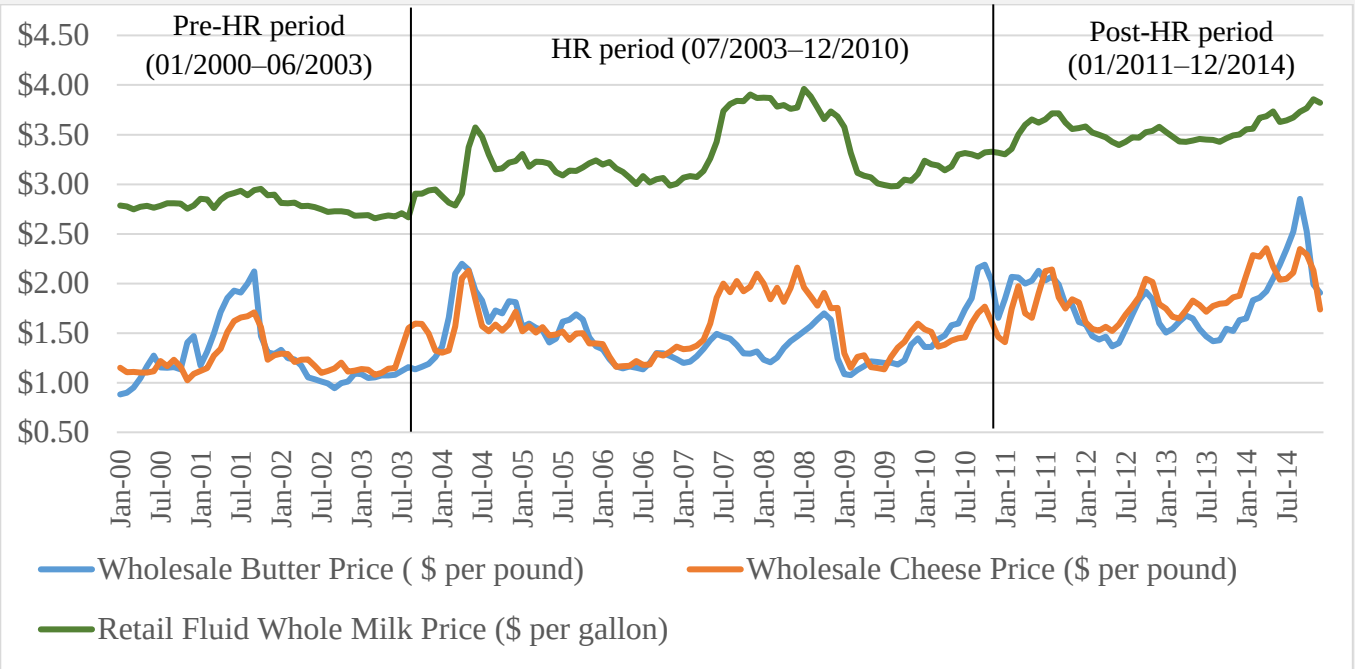

Figure 8. U.S. Monthly Wholesale Prices of Cheddar Cheese and Butter and Retail Fluid Whole Milk Prices Before, During, and After the HR Program, 2000–2014

Source: U.S. Department of Agriculture, Agricultural Marketing Service (2022) and U.S. Bureau of Labor Statistics (2022a).
Note: Pre-HR period, HR period, and post-HR period are the pre-HR program, HR program, and post-HR program periods, respectively.

HR period, the monthly average retail price of fluid whole milk increases to $3.55 per gallon (or by ___ percent), and the volatility of this price decreases.

Higher retail fluid whole milk prices in the HR and post-HR periods, relative to the pre-HR period, might reflect current and delayed effects of the HR program. A decrease in raw milk supply due to the HR program would lead to higher raw milk prices that fluid milk processors have to pay to dairy farmers for raw milk used in fluid milk manufacturing. Consequently, fluid milk processors would increase fluid milk prices when they sell fluid milk to food retailers, and food retailers would increase fluid milk prices at the retail level when they sell fluid milk to final consumers.

At the same time, other factors might have contributed to higher retail prices of fluid whole milk in the HR and post-HR period, for example possibly increasing prices of other inputs used in fluid milk manufacturing and food retailing (labor, energy, packaging, equipment, etc.), as well as output pricing strategies and seller market power of fluid milk manufacturers and food retailers.[30]

6 Legal Issues: HR Program and Antitrust

Dairy cooperatives presumed that their HR program was within the scope of the Capper-Volstead Act immunity. Section 1 of the Capper-Volstead Act provides a limited antitrust immunity to the Sherman Act

[30] By the beginning of the 2000s, the U.S. fluid milk industry was a highly concentrated industry. In 1999, the average market share of the four largest fluid milk processors reported for 14 U.S. markets was 75.6 percent (U.S. General Accounting Office 2001). In 2003, the average market share of the four largest food retailers reported for 15 U.S. markets was 73.9 percent (U.S. Government Accountability Office 2004). These market shares are the four-firm concentration ratios (CR4). The industries with CR4 exceeding 75 percent are likely to facilitate anticompetitive conduct of firms with market power (Hovenkamp 2005). In other words, firms operating in highly concentrated industries are likely to exercise market power. There is empirical evidence suggesting that retail fluid milk pricing by fluid milk retailers is consistent with oligopoly and monopoly pricing (Carman and Sexton 2005; Bolotova and Novakovic 2012; Bolotova 2022).

(1890) for collective agricultural marketing activities of individual agricultural producers implemented through their organizations.[31] Section 1 of the Sherman Act makes illegal agreements among competitors (firms producing and selling the same or similar products) that aim to affect product quantities, prices, or both in interstate commerce.[32] These agreements are often referred to as cartels, price-fixing cartels (or price-fixing conspiracies), and/or output allocation agreements.

Agricultural producers are competitors, and collective agricultural marketing activities (programs) that affect agricultural product prices, quantities, or both are agreements among competitors. For example, the CWT HR program may be interpreted as an agreement among competitors (dairy farmers participating in the CWT program) aiming to decrease output (raw milk) quantity produced with the purpose of increasing and stabilizing output (raw milk) prices received. In the absence of the Capper-Volstead Act, collective agricultural marketing activities would have violated Section 1 of the Sherman Act.

Section 1 of the Capper-Volstead Act declares:

> ***"Persons engaged in the production of agricultural products*** *as farmers, planters, ranchmen, dairymen, nut or fruit growers* ***may act together in associations****, corporate or otherwise, with or without capital stock,* ***in collectively processing, preparing for market, handling, and marketing*** *in interstate and foreign commerce,* ***such products of persons so engaged****. Such* ***associations may have marketing agencies in common****; and* ***such associations and their members may make the necessary contracts and agreements to effect such purposes****: Provided, however, That such* ***associations are operated for the mutual benefit of the members*** *thereof…"*

In 2011, buyers of fluid milk and other fresh milk products at the retail level (indirect buyers) and in 2015 buyers of raw milk, cheese, and butter at the wholesale level, who purchased these products directly from dairy cooperatives (direct buyers), filed class action antitrust lawsuits against the NMPF, CWT, and a group of dairy cooperatives. These buyers alleged that the CWT HR program was not within the scope of the Capper-Volstead Act immunity and that it violated Section 1 of the Sherman Act. The buyers argued that the HR program was *not* a form of collective agricultural *"marketing"* mentioned in Section 1 of the Capper-Volstead Act.

Buyers of cheese and butter, who purchased these products directly from dairy cooperatives (defendants), sued under the Clayton Act (1914; a Federal law), allowing them to recover treble damages and reasonable legal expenses for violations of the Sherman Act. The total overcharge is the basis for damages (Rectangle labeled as "Overcharge-2" in Figure 5). The total monetary damages are three times the total overcharge. The dairy cooperatives settled the lawsuit with direct buyers of cheese and butter in 2019 for $220 million (Fu 2019; Butter and Cheese Class Action 2022).

Buyers of fluid milk and other fresh milk products at the retail level, who purchased these products indirectly from dairy cooperatives (defendants), sued under the state antitrust statutes (antitrust laws, consumer protection laws, or restraint of trade laws). Approximately half of the states have these antitrust statues (Hovenkamp 2005). The total overcharge is the basis for damages (Rectangle labeled as "Overcharge-3" in Figure 5). The size of damages that indirect buyers can recover depends on a particular state and may range from one to three times the total overcharge. The cooperatives settled the lawsuit with indirect buyers in 2016 for $52 million (Hagens Berman 2018; Fresh Milk Products Antitrust Litigation 2022).

The organizations of agricultural producers in the potato, egg, and mushroom industries in the United States also implemented agricultural supply management programs affecting the quantities of agricultural products produced and faced similar antitrust lawsuits (Bolotova 2014; Peck 2015).

[31] These organizations should be formed according to the standard established in the Capper-Volstead Act.

[32] Section 1 of the Sherman Act refers to these agreements as contracts, combinations, or conspiracies in restraint of trade.

Apparently, there was a very limited case law interpretating the legal status of agricultural supply management programs in light of Section 1 of the Capper-Volstead Act.

Recent legal decisions and discussions establish that the types of agricultural supply management programs—whether they are implemented at the pre-agricultural production stage, agricultural production stage, or post-agricultural production stage—affect their legal status in light of the Capper-Volstead Act (Frackman and O'Rourke 2011; Hibner 2011; Bolotova 2015; Peck 2015). It is crucial whether collective agricultural marketing activities (programs) in question can be interpreted as "marketing" under Section 1 of the Capper-Volstead Act.

Collective agricultural supply management activities implemented at the post-agricultural production stage are more likely to be interpreted as "marketing" and, therefore, are likely to be within the scope of Capper-Volstead Act immunity. Collective agricultural supply management activities implemented at the pre-agricultural production and agricultural production stages are not likely to be interpreted as "marketing" and therefore are outside the scope of Capper-Volstead Act immunity. The HR program is an example. The courts interpret the legal status of collective agricultural marketing activities on a case-by-case basis.

7 Discussion and Analytical Questions

You are a regulator today and are being petitioned to revisit the topic of dairy farmers violating antitrust laws between 2003 and 2010. Using graphical techniques and price analysis explain whether dairy farmers violated antitrust laws when they enacted the HR program. Formulate your reasoning by answering a set of questions included in this section.

The teaching note provides additional guidance for responding to selected questions and suggested answers to all questions. In addition, the teaching note includes multiple-choice questions, which can be used as in-class assignments, quizzes, and exam questions.

1. Discuss the U.S. dairy industry's institutional environment at the end of the last century, which may have led to the idea of a private supply management program (the HR program).

2. Discuss the objectives and implementation procedure of the HR program. Discuss the role of dairy cooperatives in implementing this program.

3. Using a graphical analysis, explain two variations of the theoretical framework that may explain market and price effects of the HR program using the perspective of dairy farmers and the perspective of buyers of raw milk and manufactured dairy products.

   3.1. Using the perspective of dairy farmers, explain a theoretical framework that incorporates seller market power of dairy farmers and describes milk price-quantity relationships and dairy industry profitability for the three alternative market scenarios: milk oversupply, perfectly competitive industry, and a small degree of seller market power. Show on a graph relevant curves and three milk price-quantity combinations corresponding to these scenarios. Explain changes in milk quantity, price, and industry profit as the dairy industry moves from the milk oversupply scenario to a perfectly competitive industry scenario and to a scenario where the dairy industry has a small degree of seller market power.

   3.2. Using the perspective of buyers of raw milk and manufactured dairy products (fluid milk, cheese, butter, etc.), explain a theoretical framework that incorporates seller market power of dairy farmers (dairy cooperatives) and describes price-quantity relationships at different stages of the dairy product supply chain in two scenarios: without the HR program and with the HR program.

Show on a graph relevant curves and price-quantity combinations corresponding to the two scenarios. Explain changes in quantities of milk and manufactured dairy products and these products' prices as the dairy industry moves from the scenario without the HR program to the scenario with the HR program.

4. Perform an analytical analysis of the milk price-quantity relationships and dairy industry profitability for the three market scenarios mentioned in Question 3.1. To complete this analysis, use the following assumptions. The inverse (price-dependent) demand function for raw farm milk is $P = 27 - 8Q$ (P is in $ per cwt, and Q is in billion cwt), and the MC of producing milk is $14.00 per cwt. MC is the same in these three scenarios.[33] Assume that the U.S. dairy industry (all dairy farmers taken together) produces the following total milk quantity under the three alternative market scenarios: 1.40 billion cwt, 1.625 billion cwt, and 1.80 billion cwt.

   4.1. Using the milk inverse demand function ("price equation"), MC of producing milk ("cost"), and milk quantities, calculate the following economic measures to complete a profitability analysis of the dairy industry. For each market scenario, calculate milk price in $ per cwt, total costs in $, total revenue in $, total profit in $, and price-cost margin (profit) measured in $ per cwt and as a percentage of the milk price (Lerner Index of market power). Classify each scenario as milk oversupply, perfect competition, or small degree of seller market power.

   4.2. Discuss the results of your analysis. First, draw a figure similar to Figure 4 of the case study to show the three analyzed market scenarios: show relevant curves, price-quantity combinations, and price-cost margins. Second, explain the pattern of milk price-quantity relationship and industry profitability in each scenario. In which scenario(s) are dairy farmers better off? In which scenario(s) are dairy farmers worse off? In which scenario(s) are buyers of raw farm milk better off? In which scenario(s) are buyers of raw farm milk worse off? Explain your reasoning.

5. Familiarize yourself with the U.S. Department of Agriculture and U.S. Bureau of Labor Statistics databases used to collect economic variables for the analysis presented in this case study. Use the U.S. Department of Agriculture, National Agricultural Statistics Service Quick Stats database to download economic variables reported in Table 3: milk cow inventory, milk production per cow, total milk quantity produced, and milk price for the period of 1995–2014.

6. Perform a basic market and price analysis, as well as a dairy farm profitability analysis in the U.S. dairy industry.

   6.1. Evaluate changes in yearly milk cow inventory, milk production per cow, total milk production, and milk price and their volatility in this case study's three periods of interest: prior, during, and after the HR program (1995–2014). Use data reported in Table 3 to complete this analysis.

      6.1.1. Calculate percentage changes in yearly averages and coefficients of variation among the analyzed periods for all economic variables reported in Table 3.

[33] The milk inverse demand function was estimated using yearly milk production and price data for the period of 1995–2002 reported by the U.S. Department of Agriculture, National Agricultural Statistics Service (2022). The MC assumption was developed using milk production costs reported in "Commodity costs and returns" database for milk for the same period (U.S. Department of Agriculture, Economic Research Service 2022).

6.1.2. Describe the results of your analysis. Explain which patterns of changes in the analyzed economic variables are consistent with effective implementation of the HR program.

6.2. Conduct the profitability analysis of dairy farming. Evaluate changes in yearly Value of Production, Total Operating Costs, Total Costs, and profit and their volatility in this case study's three periods of interest: prior, during, and after the HR program (2000–2014). Use data reported in Table 4 to complete this analysis.

6.2.1. Calculate percentage changes in yearly averages and coefficients of variation among the analyzed periods for all economic variables reported in Table 4.

6.2.2. Describe the results of your analysis. Explain which patterns of changes in the analyzed economic variables are consistent with effective implementation of the HR program.

6.3. Evaluate changes in monthly wholesale prices of cheddar cheese and butter and in their volatility in the three periods of interest: prior, during, and after the HR program (2000–2014). Use data reported in Table 5 to complete this analysis.

6.3.1. Calculate percentage changes in monthly averages and coefficients of variation among the analyzed periods for the wholesale prices of cheese and butter presented in Table 5.

6.3.2. Explain which patterns of changes in the analyzed prices are consistent with effective implementation of the HR program.

6.4. Evaluate changes in the monthly retail price of fluid whole milk and in its volatility in the three periods of interest: prior, during, and after the HR program (2000–2014). Use data reported in Table 5 to complete this analysis.

6.4.1. Calculate percentage changes in monthly averages and coefficients of variation among the analyzed periods for the retail fluid whole milk price presented in Table 5.

6.4.2. Explain which patterns of changes in the analyzed retail fluid whole milk price are consistent with effective implementation of the HR program.

7. Explain why buyers of raw milk and manufactured dairy products (cheese, butter, fluid milk, and other fresh milk products) at the wholesale and retail levels of the dairy product supply chain filed antitrust lawsuits against a group of dairy cooperatives involved in implementation of the HR program. Explain the outcomes of the two antitrust litigations mentioned in the case study. Discuss the role of the Capper-Volstead Act and the Sherman Act in regulating collective agricultural marketing activities of dairy cooperatives in the industry setting discussed in this case study.

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Appendix 1

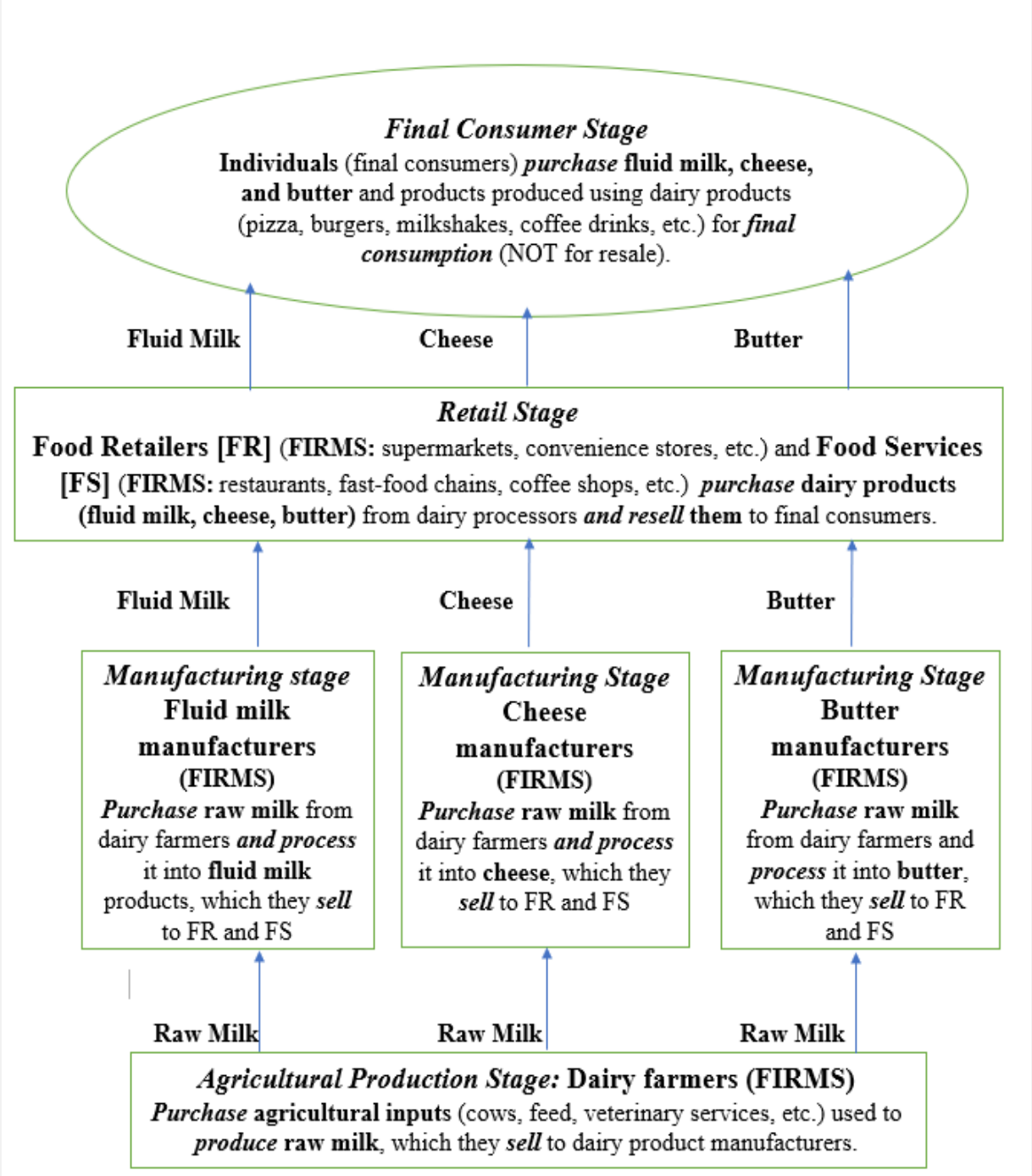

Figure A1.1. Dairy Product Supply Chain

Note: Dairy product manufacturers include dairy cooperatives and proprietary firms.

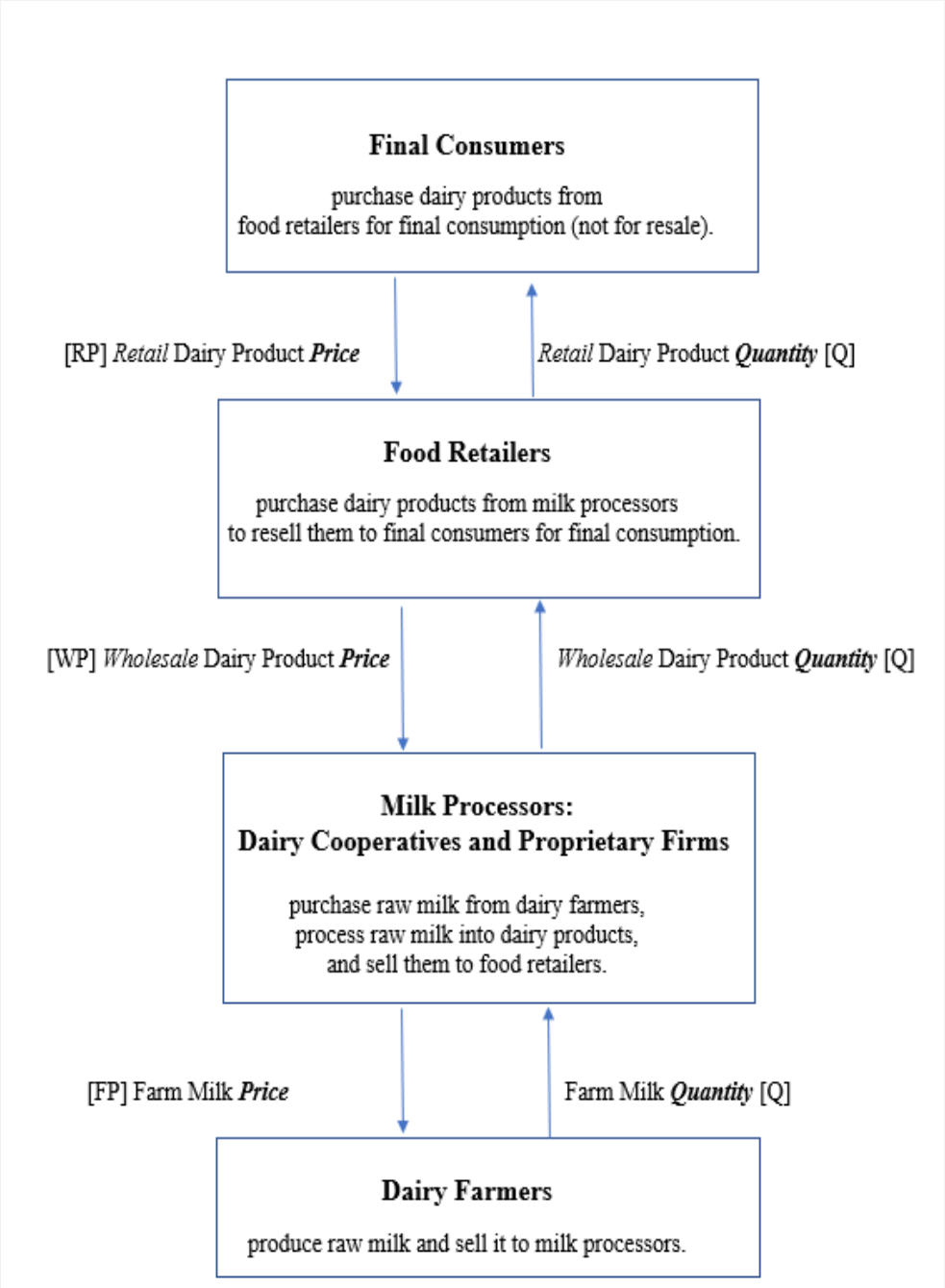

Figure A1.2. Dairy Product Supply Chain Structure (corresponds to Figure 5)

Note: As milk processors, dairy cooperatives do not purchase milk from dairy farmers. Dairy cooperatives process raw milk into manufactured dairy products (fluid milk, cheese, butter, etc.) and market them on behalf of dairy farmers. Dairy cooperatives also negotiate raw milk prices with milk processors on behalf of dairy farmers, when dairy farmers sell raw milk directly to milk processors.

Appendix 2

Milk Pricing System within the Federal Milk Marketing Orders

The system of Federal Milk Marketing Orders (FMMOs) regulates marketing and pricing of Grade A milk at the farm-first handler level in the United States. FMMOs are geographically defined areas based on the demand for fluid milk products.[34] Currently there are 11 FMMOs, which regulate the marketing of approximately 75 percent of total milk production. The objectives of FMMOs are to create orderly marketing conditions for fluid milk products and to ensure sufficient supplies of quality milk at reasonable prices for final consumers as well as to improve terms of trade and the bargaining process between milk producers and milk processors and to increase returns to dairy farmers. FMMOs are authorized in the Agricultural Marketing Agreement Act (1937). Practically all milk produced in the United States is Grade A milk.

The two main features of FMMOs are classified pricing and pooling of milk. Grade A milk produced by dairy farmers is divided into four Classes, depending on the end use of milk (i.e., the type of processed products). Class I milk is used to manufacture fluid (beverage) milk products (whole milk, reduced-fat milk, skim milk, and so on). Class II milk is used to manufacture soft dairy products (yogurt, sour cream, cottage cheese, ice cream, and so on). Class III milk is used to manufacture hard dairy products (cheese and cream cheese). Class IV milk is used to manufacture butter and milk products in dry and evaporated forms.

FMMOs are used to determine minimum prices that regulated milk handlers (processors) have to pay for Grade A milk. Class I milk has the highest price. Dairy farmers do not receive Class milk prices directly; instead, these prices and the rates of milk utilization in each class determine uniform prices (blend prices) for each FMMO. The uniform price is the minimum milk price that dairy farmers within the same Order receive. Dairy cooperatives are allowed to negotiate premiums (over-order premiums), which are added to the FMMOs' minimum prices. Over-order premiums are paid based on milk quality, volume, and milk assembling services provided by dairy cooperatives. Class milk prices and uniform prices are calculated and announced on a monthly basis.

[34] A comprehensive discussion of Federal Milk Marketing Orders is presented in U.S. Congressional Research Service (2017) and U.S. Department of Agriculture, Agricultural Marketing Service (2019).

Appendix 3

U.S. Dairy Industry: Nominal and Real Price Analysis

Nominal prices for raw milk and manufactured dairy products (cheddar cheese, butter, and fluid whole milk) are used in the empirical analysis presented in the case study for the following reasons.

(1). Figures 4 and 5 demonstrate changes in output quantity and output price due to the exercise of seller market power of dairy cooperatives. To understand the effect of a reduction in the output quantity on the output price—the output price increase or the overcharge—the output price has to be assumed to be an actual market price (nominal price). If a real price (the price adjusted for inflation) is used, theoretically there may be a price decrease or no price increase depending on the adjustments made to the price series. Figures 4 and 5 explain the industry's conduct and performance in the short-run period. For the empirical analysis to be consistent with these figures, nominal wholesale and retail prices are used.

(2). When dairy cooperatives, as producers of manufactured dairy products (cheese, butter, fluid milk, etc.), make decisions on output quantities to produce, they consider actual market prices for their outputs that they currently observe, not output prices adjusted for inflation. Similarly, dairy farmers, as agricultural producers, make their production decisions by taking into consideration current market prices (Kohls and Uhl 2002; Bolotova 2019).

(3). The empirical analysis presented in this case study is a very simplified version of the analysis that would be used in antitrust proceedings to calculate damages: the overcharge rectangles in Figure 5. When the overcharge in $ per unit of output (the output price increase due to illegal collusion) is calculated, actual firm-specific transaction prices are used. These prices are not adjusted for inflation because this adjustment may distort the size of damages and may lead to lower damages or no damages.

(4). Some of the U.S. Department of Agriculture, Economic Research Service reports, which compare yearly production and price data for agricultural commodities over several years, use actual market prices (Dohlman and Livezey 2005; Dohlman, Foreman, and Da Pra 2009).

Table A3.1 presents descriptive statistics for nominal and real wholesale prices of raw farm milk like the ones reported in Table 3. To adjust the nominal raw milk price for inflation, the Producer Price Index (PPI) reported by the U.S. Bureau of Labor Statistics (2022b) for raw milk is used. The monthly average real milk price decreases from $13.57 per cwt in the pre-HR period to $13.42 per cwt in the HR period (or by 1.1 percent). This price increases to $13.43 per cwt in the post-HR period (or by 0.1 percent).

Table A3.2 presents descriptive statistics for nominal and real wholesale prices of cheddar cheese like the ones reported in Table 5. To adjust the nominal wholesale cheddar cheese price for inflation, the PPI reported by U.S. Bureau of Labor Statistics (2022c) for cheese manufacturing is used. The monthly average real cheddar cheese price increases from $1.00 per pound in the pre-HR period to $1.02 per pound in the HR period (or by 1.5 percent). This price decreases to $0.97 per pound in the post-HR period (or by 4.8 percent).

Table A3.1. U.S. Yearly Nominal and Real Milk Prices Received by Dairy Farmers, 1995–2014.

Period	Nominal milk price	PPI for raw farm milk	Real milk price, PPI adjusted
	$ per cwt	1982 = 100	$ per cwt
	Average (coefficient of variation)		
Pre-HR period (1995–2002)	13.79 (0.09)	101.60 (0.09)	13.57 (0.01)
HR period (2003–2010)	15.47 (0.16)	115.30 (0.16)	13.42 (0.00)
Percentage change in HR period relative to pre-HR period	12.2 (78.4)	13.5 (83.1)	-1.1 (-70.5)
Post-HR period (2011–2014)	20.75 (0.11)	154.45 (0.11)	13.43 (0.00)
Percentage change in post-HR period relative to HR period	34.1 (-31.4)	34.0 (-31.5)	0.1 (-58.0)

Source: For nominal prices was U.S. Department of Agriculture, National Agricultural Statistics Service (2022).
Note: "PPI for raw farm milk" is Producer Price Index commodity data for farm products (raw milk), series ID WPU016 (U.S. Bureau of Labor Statistics 2022b).
Real price = (Nominal price / PPI) * 100.

Table A3.2. U.S. Monthly Nominal and Real Wholesale Cheddar Cheese Prices, 2000–2014.

Period	Nominal wholesale cheese price	PPI for cheese	Real wholesale cheese price, PPI adjusted
	$ per pound	1981/06 = 100	$ per pound
	Average (coefficient of variation)		
Pre-HR period (01/2000–06/2003)	1.23 (0.14)	122.49 (0.05)	1.00 (0.09)
HR period (07/2003–12/2010)	1.54 (0.17)	151.31 (0.11)	1.02 (0.09)
Percentage change in HR period, relative to pre-HR period	25.5 (20.3)	23.5 (106.4)	1.5 (5.6)
Post-HR period (01/2011–12/2014)	1.86 (0.13)	192.48 (0.09)	0.97 (0.06)
Percentage change in post-HR period, relative to HR period	20.8 (-26.3)	27.2 (-20.3)	-4.8 (-34.6)

Source: For nominal prices was U.S. Department of Agriculture, Agricultural Marketing Service (2022).
"PPI for cheese" is Producer Price Index (industry data) for the cheese manufacturing, series ID PCU311513311513 (U.S. Bureau of Labor Statistics 2022c).
Real price = (Nominal price / PPI) * 100.

Table A3.3 presents descriptive statistics for nominal and real wholesale prices of butter like the ones reported in Table 5. To adjust the nominal wholesale butter price for inflation, the Producer Price Index (PPI) reported by U.S. Bureau of Labor Statistics (2022d) for creamy butter manufacturing is used. The monthly average real butter price increases from $1.33 per pound in the pre-HR period to $1.35 per pound in the HR period (or by 1.4 percent). This price further increases to $1.38 per pound in the post-HR period (or by 2.7 percent).

Table A3.3. U.S. Monthly Nominal and Real Wholesale Butter Prices, 2000–2014

Period	Nominal wholesale butter price	PPI for butter	Real wholesale butter price, PPI adjusted
	$ per pound	1984/06 = 100	$ per pound
	Average (coefficient of variation)		
Pre-HR period (01/2000–06/2003)	1.26 (0.25)	94.49 (0.23)	1.33 (0.03)
HR period (07/2003–12/2010)	1.45 (0.19)	107.29 (0.17)	1.35 (0.03)
Percentage change in HR period, relative to pre-HR period	15.2 (-23.8)	13.5 (-27.7)	1.4 (-11.2)
Post-HR period (01/2011–12/2014)	1.81 (0.18)	130.64 (0.18)	1.38 (0.02)
Percentage change in post-HR period, relative to HR period	24.8 (-5.3)	21.8 (4.9)	2.7 (-29.5)

Source: For nominal prices was U.S. Department of Agriculture, Agricultural Marketing Service (2022).
Note: "PPI for butter" is Producer Price Index (industry data) for the creamy butter manufacturing, series ID PCU3115123115120 (U.S. Bureau of Labor Statistics 2022d).
Real price = (Nominal price / PPI) * 100.

Table A3.4 presents descriptive statistics for nominal and real retail prices of fluid whole milk like the ones reported in Table 5. To adjust the nominal retail fluid whole milk price for inflation, the Consumer Price Index (CPI) reported by U.S. Bureau of Labor Statistics (2022e) for fresh whole milk (U.S. city average) is used. The monthly average real fluid whole milk price decreases from $1.73 per gallon in the pre-HR period to $1.71 per gallon in the HR period (or by 1.0 percent). This price further decreases to $1.65 per gallon in the post-HR period (or by 3.8 percent). The teaching note Excel file includes data and calculations, which results presented in Tables A3.1–A3.4.

Table A3.4. U.S. Monthly Nominal and Real Retail Fluid Whole Milk Prices, 2000–2014.

Period	Nominal retail fluid whole milk price	CPI for fluid whole milk	Real retail fluid whole milk price, CPI adjusted
	$ per gallon	1982 - 1984 = 100	$ per gallon
	Average (coefficient of variation)		
Pre-HR period (01/2000–06/2003)	2.79 (0.03)	161.20 (0.03)	1.73 (0.02)
HR period (07/2003–12/2010)	3.27 (0.10)	190.67 (0.09)	1.71 (0.02)
Percentage change in HR period, relative to pre-HR period	17.2 (242.8)	18.3 (225.9)	-1.0 (-17.3)
Post-HR period (01/2011–12/2014)	3.55 (0.03)	215.80 (0.04)	1.65 (0.02)
Percentage change in post-HR period, relative to HR period	8.8 (-64.0)	13.2 (-53.9)	-3.8 (47.1)

Source: For nominal prices was U.S. Bureau of Labor Statistics (2022a).
Note: "CPI for fluid whole milk" is Consumer Price Index for fresh whole milk, U.S. city average, series ID: CUUR0000SS09011 (U.S. Bureau of Labor Statistics 2022e).
Real price = (Nominal price / CPI) * 100.

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