Teaching and Educational Methods

Teaching Competition Topics: Applications of Seller Market Power in Agricultural Industries

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Abstract
The article presents a simple theoretical framework that can be used to explain conduct and performance of agricultural industries and seller market power in these industries. The framework components include a linear inverse demand function, a constant marginal cost function, and a set of measures of costs, revenue, and profit. The theoretical framework is consistent with agricultural supply and price cycle, and the decision-making process of agricultural producers. The theoretical framework is used to develop applications for the U.S. peanut and potato industries represented by two problem sets provided in the teaching note, which also includes four sets of assessment questions. The article discusses implementation and practical applications of the proposed teaching activity. The target audience includes students taking undergraduate courses in agricultural economics and agribusiness programs as well as extension and outreach audiences.

1 Introduction

Structural changes taking place in agricultural and food industries and changes in the regulatory environment affecting marketing and pricing of agricultural and food products reveal the importance of understanding competition processes in the modern food supply chains.[1] This highlights the need for teaching competition topics in a variety of undergraduate courses in agribusiness and agricultural economics programs.

A review of the relevant textbooks indicates that competition topics are typically considered to be elements of "markets and prices." Kohls and Uhl (2002) in their "Marketing of Agricultural Products" offer a thorough descriptive introduction of competition in agricultural and food industries. Hudson (2007) in "Agricultural Markets and Prices," Norwood and Lusk (2008) in "Agricultural Marketing and Price Analysis," and Tomek and Kaiser (2014) in "Agricultural Product Prices" introduce traditional economic models of seller market power (monopoly and oligopoly) and buyer market power (monopsony and oligopsony). These economic models are similar to the ones included in classic textbooks in the areas of microeconomics (Varian 1996) and industrial organization (Carlton and Perloff 2005) recommended for undergraduate courses in economics departments and business schools.

A discussion of applications of these traditional economic models in agribusiness systems, especially in agricultural industries, which can be used as examples in undergraduate teaching, is limited. At the same time, there are many examples of the presence of competition problems in national and global

[1] Simply defined, competition is a business conduct. The examples of structural changes include increasing consolidation and concentration at all stages of the food supply chain and increasing presence of firms with seller and/or buyer market power (U.S. Department of Justice, Antitrust Division, and U.S. Department of Agriculture 2010; Organisation for Economic Co-operation and Development [OECD] 2014). The examples of changes in the regulatory environment include decreasing effects of domestic government programs affecting agricultural marketing and pricing, as well as increasing effects of international trade policies (Food and Agriculture Organization [FAO] 2003, 2015; Greenville 2017).

industries comprising modern food supply chains (U.S. Department of Justice, Antitrust Division, and U.S. Department of Agriculture 2010; OECD 2014).

The first objective of this article is to present a simple theoretical framework that can be used to explain conduct and performance of agricultural industries and seller market power in agricultural industries and agribusiness. The framework components include a linear inverse demand function, a constant marginal cost function and a set of measures of costs, revenue, and profit. The key decision (strategic) variables are product quantity and product price. The second objective is to present applications of this framework in the U.S. peanut and potato industries. The target audience includes students taking undergraduate courses in agricultural economics and agribusiness programs as well as extension and outreach audiences.

The article is organized as follows. Section 2 presents the theoretical framework, which is used to develop a generic problem set and two problem sets illustrating applications in the U.S. peanut and potato industries. Section 3 provides a background of the U.S. peanut and potato industries. Section 4 discusses factors affecting agricultural product quantity produced and marketed by agricultural industries. Section 5 discusses collective agricultural marketing and relevant antitrust issues. Section 6 explains data necessary to develop applications for other agricultural industries. Section 7 discusses implementation, assessment, and practical applications of the proposed teaching activity. A separate teaching note includes three problem sets, four sets of assessment questions, and a summary of the background concepts and definitions required to effectively learn the proposed lecture topic.

2 Theoretical Framework

This section discusses the theoretical framework, agricultural supply and price cycle, and decision-making process of agricultural producers; and provides a summary of teaching materials.

2.1 Theoretical Framework

A simple theoretical framework explaining conduct and performance of agricultural industries and seller market power in these industries focuses on product (output) price-quantity relationships and industry profitability. The theoretical framework components include a linear inverse demand function (a price-dependent demand function), a constant marginal cost function (a cost assumption), and a set of measures of costs, revenue, and profit.[2]

A brief description of the framework is as follows. Three typical market scenarios that agricultural industries can experience are introduced: a product over-supply scenario, a perfectly competitive industry scenario, and a seller market power scenario. They differ due to the total product quantity produced and marketed, product price, and industry profit. These market scenarios can be thought of as different production and marketing seasons (or different years).

All firms (agricultural producers) comprising the industry make individual production decisions, which affect the total product quantity produced. This quantity determines market price.[3] The product quantity, price, and costs determine industry profit. Seller market power is the industry ability to decrease product quantity, which would increase product price and would increase industry profit. The framework is explained in two stages by using a graphical approach (Appendix: Figures 1 and 2) and an analytical approach (Problem Set #1 included in the teaching note).

At the first stage, the focus is on explaining the product price-quantity relationship by using an inverse demand function (Appendix: Figure 1). Product quantity (Q) determines product price (P), or product price is a function of its quantity. The relationship between product price and its quantity can be

[2] A discussion of this framework and its applications in the U.S. dairy and potato industries is presented in Bolotova (2016). A comprehensive discussion of a more complex version of this framework, as applied to the U.S. cotton industry, is presented in Moore (1919).

[3] While individually agricultural producers are price takers, the total product quantity produced by all of them (this is the total industry quantity) determines market price. Market price is a function of quantity. So, the industry is a price maker.

interpreted using two alternative approaches: (a) an increase in product quantity causes price to decrease, or (b) a decrease in product quantity causes price to increase.

To introduce seller market power, two market scenarios differing due to product quantity and price are presented. Scenario A "a larger quantity and a lower price" and Scenario B "a smaller quantity and a higher price." Seller market power is the industry ability to decrease product quantity produced and/or marketed, which would cause product price to increase: moving from Scenario A to Scenario B. The results are interpreted using the perspectives of sellers and buyers. Producers (sellers) sell a smaller product quantity and receive a higher price. Buyers have access to a smaller product quantity and pay a higher price.

At the second stage, a constant marginal cost function (MC) is introduced.[4] Having inverse demand and marginal cost allows for the evaluation of industry profitability in a set of typical market scenarios, which differ due to product quantity, price, and industry profit (Appendix: Figure 2).[5] The industry profit is measured using a price-cost margin (PCM) expressed in $ per unit (P-MC). Table 1 summarizes three typical market scenarios for agricultural industries: a perfectly competitive industry scenario, a product over-supply scenario, and a seller market power scenario.[6]

Seller market power is the industry ability to decrease product quantity produced and/or marketed, which would cause product price and industry profit to increase. This corresponds to the industry moving from the over-supply scenario (Scenario O) to a perfectly competitive industry scenario (Scenario C) and possibly to a seller market power scenario (Scenario M). The results are interpreted using the perspectives of sellers and buyers. If producers (sellers) sell a smaller product quantity, they would receive a higher

Table 1. Three Typical Market Scenarios for Agricultural Industries: Perfect Competition, Over-Supply, and Seller Market Power

Market scenario	Price and quantity depicted in Figure 2 in the Appendix	Comparison of prices and quantities between scenarios	Profit
A perfectly competitive industry scenario	Scenario C Qpc and Ppc[a]	Ppc = MC	PCMpc = Ppc – MC = 0; Zero profit for the industry and firms
A product over-supply scenario	Scenario O Qo and Po	Qo > Qpc Po < Ppc Po < MC	PCMo = Po – MC < 0; Loss for the industry and firms
A seller market power scenario	Scenario M Qm and Pm	Qm < Qpc Pm > Ppc Pm > MC	PCMm = Pm – MC > 0; Profit for the industry and firms

[a] Q, P, MC, and PCM are quantity, price, marginal cost, and price-cost margin, respectively. Subscripts "pc", "o," and "m" are used to denote a perfectly competitive industry scenario, a product over-supply scenario, and a seller market power scenario, respectively.

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[4] A constant marginal cost is assumed to develop a cost assumption for agricultural industry applications.

[5] It is assumed for simplicity that product price-quantity relationship (demand) and marginal cost do not change across the analyzed market scenarios.

[6] A seller market power scenario is related to a standard monopoly (or oligopoly) model explained in microeconomics textbooks. Marginal revenue for monopoly is not introduced for a simplicity purpose. However, a hypothetical monopoly scenario can be developed as an additional scenario. Assuming a linear inverse demand function $P = a - bQ$, a marginal revenue function for monopoly is $MRm = a - 2bQ$. The profit-maximizing quantity produced by monopoly is 50 percent smaller than the profit-maximizing quantity produced by a perfectly competitive industry (assuming the same demand and supply conditions). While

price and would earn a higher profit. At the same time, buyers would have access to a smaller product quantity and would pay a higher price.[7]

A classic interpretation of seller market power is the one based on the Lerner Index of market power (a percentage price-cost margin). The Lerner Index is equal to $\frac{P - MC}{P}$. Seller market power is the ability of a large firm (or a group of large firms) to increase product price (P) above marginal cost (MC; or above a perfectly competitive price). Increasing product price would require decreasing product quantity. The Lerner Index falls in the range of 0 to 1 (or 0 to 100 percent). In perfectly competitive industries, product price is equal to marginal cost, and the Lerner Index is equal to zero. In industries with seller market power, product price is greater than marginal cost, and the Lerner Index is positive.

The degree of industry seller market power depends on the number of firms operating in the industry, their size relative to the overall industry size, and the own price elasticity of demand. Industries with a smaller number of firms have greater seller market power than industries with a larger number of firms. Industries with less elastic demand have greater seller market power than industries with more elastic demand.[8] The own price elasticity of demand is affected by the availability of products-substitutes.

The theoretical framework (in the manner it is presented in this article) has a few limitations, which are mostly due to its simplicity. The first limitation is that it is assumed that product quantity produced each year determines market price. In reality, product quantity available for domestic consumption (market) and various demand factors determine market price. Product quantity produced constitutes the largest share in the total product quantity available for domestic consumption.[9] In addition, various demand factors affect market prices. For example, the availability of products and substitutes, changes in prices of related products, changes in consumer income, and changes in consumer preferences affect market prices.

The second limitation is the assumption that marginal cost does not change across the three market scenarios presented. In reality, marginal cost might increase or decrease, which would represent a shift of the original marginal cost curve and would cause changes in product quantity produced, market price, and industry profit.[10] This will impact the classification of a particular market scenario as product over-supply, perfect competition, or seller market power.

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agricultural industries are not likely to exercise monopoly (or oligopoly) market power, agricultural industries can exercise a small degree of seller market power. This is the reason why a generalized version of the seller market power scenario is used, without explicitly introducing monopoly or oligopoly.

[7] Note that while buyers might benefit from a product over-supply scenario (a larger product quantity available at a lower price), this scenario is detrimental for producers.

[8] For a monopoly: $Lerner \quad Index = -\frac{1}{\varepsilon_{Q,P}}$. For an oligopoly (assuming the firms are the same size): $Lerner \quad Index = -\frac{1}{N\varepsilon_{Q,P}}$. $\varepsilon_{Q,P} = \frac{dQ}{dP} \times \frac{P}{Q}$ is the own price elasticity of demand, which indicates a percentage increase (decrease) in product quantity demanded following a 1-percent decrease (increase) in product price. N is the number of firms. A discussion of the Lerner Index of market power is presented in microeconomics and industrial organization textbooks (for example, see Carlton and Perloff 2005).

[9] Product quantity available for domestic consumption during each year is equal to product stock at the beginning of the year plus product quantity produced during this year plus imported quantity minus exported quantity minus stock at the end of the year.

[10] For example, an increase in agricultural input prices (variable inputs: fertilizers, agricultural chemicals, feed, gasoline, seeds, etc.) would cause an upward shift in the marginal cost curve, causing agricultural industries to decrease product quantity, thus increasing product price to try to maintain the same level of profitability. Some agricultural input markets are concentrated, where agricultural input suppliers have seller market power, which causes agricultural input prices to increase over time. In addition, some agricultural commodities used as agricultural inputs (for example, grains used as feed) are characterized by high price volatility, which contributes to increases or decreases in marginal cost over time. A discussion of the theoretical framework in a scenario of a marginal cost shift, as applied to the U.S. broiler and pork industries, is presented in Bolotova (2019).

Depending on the course where this lecture topic is taught (a junior or senior level) and the background knowledge students have, the extensions of the theoretical framework can be developed by introducing shifts in a marginal cost curve and/or an inverse demand curve.

2.2 Agricultural Supply and Price Cycle, and Decision Making by Agricultural Producers

The introduced market scenarios (product over-supply, perfect competition, and seller market power) reflect agricultural supply and price cycle and decision-making processes of agricultural producers.[11] Agricultural producers expand their production (increase product quantity) in response to higher prices, and they contract their production (decrease product quantity) in response to lower prices. These production decisions are based on the previous year prices and profit. If the previous year price received by agricultural producers was relatively high, then during the current year they would increase product quantity produced anticipating a higher price. A simultaneous increase in the total product quantity produced by all agricultural producers would cause the current year price to decrease. In response, during the next year, agricultural producers would decrease product quantity produced anticipating a lower price. A simultaneous decrease in the total product quantity produced by all agricultural producers would cause the next year price to increase.

A year (a single production and marketing season) characterized by a large product quantity produced and a low price might be an example of a product over-supply scenario. A year characterized by a small product quantity produced and a high price might be an example of a seller market power scenario. Given that agricultural industries are characterized by a high level of agricultural supply and price volatility, a decrease in product quantity as a result of natural factors from one year to another year might lead to a higher price received by agricultural producers. An increase in product quantity as a result of natural factors from one year to another year might lead to a lower price received by agricultural producers. For example, bad weather conditions or disease outbreaks might decrease crop yield per acre, which would decrease total crop quantity produced leading to a higher crop price. On the other hand, good weather conditions might increase crop yield per acre, which would increase total crop quantity produced leading to a lower crop price. These examples consider agricultural environmental factors affecting product quantity, which are out of the agricultural producers' control.

Collective marketing activities of agricultural producers are used to purposely affect agricultural product quantity produced and marketed and/or agricultural product prices. Collective agricultural marketing might increase seller market power of agricultural producers leading to higher agricultural product prices and profits. Factors affecting agricultural product quantity produced and marketed are summarized in Section 4, and collective agricultural marketing is discussed in Section 5 of this article. The information presented in these two sections can be used to develop simple examples than can facilitate effective explanation and learning of the theoretical framework.

2.3 Teaching Materials: Summary

The theoretical framework was used to develop a generic problem set (Problem Set #1 included in the teaching note), two problem sets representing applications in the U.S. peanut and potato industries (Problem Sets #2 and #3 included in the teaching note), and four sets of assessment questions (Assessment Questions Sets #1–#4 included in the teaching note). The sets of assessment questions include additional

[11] A discussion of agricultural supply and price cycle and decision-making processes of agricultural producers is presented in Kohls and Uhl (2002). The cobweb model is often used to explain agricultural supply and price cycle in light of the decision-making process of agricultural producers. This model assumes that agricultural producers have adaptive expectations about prices. Agricultural producers use past prices to form expectations about future prices, while making decisions on product quantity to produce.

applications developed for the U.S. peanut and potato industries and applications developed for the U.S. corn and dairy industries.

The background information used to complete the problem sets and assessment questions includes inverse demand function, product quantities corresponding to three market scenarios, and assumption on marginal cost. A logical sequence of steps (questions) is as follows:

(a) calculating market prices for the three market scenarios by using the inverse demand function and product quantities;
(b) calculating industry profit (a price-cost margin expressed in $ per unit and as a percentage of market price) by using the calculated prices and marginal cost;
(c) classifying each market scenario as product over-supply, perfect competition, or seller market power;
(d) calculating the industry total costs, revenue, and profit in the analyzed market scenarios; and
(e) calculating the industry break-even quantity and price (i.e., a perfectly competitive industry quantity and price).

3 U.S. Peanut and Potato Industries

This section provides a background on the U.S. peanut and potato industries, which can be used to facilitate effective explanation and learning of the industry applications. The industry background includes a brief discussion of products and production regions, a discussion of changes in product quantities and prices over several recent years, and a brief introduction of the recent industry events, which affected product quantities and prices.

3.1 U.S. Peanut Industry

Peanut production is concentrated in the South: the Southeast (Alabama, Arkansas, Florida, Georgia, Mississippi, and South Carolina), the Southwest (New Mexico, Oklahoma, and Texas), and Virginia and North Carolina. There were 6,561 farms growing peanuts in the U.S. in 2012, an increase from 6,182 farms in 2007 (U.S. Department of Agriculture, National Agricultural Statistics Service 2012).

Georgia is the leading peanut producer in the country. In 2017 Georgia produced 3.57 billion pounds of peanuts, representing 50 percent of national peanut production (7.12 billion pounds; U.S. Department of Agriculture, National Agricultural Statistics Service 2019). Texas and Alabama produced 0.70 billion pounds each in 2017, representing approximately 20 percent of national peanut production.

Peanuts are planted in the spring (April/May) and are harvested in the fall (September/October). Four types of peanuts produced include the Runner, Spanish, Virginia, and Valencia. Peanuts may be consumed in fresh form, but typically are consumed as processed products. The latter include peanut butter, roasted peanuts (snacks), peanut oil, and peanut flour. Peanuts are also used to produce biodiesel.[12]

Table 2 summarizes yearly data on area planted, area harvested, yield, production, and price for the U.S peanut industry for the period of 2000–2016.[13] The area harvested is typically smaller than the area planted.[14] The area harvested multiplied by yield per acre is equal to total peanut quantity produced ("peanut production" in Table 2). This quantity affects peanut price. Figure 1 is a simple logical representation of the relationship among all these variables in light of the peanut production and marketing seasons.

[12] A peanut profile is available on Agricultural Marketing Resource Center's (2018a) webpage.
[13] Peanut price and quantity are depicted in Figure 3 in the Appendix. Peanut price and quantity for the most recent years were used to estimate (using a regression analysis technique) a linear inverse demand function for the U.S. peanut industry used in the peanut industry problem set (additional details can be found in Bolotova 2018a).
[14] The area harvested may be smaller than the area planted due to crop failure (because of weather, insects, and diseases), lack of labor, low market prices, or other factors (U.S. Department of Agriculture Economic Research Service 2019b).

The data presented in Table 2 reveals the following market scenarios reflecting agricultural production and price cycle and decision-making process of peanut growers.[15] The first market scenario is that an increase in peanut production in the current year, as compared with the previous year, leads to a decrease in peanut price received by peanut growers in the current year, as compared with the previous year (2001, 2004, 2005, 2012, 2014, and 2015). The second market scenario is that a decrease in peanut production in the current year, as compared with the previous year, leads to an increase in peanut price received by peanut growers in the current year, as compared with the previous year (2006, 2011, and 2016).

The peanut industry is characterized by a high level of production and price volatility, which reflects changes in peanut production and price over time. For example, as compared with 2010, in 2011 peanut area planted decreased by 11 percent, area harvested decreased by 14 percent, and yield increased by 2 percent. As a result, peanut production decreased by 12 percent, and peanut price increased by 41 percent. As compared with 2011, in 2012 peanut area planted increased by 44 percent, area harvested increased by 48 percent, and yield increased by 24 percent. As a result, peanut production increased by 85 percent, and peanut price decreased by 5 percent.

Table 2. U.S. Peanut Industry: Acres Planted, Acres Harvested, Yield, Production, and Price (2000–2016)

Year	Peanut acres planted	Peanut acres harvested	Peanut yield	Peanut production	Peanut price[a]
	thousand	thousand	pounds/acre	billion pounds	$/pound
2000	1,537	1,336	2,444	3.27	0.274
2001	1,541	1,412	3,029	4.28	0.234
2002	1,353	1,292	2,571	3.32	0.182
2003	1,344	1,312	3,159	4.14	0.193
2004	1,430	1,394	3,076	4.29	0.189
2005	1,657	1,629	2,989	4.87	0.173
2006	1,243	1,210	2,863	3.46	0.177
2007	1,230	1,195	3,073	3.67	0.205
2008	1,534	1,507	3,426	5.16	0.230
2009	1,116	1,079	3,421	3.69	0.217
2010	1,288	1,255	3,312	4.16	0.225
2011	1,141	1,081	3,386	3.66	0.318
2012	1,638	1,604	4,211	6.75	0.301
2013	1,067	1,043	4,001	4.17	0.249
2014	1,354	1,323	3,923	5.19	0.220
2015	1,625	1,561	3,845	6.00	0.193
2016	1,671	1,536	3,634	5.58	0.197

[a] Peanut price is a survey-based price reported by the U.S. Department of Agriculture, National Agricultural Statistics Service (USDA NASS Quick Stats database 2019). This is the price received by peanut growers (i.e., the price paid by the first-level handlers/buyers of peanuts).
Data Source: USDA NASS Quick Stats database (2019).

[15] These patterns of peanut quantity and price changes are consistent with an inverse demand framework. The decisions of peanut growers on peanut area to plant each year are affected by the expected peanut prices and profit and by the expected prices and profit of alternative (competing) crops grown in rotations with peanuts. These alternative crops commonly include corn and cotton.

April/May **September/October**

PLANTING HARVEST Time

Production Season
Ag producers grow crop

Marketing Season
Ag producers market (sell) crops

Area Planted

Yield per acre ***** **Area** harvested **=Quantity** produced

will determine **Market Price** and **Prices received** by individual ag producers

Figure 1. Peanut and Potato Production and Marketing Seasons: Quantity Produced and Price

Beginning in the 1930s and through 2002, Federal government programs affected the peanut industry production and marketing.[16] In particular, peanut marketing quotas (a form of supply management) affected the quantity of peanuts produced each year. The peanut marketing quota system was a form of price support program, which included two loan rates and limited the quantity of peanuts produced for domestic market for food uses (“quota peanuts”), which were eligible for the higher level of the two loan rates. The U.S. Department of Agriculture established a peanut marketing quota level on an annual basis based on projected demand for peanuts. The rights to sell “quota peanuts” were allocated to quota owners, who farmed or leased these quotas. Peanuts produced in excess of the marketing quota (“additional peanuts”) had to be exported or diverted to lower value uses and were eligible for a lower loan rate.

In 2002, the peanut industry was deregulated through the implementation of a marketing quota buyout program. Peanut growers became eligible for marketing assistance loans that were previously only available to growers of selected field crops (corn, cotton, soybeans, wheat, etc.). These changes in the regulatory environment and a shift toward a market-oriented environment affected production, marketing, and pricing decisions of peanut growers. A high degree of peanut production and price volatility observed since 2002 might reflect the effects of industry deregulation.

3.2 U.S. Potato Industry

While potatoes are grown in many states, the Pacific Northwest is the leading potato production region. In 2017, Idaho and Washington produced 135 thousand hundredweights (cwt)[17] and 99 thousand cwt of potatoes, respectively, representing 30.5 percent and 22.4 percent of national potato production (442 million cwt). Wisconsin and North Dakota produced 6.4 percent and 5.5 percent, respectively, and Colorado and Oregon each produced 4.8 percent of national potato production (U.S. Department of Agriculture, National Agricultural Statistics Service 2018). There were 21,079 farms growing potatoes in the United States in 2012, an increase from 15,014 farms in 2007 (U.S. Department of Agriculture, National Agricultural Statistics Service 2012).

Depending on the harvesting season, potatoes are classified as fall, winter, spring, and summer potatoes. The majority of potatoes produced in the United States are fall potatoes (91 percent of total potato production in 2017). Fall potatoes are planted in the spring (April/May) and are harvested in the fall (September/October). The most common potato types produced include Russets, Reds, Whites, and Yellows. Potatoes are consumed in fresh and processed forms. The latter include French fries and other frozen potato products, potato chips, canned products, etc. In 2017, 24 percent of all potatoes produced were sold as fresh potatoes, and 63 percent were used in processing.[18]

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[16] The Federal programs affecting the U.S. peanut industry in the past, the changes in these programs, and the current programs are discussed in Jurenas (2002), Dohlman and Livezey (2005), Dohlman, Foreman, and Da Pra (2009), and Schnepf (2016).
[17] One hundredweight (cwt) is equal to 100 pounds.
[18] A potato profile is available on Agricultural Marketing Resource Center’s (2018b) webpage.

Table 3 summarizes yearly data on area planted, area harvested, yield, production, and price for the U.S potato industry for the period of 2000–2016.[19] The area harvested is typically smaller than the area planted. The area harvested multiplied by yield per acre is equal to total potato quantity produced ("potato production" in Table 3). This quantity affects potato price. Figure 1 is a simple logical representation of the relationship among all these variables in light of the potato production and marketing seasons.

The data presented in Table 3 reveals the following market scenarios reflecting agricultural production and price cycle and the decision-making process of potato growers.[20] The first market scenario is that an increase in potato production in the current year, as compared with the previous year, leads to a decrease in potato price received by potato growers in the current year, as compared with the previous year (2002, 2009, 2012, and 2014). The second market scenario is that a decrease in potato production in the current year, as compared with the previous year, leads to an increase in potato price received by potato growers in the current year, as compared with the previous year (2001, 2005, 2008, 2010, 2013, and 2016). A general trend was for the potato area planted to decrease and yield to increase. Potato production decreased and stabilized during the most recent years, and potato price increased.

Table 3. U.S. Potato Industry: Acres Planted, Acres Harvested, Yield, Production, and Price (2000–2016)

Year	Potato acres planted	Potato acres harvested	Potato yield	Potato production	Potato price[a]
	thousand	thousand	cwt/acre	million cwt	$/cwt
2000	1,383	1,348	381	514	5.08
2001	1,247	1,221	358	438	6.99
2002	1,300	1,266	362	458	6.67
2003	1,274	1,250	367	458	5.88
2004	1,192	1,166	391	456	5.65
2005	1,108	1,086	390	424	7.04
2006	1,139	1,120	393	441	7.31
2007	1,142	1,122	396	445	7.51
2008	1,060	1,047	396	415	9.09
2009	1,071	1,044	414	433	8.25
2010	1,027	1,009	401	405	9.20
2011	1,101	1,079	399	430	9.41
2012	1,155	1,139	408	465	8.63
2013	1,074	1,051	414	435	9.75
2014	1,076	1,051	421	442	8.88
2015	1,083	1,054	418	441	8.76
2016	1,057	1,008	437	441	8.90

[a] Potato price is a survey-based price reported by the U.S. Department of Agriculture, National Agricultural Statistics Service (USDA NASS Quick Stats database 2019). This is the price received by potato growers (i.e., the price paid by the first-level handlers/buyers of potatoes).
Data Source: USDA NASS Quick Stats database (2019).

[19] Potato price and quantity are depicted in Figure 4 in the Appendix. Potato price and quantity for the most recent years were used to estimate (using a regression analysis technique) a linear inverse demand function for the U.S. potato industry used in the potato industry problem set (additional details can be found in Bolotova 2017).

[20] These patterns of potato quantity and price changes are consistent with an inverse demand framework. The decisions of potato growers on the potato area to plant each year are affected by the expected potato prices and profit and by the expected prices and profit of alternative (competing) crops grown in rotation with potatoes. In the case of commercially grown potatoes, these alternative crops commonly include wheat, corn, and barley.

The potato industry is characterized by some degree of production and price volatility. For example, as compared with 2011, in 2012, potato area planted increased by 5 percent, area harvested increased by 6 percent, and yield increased by 2 percent. As a result, potato production increased by 8 percent, and potato price decreased by 8 percent. As compared with 2012, in 2013 potato area planted decreased by 7 percent, area harvested decreased by 8 percent, and yield increased by 2 percent. As a result, potato production decreased by 7 percent, and potato price increased by 13 percent.

At the beginning of the 2000s, a high level of potato supply and price volatility led to an over-supply of potatoes, which adversely affected the profitability of potato growers. In 2005, potato growers organized a marketing cooperative, the United Potato Growers of America, and a number of regional cooperatives, which developed and implemented a potato supply management program. It included a potato acreage management program and a potato flow control program. The potato acreage management program (2005–2010) affected the area of potatoes planted each year. In particular, the objective was to decrease the area planted to decrease potato quantity produced in order to eliminate the potato surplus, which was expected to increase potato prices received by growers. This program was also expected to reduce the potato supply and price volatility. A decrease in potato area planted and potato quantity produced, as well as an increase in the potato price over time might reflect the effects of the potato supply management program.

The potato acreage management program raised legal concerns. Buyers of potatoes filed antitrust lawsuits claiming that a decrease in potato quantity produced led to higher potato prices paid by potato buyers (i.e., the industry was engaged in price-fixing). Buyers of potatoes argued that implementation of the potato acreage management program was a violation of Section 1 of the Sherman Antitrust Act (1890).[21]

4 Factors Affecting Agricultural Product Quantity Produced and Marketed

Given that agricultural industries include many agricultural producers making individual production decisions, it is important to take into consideration factors that might affect agricultural product quantity produced and marketed each year by all agricultural producers comprising the analyzed industry. This quantity would eventually affect market price, prices received by agricultural producers and their profitability. Factors affecting agricultural product quantity produced and marketed are summarized in Table 4.

5 Collective Agricultural Marketing and Antitrust Issues

The Capper-Volstead Act (1922) allows agricultural producers to form organizations to market their products collectively (i.e., to engage in collective agricultural marketing). Section 1 of the Capper-Volstead Act defines in a very broad manner the scope of collective agricultural marketing activities.

"Persons engaged in the production of agricultural products as farmers, planters, ranchmen, dairymen, nut or fruit growers may act together in associations, . . . 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" (Capper-Volstead Act [1922] 7 U.S.C. §291).

The Capper-Volstead Act is a limited antitrust exemption from the Sherman Act (1890). Section 1 of the Capper-Volstead Act allows agricultural producers to act together in a cartel-like manner to collectively market their products. By acting collectively through properly organized organizations,[22] agricultural producers might gain seller market power they would not have had by acting individually. This type of

[21] The potato supply management program and its market and price effects are discussed in Bolotova et al. (2010), Guenthner (2012), and Bolotova (2014, 2015, and 2016). Legal issues associated with implementation of the potato acreage management program are discussed in Bolotova (2015).

[22] To be an exempt organization, it must conform to the requirements established in Section 1 of the Capper-Volstead Act.

Table 4. Factors Affecting Agricultural Product Quantity Produced and Marketed

Factor	Affected economic variables
Field Crops, Fruits, and Vegetables	
Production decisions of agricultural producers: the area to plant	Total product quantity
Production decisions of agricultural producers: product varieties to plant	Yield per acre and total product quantity
Crop rotations, prices, and profits of alternative crops	Area to plant and total product quantity
Agricultural production management practices implemented by agricultural producers	Yield per acre and total product quantity
Weather conditions and disease outbreaks	Yield per acre, area harvested (as compared with area planted) and total product quantity
Livestock, Dairy, and Poultry	
Production decisions of agricultural producers: the herd size (the number of heads)	Total product quantity
Production decisions of agricultural producers: livestock breeds to raise	Yield per head and total product quantity
Agricultural production management practices implemented by agricultural producers	Yield per head and total product quantity
Weather conditions	Yield per head and total product quantity
Disease outbreaks	Yield per head, slaughter rates, and total product quantity
All industries	
Marketing programs of the organizations of agricultural producers (marketing cooperatives)	Product quantities and/or market prices
Government programs directly and indirectly affecting agricultural product quantities and/or prices: Federal and State Marketing Orders and Agreements[a]; Marketing Assistance Loans[b]	Product quantities and/or market prices
International trade policies	Product quantity available for domestic market and market prices

[a] Federal and State Marketing Orders and Agreements are government programs for fruits, vegetables, and specialty crops; milk and dairy products. A description of these programs is available on the webpage of the U.S. Department of Agriculture, Agricultural Marketing Service (2019).
[b] Marketing Assistance Loans are the Federal government programs for selected field crops (wheat, corn, cotton, soybeans, rice, peanuts, etc.), selected pulse crops (dry peas, lentils, chickpeas, etc.), honey, mohair and wool. A description of these programs is available on the webpage of the U.S. Department of Agriculture, Farm Service Agency (2019).

business conduct is generally prohibited by Section 1 of the Sherman Act, which considers agreements among competitors potentially affecting product prices and/or quantities to be illegal. Agricultural producers are competitors, and by being members of their marketing organizations they make agreements, which may affect product quantities produced and marketed and/or market prices.

Table 5. Examples of Agricultural Supply Management Programs: U.S. Potato, Dairy, and Egg Industries

Industry	Cooperative	Supply management programs
Potato industry	United Potato Growers of America (UPGA): Members include several regional cooperatives representing potato growers in major potato growing regions[a]	*Potato acreage management program* affected potato area planted *Potato flow control program* affected the flow of already produced potatoes to the market
Dairy industry	Cooperatives Working Together (CWT): Members include approximately 30 cooperatives and many individual dairy farmers; dairy farmers-members produce the majority of national milk quantity[b]	*Herd retirement program* affected the size of the national dairy herd (the number of cows) *Export assistance program* affects (facilitates) export of manufactured dairy products
Egg industry	United Egg Producers (UEP): Members represent approximately 95 percent of U.S. egg production[c]	*Supply control and United Egg Producers Certified Program* affected the total number of hens, the number of hens per cage, the total egg quantity produced, and the egg quantity exported

[a] United Potato Growers of America (2019).
[b] Cooperatives Working Together (2019).
[c] United Egg Producers Fact Sheet (2017).

The Capper-Volstead Act is interpreted on a case-by-case basis. There is a well-established case law informing that price-fixing by the organizations of agricultural producers is generally within the scope of the Capper-Volstead Act immunity. During recent decades, the organizations of agricultural producers in the U.S. potato, egg, and dairy industries implemented supply management (control) programs, which affected the quantity of agricultural products produced, marketed, and available for domestic consumption (Table 5).[23] There is no well-established case law interpreting the legal status of agricultural supply management programs in light of the Capper-Volstead Act.

Agricultural supply management activities may be classified as those implemented at the pre-production stage, production stage, and post-production stage.[24] The analysis of the most recent legal decisions and discussions may suggest the following. Agricultural supply management activities implemented at the post-production stage are likely to be within the scope of the Capper-Volstead Act immunity, as they tend to be consistent with the definition of "marketing" included in Section 1 of this act. Agricultural supply management activities implemented at the pre-production and production stages are likely to be outside the scope of the Capper-Volstead Act immunity.

[23] The dairy industry supply management program is discussed in Siebert and Lyford (2009), Brown et al. (2010), and Bolotova (2014, 2015). The potato industry supply management program is discussed in Guenthner (2012) and Bolotova (2014, 2015).

[24] Agricultural supply management activities aiming to decrease product quantity produced are also referred to as production restrictions or output control practices. Contemporary legal issues involving the interpretation of the legal status of agricultural supply management (control) practices in light of the Capper-Volstead Act are discussed in Varney (2010), Frackman and O'Rourke (2011), and Ondeck and Clair (2012).

6 Agricultural Industry Applications: Data

The data required to develop an industry-specific application include a linear inverse demand function and a cost assumption. The yearly production and price data for many agricultural commodities are available in the USDA National Agricultural Statistics Service Quick Stats database (U.S. Department of Agriculture, National Agricultural Statistics Service 2019). The quantity (production) variable is the total product quantity produced. The price variable is the product price received (a marketing year price). The quantity and price variables can be used to estimate a linear inverse demand function using linear regression. The assumption on marginal cost can be formulated using information presented in relevant enterprise (production) budgets. The USDA Economic Research Service maintains a large collection of commodity costs and returns estimates (U.S. Department of Agriculture, Economic Research Service 2019a). Land-grant universities maintain collections of the enterprise budgets for agricultural commodities produced in specific geographic regions.

The following issue (limitation) related to using cost estimates in developing industry applications should be mentioned. If the inverse demand functions are estimated using national data (the case of this article), the cost estimates for the national industries are used in the industry applications. In reality, agricultural production costs vary substantially across different geographic regions. The cost assumption affects the calculated product quantity, price and industry profit, and the classification of the analyzed market scenarios as product over-supply, perfect competition, or seller market power.

7 Implementation, Assessment, and Practical Applications

7.1 Lecture Topic Fit: Course Content and Curriculum

This lecture topic was taught in two undergraduate courses in the agribusiness program at Clemson University during several semesters. The material is explained generally as it is presented in this article and teaching note in a junior level "Economics of Agricultural Marketing" course taken by agribusiness major and minor students. A more advanced discussion of the same theoretical framework and a wider range of industry applications are presented in a senior level "Prices" course taken by the agribusiness major students. In the latter course, students are asked to download data (agricultural product quantities and agricultural product prices received by agricultural producers) from the USDA National Agricultural Statistics Service Quick Stats database and to use these data to estimate linear inverse demand functions by using linear regression. The estimated linear inverse demand functions are further used to evaluate alternative market scenarios differing due to product quantity and market price.[25] Also, a modified version of the inverse demand function is estimated by replacing the total quantity produced by two variables: area harvested and yield per acre.

This lecture topic may be suitable for "Agribusiness Management" (a section focusing on the economics for agribusiness managers) and for "Agricultural Economics" and "Applied Microeconomics" courses taught in agricultural economics and agribusiness undergraduate programs.

In addition, the theoretical framework and its industry applications can be used in extension and outreach activities to explain to agricultural producers the economics of conduct and performance of

[25] As an additional market scenario, a hypothetical monopoly scenario is introduced. First, a linear inverse demand function is used to derive a marginal revenue function for a hypothetical monopoly. Using a general version of a linear inverse demand function $P = a - bQ$, a marginal revenue function for monopoly is $MRm = a - 2bQ$ (note that marginal revenue is the derivative of the total revenue (TR) with respect to quantity (Q): $MRm = \frac{dTR}{dQ} = \frac{d(PQ)}{dQ} = \frac{d((a-bQ)Q)}{dQ} = a - 2bQ$). Second, the profit-maximization rule $MRm = MC$ is used to calculate the profit-maximizing product quantity to produce for the hypothetical monopoly. The inverse demand function and this quantity are used to calculate the hypothetical monopoly price.

agricultural industries and how their individual production and marketing decisions affect market prices, the industry revenue, and profit as well as their individual profit.[26]

7.2 Student Background Knowledge

This lecture topic requires some background knowledge. Students typically obtain this knowledge in an introductory microeconomics course or in an introductory agricultural economics course. The main background concepts include: (a) the firm's economic objective (profit-maximization) and the output quantity and price as key decision (strategic) variables affecting this objective; and (b) the profit-maximization rule for a perfectly competitive firm (industry): to maximize its profit, the firm (industry) produces the output quantity, at which output price is equal to marginal cost. A summary of the background concepts and definitions is included in the teaching note.

If in-class activities include estimation of the inverse demand functions (empirical demand and price analysis), then students are expected to be familiar with regression analysis. The inverse demand functions can be conveniently estimated using Excel.

7.3 Teaching Strategies

Two alternative teaching strategies are summarized in Table 6. They differ due to the number of classes allocated to this lecture topic: four classes in the case of teaching strategy #1 and two classes in the case of teaching strategy #2. Teaching strategies are discussed in a greater detail in the teaching note.

Table 6. Teaching Strategies

Class	Lecture topic	Teaching strategy #1: 4 classes	Teaching strategy #2: 2 classes
1	Introduction to competition: market structures and market power	+	
2	Theoretical framework	+	+
3	Agricultural industry applications	+	+
4	Collective agricultural marketing and antitrust issues	+	

7.4 Assessment Materials

The assessment materials used in a junior level "Economics of Agricultural Marketing" course included in-class assignments, quizzes, homework, and exams. The assessment materials used in a senior level "Prices" course included in-class assignments, quizzes, homework, research projects, and exams. Four sets of assessment questions that are used in in-class assignments, quizzes, and exams are included in the teaching note.

7.5 Challenges in Learning

The lecture topic discussed in this article was taught during several semesters to relatively large groups of undergraduate students (40 to 70 students in one class). The theoretical framework and its applications are generally easy to learn for many students. While the theoretical framework and its applications are mathematically simple, it is important that students think using the perspective (decision making) of an

[26] For examples of using this theoretical framework and/or its applications in extension and outreach settings see Pavlista and Feuz (2005), Bolotova and Jemmett (2010), Loy, Riekert, and Steinhagen (2011), and Bolotova (2018b).

individual agricultural producer and also using the perspective of the agricultural industry as a seller. There are a few challenges in learning that should be taken into consideration while teaching this material.

The first challenge might be in understanding a logical connection among all variables characterizing industry conduct and performance in light of the timeline of agricultural production and marketing seasons. For example, in the case of crops, area planted will affect area harvested during the harvesting season. Area harvested and yield per acre at the harvest will determine the total product quantity produced, which is the product quantity available to market. This quantity will affect market price during the following marketing season. Figure 1, data presented in Tables 2 and 3, and the industry background information may be used to overcome this challenge in learning.

The second challenge might be in understanding the effects of individual production decisions of agricultural producers made at the beginning of the production season on prices they will receive during the marketing season and eventually on their profit. Individual production decisions made by agricultural producers (i.e., the area to plant) affect the total product quantity produced by all of them. This total industry quantity will affect market price, which will affect prices received by individual agricultural producers and subsequently profit. While agricultural producers make individual production decisions, prices they receive will be affected by the total product quantity produced by all producers. Figure 1 may be used to overcome this challenge in learning.

7.6 Strengths

The main strength of the theoretical framework and industry applications presented in this article and teaching note is that they allow students to acquire a valuable working knowledge of the conduct and performance of agricultural industries in a simple and effective manner. An additional strength of the theoretical framework includes its connection to agricultural production and price cycle and to a real-world decision-making process facing agricultural producers. Finally, agricultural industry applications allow students to become familiar with the types of data available in the U.S. Department of Agriculture databases and how to use these data to perform agricultural industry analysis, which results could be valuable in the decision-making process of agricultural producers and their marketing organizations.

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Appendix: Supplementary Figures 1 to 4.

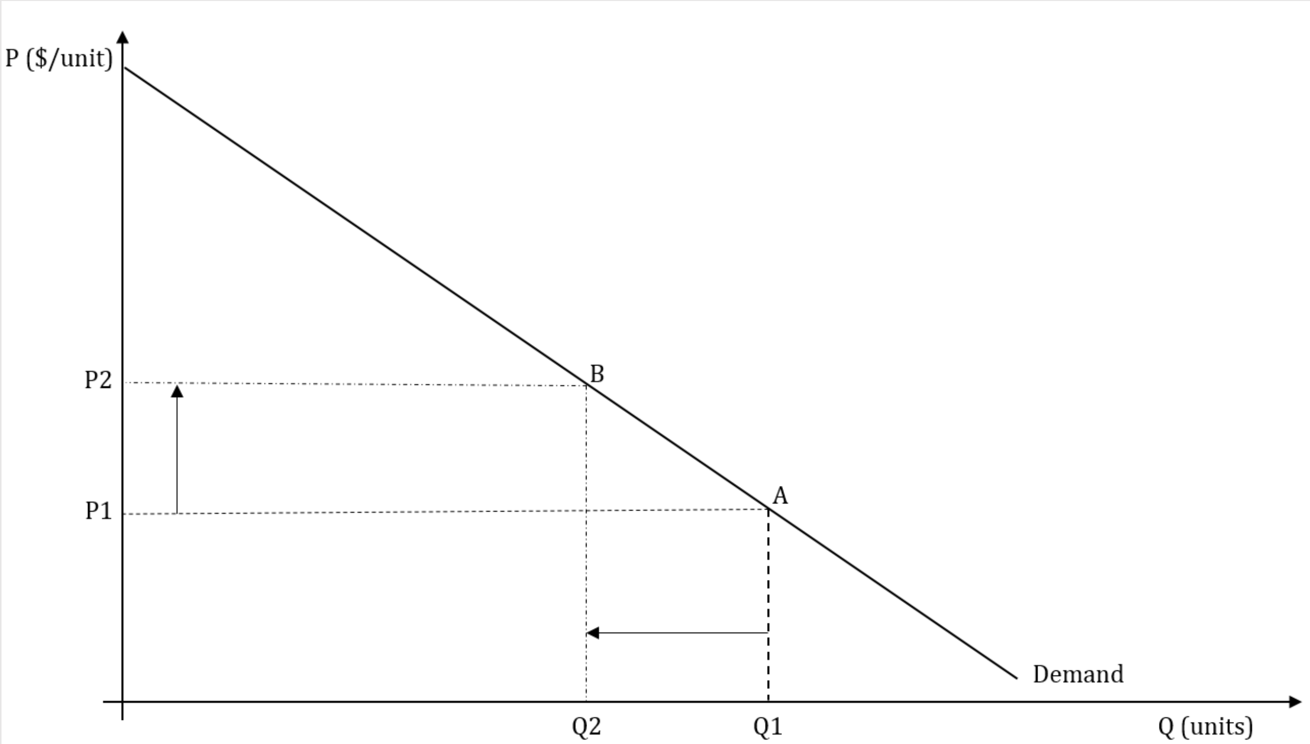

Figure 1. The Product Price-Quantity Relationship: Two Representative Market Scenarios

Note: Q1 and P1 (PointA): A *larger* quantity and a *lower* price. Q2 and P2 (Point B): A *smaller* quantity and a *higher* price. Seller market power is the industry ability to move from A to B: a decrease in quantity causes price to increase.

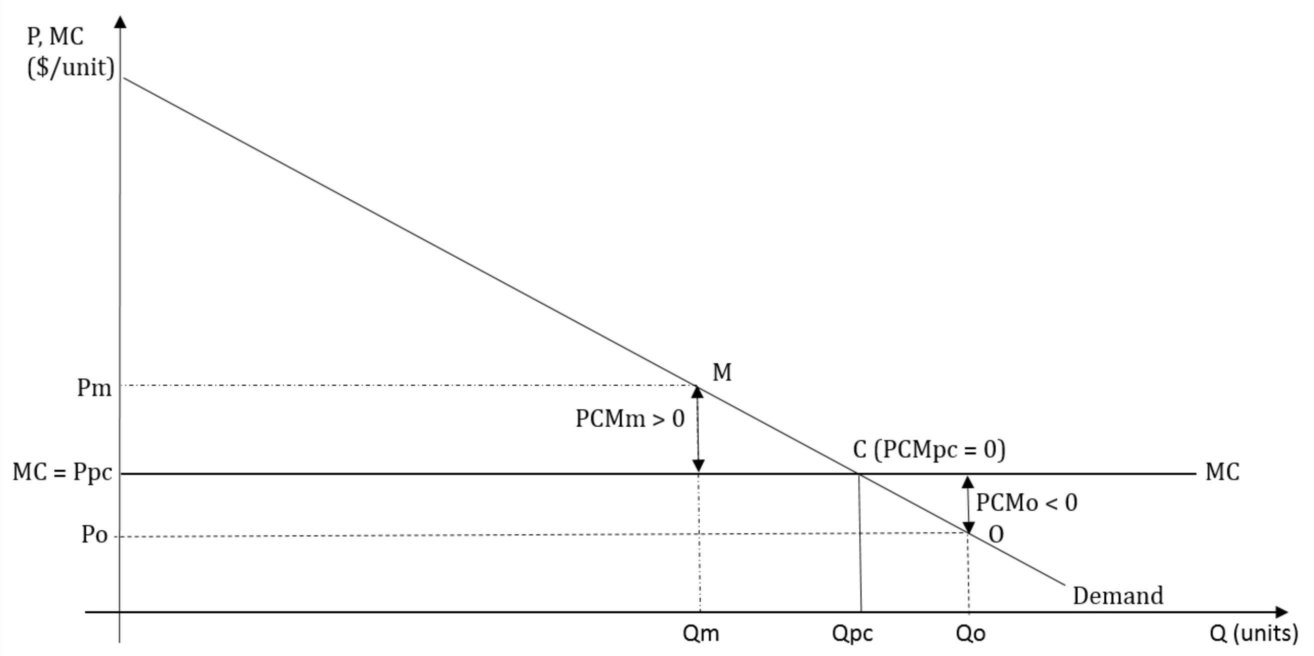

Figure 2. The Product Price-Quantity Relationship and Industry Profitability

Note: Oo and Po (Point O) is a product *over-supply* scenario. Qpc and Ppc (Point C) is a *perfectly competitive industry* scenario. Qm and Pm (Point M) is a *seller market power* scenario. Seller market power is the industry ability to move from O to C and to M: a decrease in quantity causes price to increase, which increases industry profit.

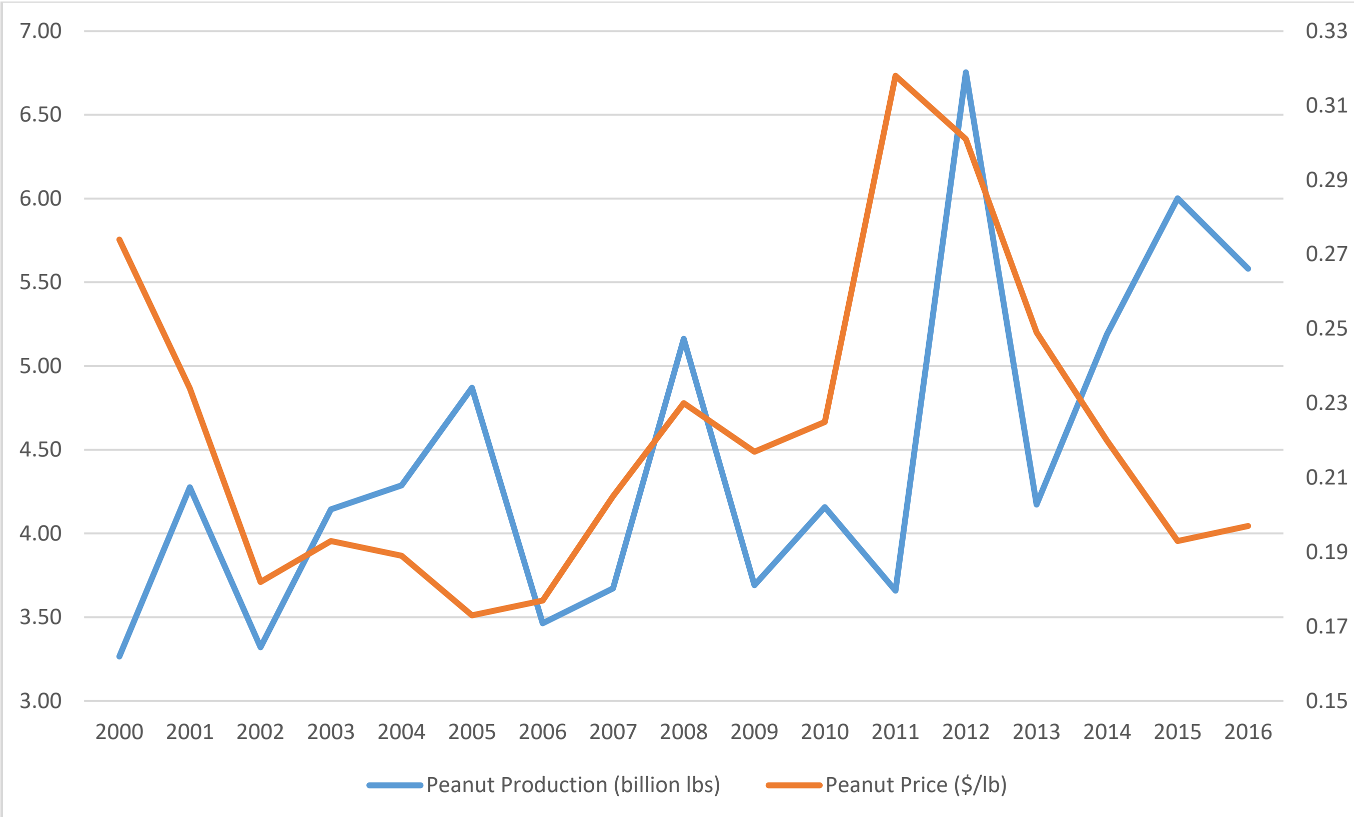

Figure 3. U.S. Peanut Industry: Peanut Production and Peanut Price (2000–2016)
Data Source: USDA NASS Quick Stats database (2019)

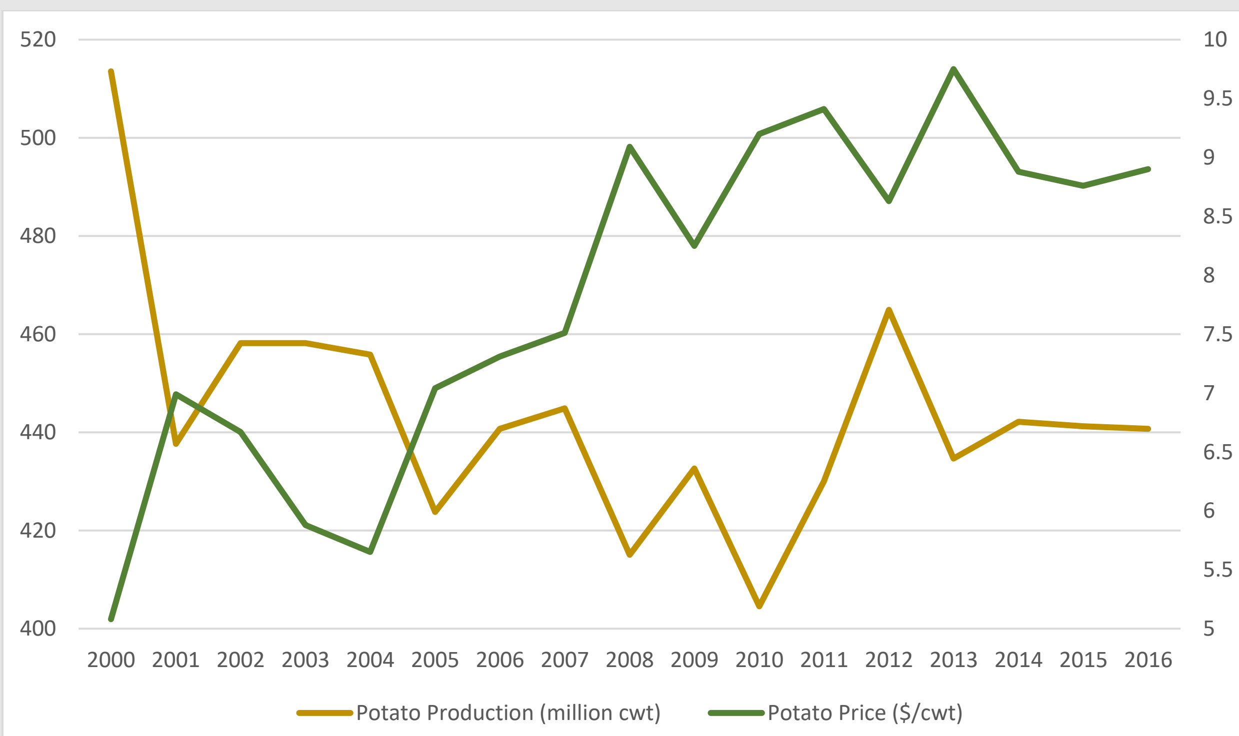

Figure 4. U.S. Potato Industry: Potato Production and Potato Price (2000–2016)
Data Source: USDA NASS Quick Stats database (2019)

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