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The Impact of Coordination of Production and Marketing Strategies on Price Behavior: Evidence from the Idaho Potato Industry

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Abstract

High potato price volatility, decreasing demand for fresh potatoes and prices below the cost of production led to a decision of a number of Idaho potato growers to organize the United Fresh Potato Growers of Idaho, a marketing cooperative. The programs and strategies of the cooperative target both the production and marketing of fresh potatoes in Idaho. To evaluate the effectiveness of the programs implemented by the cooperative, we examine the level and volatility of fresh potato prices during two periods: before the cooperative was organized and when the cooperative is in the market. We find empirical evidence suggesting that fresh potato prices were higher and less volatile during the period when the cooperative was in the market.

Keywords: agricultural markets, cooperative, price volatility, potato industry

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Introduction

Agricultural markets are traditionally characterized by high level of price volatility and the potato industry is no exception. High potato price volatility, decreasing demand for fresh potatoes and low levels of growers' returns that often do not cover the potato production costs led to a decision of a number of Idaho potato growers to organize a cooperative. The United Fresh Potato Growers of Idaho (the United) was officially founded in November 2004 and that time represented 85% of fresh potato growers in Idaho. This is one of many agricultural cooperatives that enjoy the exemptions granted by antitrust laws. The Capper-Volstead Act allows farmers to act collectively in preparing for market and marketing their products.

The overall goal of the United is to stabilize the supply of potatoes in Idaho and to facilitate equitable and stable marketing of its members' production in order to provide a fair level of returns to potato growers. To perform this goal, the potato supply management program targeting both production and marketing of potatoes was developed and enforced starting in spring 2005. The main components of this program are the acreage management, potato flow control and secondary marketing strategies. The acreage management is administered through the bid buy down program and targets the number of potato acres planted. The potato flow control program coordinates potato shipments throughout the marketing year. The secondary marketing programs divert excess supply of already produced potatoes.

Although Idaho is the largest potato producer in the United States with almost a 30% market share in the national fall potato production, the success of the United Fresh Potato Growers of Idaho depends on whether similar strategies are followed by growers in other potato growing regions. Consequently, the efforts were made to organize potato growers nationally. The United Potato Growers of America was founded in March 2005 and a number of potato grower cooperatives with similar objectives were organized in other potato growing regions and in Canada.

The United Fresh Potato Growers of Idaho reported increases in potato growers' returns as a result of implementation of the acreage management program[1]. The impact of the United was also noted at the national level (Lucier and Jerardo 2005a, 2005b). As a result of the acreage bid buy down program implemented in spring 2005, the United reported that 26,000 acres were withdrawn from production that year, which represented 7% of the Idaho potato planted area in 2004. Although this reduction was still below the targeted 10% reduction relative to 2004, fresh potato prices increased during the following marketing year.

[1] The potato market situations are discussed in the United Fresh Potato Growers of Idaho newsletters.

The United is one of many marketing cooperatives that have been active in various agricultural industries and some of them were more successful than others. A distinct feature of the presented case is the scope of its operation; the group of fresh potato growers cooperatives is about to encompass the whole North American market. If successful in developing effective sets of policies and programs and enforcing them in a proper way, the cooperatives are likely to gain control over the fresh potato supply and, consequently, over the potato price volatility. To accomplish this goal, the cooperatives have to enforce their policies and programs effectively and to monitor the performance of their members. Otherwise, the organizational and discipline enforcement problems would undermine the success and would lead to over production and high price volatility.

The United Fresh Potato Growers of Idaho is a dominant player in the North American potato industry. The success of this cooperative has important implications for fresh potato growers in all potato producing regions in North America. Although there is some evidence on a positive impact of the United's actions on the potato price and supply stability, there has not been any systemized economic analysis done to examine this situation. The results of such analysis would be useful for the potato industry participants in all potato growing regions.

The objective of our paper is to evaluate the effectiveness of programs and strategies of the United Fresh Potato Growers of Idaho. To perform this objective, we analyze Idaho and US level monthly and Idaho weekly shipping point prices for fresh potatoes during two periods: before the cooperative was formed and during the period when the cooperative is in the market. We examine changes in the fresh potato price level and volatility between these two periods, which are hypothesized to be due to implementation of the United's programs and strategies. The effects of potato supply management program, if it is effectively enforced, are reflected in the pattern of price behavior, as prices are indicators of the effectiveness of economic performance of market players like the United.

The paper is organized as follows. Section 2 presents the overview of the US potato industry. Section 3 discusses the Idaho potato industry, economic forces leading to formation of the United Fresh Potato Growers of Idaho and the programs implemented by the cooperative. Section 4 develops hypotheses and Section 5 presents data and descriptive statistical analysis. Section 6 discusses empirical models and is followed by Section 7 summarizing the estimation results. Finally, the conclusion of our study is presented.

Overview of the US Potato Industry

Potatoes are one of the most significant products in a diet of the US consumers. Being the most important vegetable in food consumption, during the last twenty years potatoes were ranked as the second important product in the US food

consumption following wheat flour[2]. Potatoes are consumed in fresh and processed forms; processing potatoes are represented by frozen potatoes, dehydrated potatoes and potato chips. Although potato consumption was increasing during the recent decades, there was a change in the consumption pattern of fresh versus processed potatoes. Before 1990, fresh potato consumption exceeded frozen potato consumption; after 1990, there has been a steady increase in consumption of frozen potatoes and a steady decrease in consumption of fresh potatoes (Figure 1). For example, in 1990 fresh potato consumption was only 0.7% higher than frozen potato consumption; in 2006 frozen potato consumption was almost 30% higher than fresh potato consumption[3].

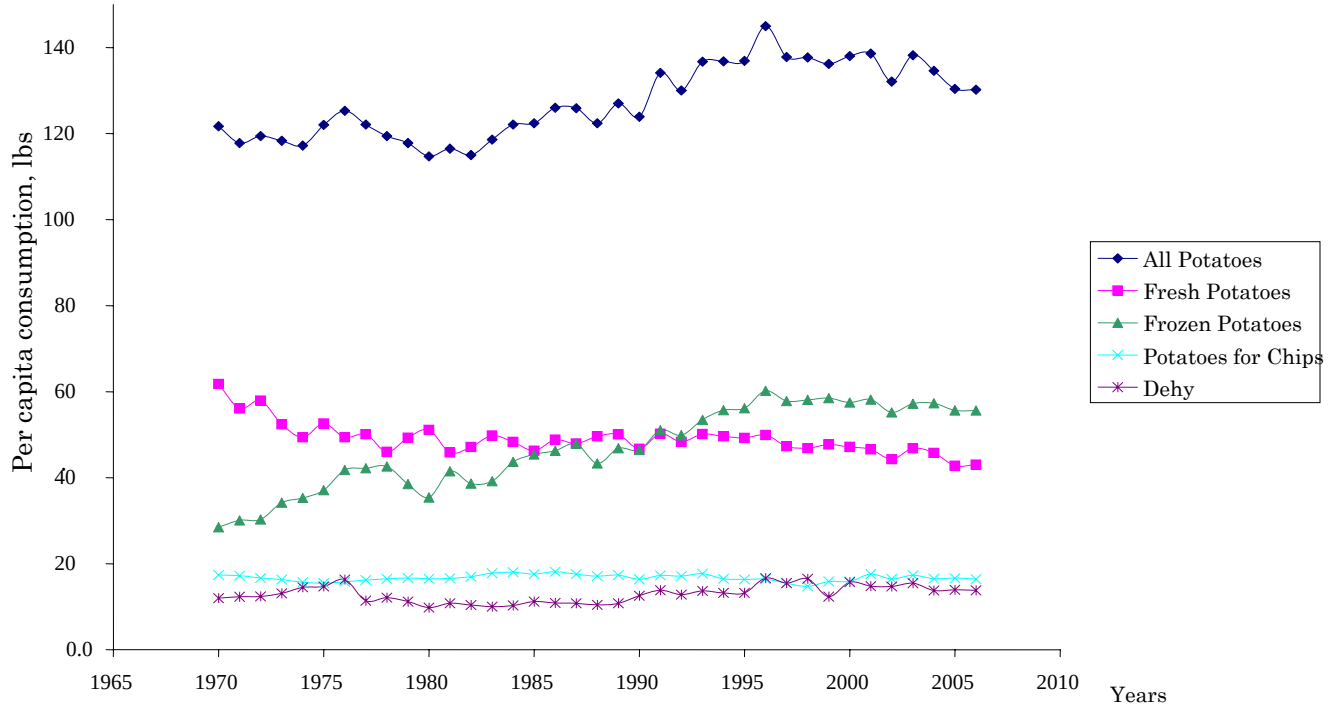

Figure 1: Trends in US Potato Consumption, 1970-2006
Data source: Economic Research Service.

[2] Before 1987, potato consumption (in pounds per capita per year) exceeded the wheat flour consumption (in pounds per capita per year). In 2004 the wheat consumption and potato consumption were approximately at the same level (ERS/USDA food availability data system).
[3] Fresh and frozen potatoes represent the largest share in the total potato consumption. In 1990, fresh and frozen potatoes constituted 37.7% and 37.4% of the total potato consumption, receptively. In 2006, these shares were 33.1% and 42.7%. The numbers were calculated by the authors using data reported by ERS/USDA.

In 2005, the United States was the fourth largest producer of potatoes in the world following China, Russia and India (ERS/USDA potato statistics; Table 95). In 2000, the United States was the largest producer of frozen French fries followed by the Netherlands and Canada (Plummer and Makki 2002). Potatoes are the source of revenue for 9,408 potato producing farms in the US[4]. The total value of the US potato production in 2007 was almost $3 billion, which did not account for the value added through processing.

Potatoes are grown in several states in the United States and there are obvious seasonal patterns in potato production. Depending on the season of production, which is associated with a particular geographic location, potatoes are classified as fall, winter, spring and summer potatoes. Fall potatoes are planted in the spring and are harvested in the fall. In terms of the area planted and value of production, fall potatoes accounted for 86% and 82% in the total potato production in the country in 2007[5]. Because of good storage possibilities, the marketing season for fall potatoes is usually from July (early harvest areas) through June of the following year. The two leading states in production of fall potatoes are Idaho and Washington (Table 1).

Table 1: 2007 Structure of the US Fall Potato Industry: 9 Leading States

State	Area planted	Production	Price per unit	Value of production	Market share in value of production	Number of potato farms
	1,000 acres	1,000 cwt*	$/cwt	$1,000	%	number (% share in the total)
United States	*1,010.6*	*409,082*	*6.61*	*2,704,113*	*100.00*	*9,408 (100.0)*
Idaho	350.0	131,650	5.80	763,570	28.24	818 (8.7)
Washington	165.0	102,300	6.00	613,800	22.70	408 (4.3)
Wisconsin	64.5	28,160	7.45	209,792	7.76	399 (4.2)
Colorado	59.2	20,981	8.30	174,142	6.44	229 (2.4)
North Dakota	97.0	23,660	6.60	156,156	5.77	216 (2.3)
Oregon	36.5	20,238	7.25	146,726	5.43	278 (3.0)
Minnesota	50.0	20,680	6.40	132,352	4.89	284 (3.0)
Maine	57.1	16,530	7.50	123,975	4.58	444 (4.7)
Michigan	42.5	14,700	8.40	123,480	4.57	395 (4.2)

Data sources: National Agricultural Statistics Service and 2002 Census of Agriculture.
All presented in the table economic indicators are for 2007, except for the number of potato farms, which is for 2002.
* 1 cwt (hundredweight) = 100 pounds.

[4] This number of potato farms is recorded in the 2002 US Census of Agriculture.
[5] The percentages are calculated by the authors using the NASS/USDA statistics for all potatoes and fall potatoes.

The leading states in production of winter, spring and summer potatoes are California, Florida and Texas. Although these potatoes have a considerably smaller share in the total potato production, they help satisfy some specific marketing needs and are usually priced higher than fall potatoes.

In terms of potato utilization, fresh potatoes (table stock) and processing potatoes accounted for 28.4% and 58%, respectively in 2005 (ERS/USDA potato statistics; Table 120). The most significant processing uses are frozen French Fries, chipping potatoes and dehydrated potatoes, which constituted 29.1%, 12% and 10% of the total potato utilization in 2005. Fresh potatoes are usually sold in the open market and processing potatoes are typically sold through contracts; the latter are usually signed prior to the planting season and specify a potato variety, quantity and price tied to a set of quality requirements.

The most popular potato variety is Russet Burbank; in 2006 the share of Russet Burbank in the total area of fall potatoes planted was 46% nationally, followed by Russet Norkotah (13.1%) and Ranger Russet (9.5%) (ERS/USDA potato statistics; Table 67)[6]. Idaho is the leading producer of Russet Burbank; in 2006 this variety was planted on 66% of all potato acres in this state, which represented 48.4% of the fall potato acres planted nationally. Idaho is followed by Washington, North Dakota and Colorado with 12%, 10% and 8% of the national Russet Burbank area planted (ERS/USDA potato statistics; Table 67). A distinct feature of Russet Burbank is its universal uses. This potato variety is sold in the fresh potato market and for processing into French Fries and dehydrated potato products.

Table 1 presents the structure of the US fall potato industry. In 2007, the share of the nine leading states in the total value of fall potato production was 91%. The two leaders are Idaho and Washington with the market shares of 28.2% and 22.7%, respectively. The following seven states have market shares within the range of 4.6% (Michigan) to 7.8% (Wisconsin). Therefore, 51% of value of fall potato production is concentrated in Idaho and Washington. According to the 2002 US Census of Agriculture, there were 818 potato producing farms in Idaho and 408 potato producing farms in Washington in 2002. They represented 8.7% and 4.3% of all potato producing farms in the country, with Idaho being ranked as number two after Pennsylvania in terms of the number of potato producing farms[7]. Therefore, a half of fall potatoes production is concentrated in approximately 13% of all potato producing farms in the country[8].

If compared to one another in terms of the area planted in 2007, the area of potatoes planted in Idaho was 350 thousand acres, which was more than two times larger

[6] The percentages are calculated by the authors.
[7] There were 984 potato producing farms in Pennsylvania in 2002 (2002 Census of Agriculture).
[8] The percentages are calculated by the authors using the 2002 Census of Agriculture data.

than the area planted in Washington, 165 thousand acres (Table 1). Due to a 64% higher potato yield in Washington, the value of potato production in Idaho ($763,570 thousand) was only 24% higher than in Washington ($613,800 thousand). Although these two states have the largest market shares, potato producers in these states received the lowest prices in 2007, $5.80 and $6.00 per hundredweight (cwt)[9]; the average US price was $6.61 per cwt. The 2007 fall potato price-quantity combinations for the nine leading states are shown on Figure 2. The pattern indicated on the figure suggests that the areas with the lowest level of potato production receive highest prices.

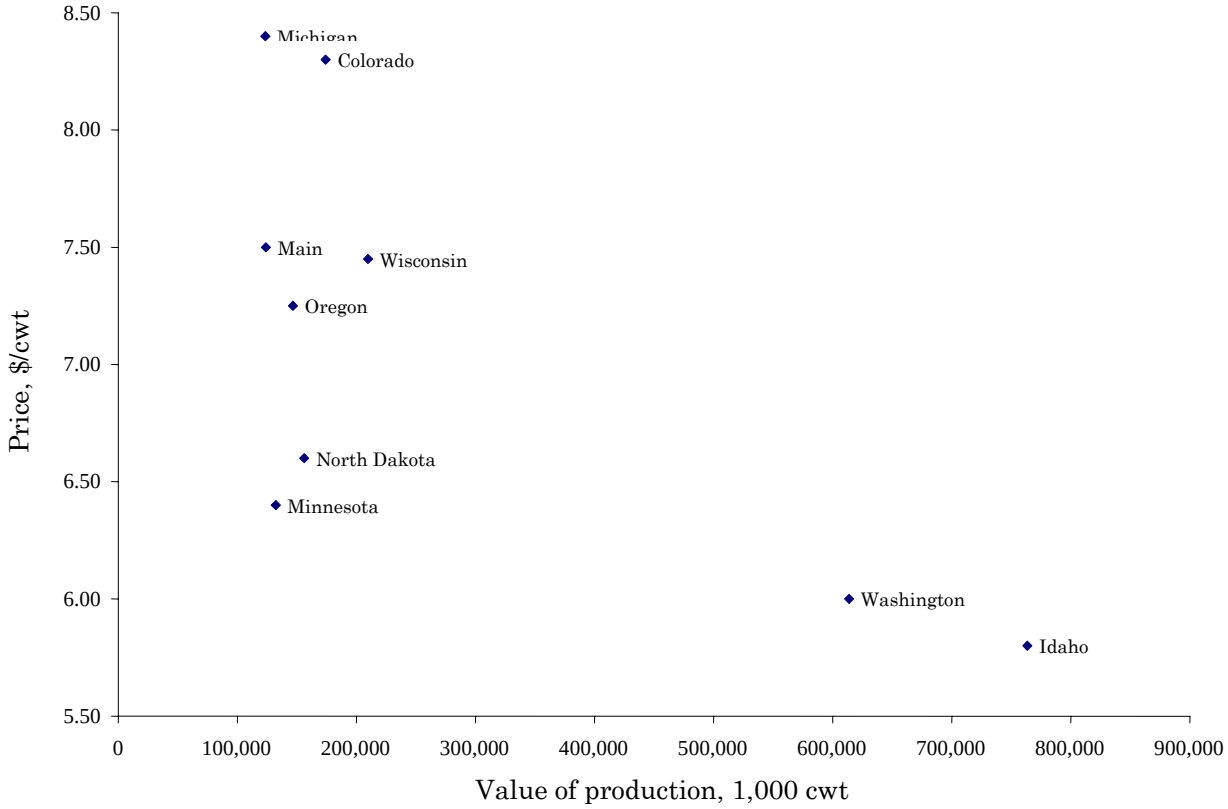

Figure 2: 2007 Fall Potato Production and Prices, 9 Leading States
Data Source: National Agricultural Statistics Service.

[9] One hundredweight (cwt) is equivalent to 100 pounds.

Idaho Potato Industry and United Fresh Potato Growers of Idaho

Economic Forces Leading to the Formation of the United Fresh Potato Growers of Idaho

To discuss the economic forces leading to formation of the United Fresh Potato Growers of Idaho, we analyze the level and volatility of potato area planted, potato production and potato prices across the nine states identified earlier. Table 2 presents the average potato area planted, the average potato production and the average potato price for the period before the cooperative was organized (1990-2004) and the period when the cooperative is in the market (2005-2007). Also, Table 2 presents the coefficient of variation for each of the analyzed variables. The United Fresh Potato Growers of Idaho was officially organized in November 2004; the cooperative programs and policies started being enforced in Spring 2005.

Table 2: Average Yearly Fall Potato Production and Prices, 1990-2004 vs. 2005-2007, 9 Leading States

State	Area planted		Production		Price per unit	
	1,000 acres		1,000 cwt*		$/cwt	
	1990-2004**	2005-2007**	1990-2004	2005-2007	1990-2004	2005-2007
Idaho	390 (5.6)	337 (3.7)	132,096 (7.1)	126,284 (5.6)	4.77 (14.6)	5.80 (1.7)
Washington	155 (8.3)	158 (3.7)	87,722 (12.1)	95,893 (6.5)	5.06 (14.2)	5.95 (5.5)
Wisconsin	80 (9.3)	66 (2.7)	29,372 (12.9)	28,470 (2.8)	5.53 (16.0)	7.70 (2.8)
Colorado	72 (6.6)	59 (1.4)	24,899 (8.9)	22,192 (4.8)	4.62 (42.3)	8.30 (4.2)
North Dakota	130 (11.1)	96 (4.2)	25,733 (13.8)	23,213 (10.9)	5.38 (12.3)	6.65 (2.0)
Oregon	52 (13.0)	36 (3.2)	24,727 (14.1)	20,265 (8.6)	5.28 (13.0)	6.52 (10.8)
Minnesota	70 (14.7)	49 (5.4)	18,845 (16.4)	19,570 (8.6)	5.22 (11.3)	6.33 (2.5)
Maine	72 (10.8)	58 (1.2)	18,797 (10.8)	16,655 (7.6)	6.24 (11.8)	7.85 (4.8)
Michigan	44 (13.8)	43 (1.2)	13,162 (17.0)	14,267 (2.8)	6.80 (8.1)	8.22 (3.4)
United States	**1,180 (5.3)**	**991 (2.2)**	**410,306 (7.4)**	**396,915 (3.3)**	**5.27 (12.7)**	**6.61 (1.1)**

Data source: National Agricultural Statistics Service.

The entries in the cells are the average values with the coefficient of variations in the parentheses. Coefficient of variation is calculated as the ratio of standard deviation to the mean.

* 1 cwt (hundredweight) = 100 pounds.

** 15 observations (years) are used to calculate the average values for the period of 1990-2004 and 3 observations (years) are used to calculate the average values for the period of 2005-2007.

Analysis of the level and volatility of the potato production and prices across the nine leading states may explain the adverse economic situation that the Idaho potato growers found themselves in by 2004. During the period of 1990-2004, Idaho had one of the lowest average potato prices with one of the highest price variability (volatility). Among the nine states, only Colorado had lower average potato prices

and a higher level of price volatility[10]. The average potato price during 1990-2004 received by Idaho potato growers was $4.77 per cwt, while the average US level price was $5.27 per cwt. Potato growers in seven out of nine states received the average price above $5 per cwt, and many of these states had lower price volatility than Idaho.

On the other hand, in terms of the number of acres planted and the level of production, Idaho potato production is characterized by the lowest level of volatility. While other eight states are characterized by a higher level of potato production volatility, it may be an evidence of a better reaction of these states to the current market situations, which leads to a higher price level and a lower price volatility. A lower level of potato production volatility in Idaho may be an indicator of a poor reaction of the Idaho potato industry to changes in market environment.

Another factor adversely affecting the economic condition of the Idaho potato industry is the level and volatility of potato production costs. Potato production is concentrated in three distinct growing regions across the Snake River Plain in southern Idaho. Potato production costs per acre vary significantly across the regions and are affected by the production practices used and potato varieties grown. Typically, potato production costs per acre decrease going from west to east across southern Idaho and from south to north in eastern Idaho. Potato production costs per acre in 2007 for Russet Burbank without storage ranged from nearly $2,900 in southwestern Idaho to under $2,000 in eastern Idaho (Patterson 2008). Including storage costs adds an additional $225 to $300 per acre[11].

However, it is the cost per hundredweight that best illustrates the problem that Idaho growers encounter. Many Idaho potato producers were not able to recover their costs for a number of years. For example, while the without storage cost was approximately $4.65 per cwt in 2004, a monthly average fresh potato market price in October was $3.30 per cwt. With five months of storage, the cost per cwt had risen to approximately $5.20 per cwt and the average March price had fallen to $2.70 per cwt. Furthermore, in 2004 the average production cost was higher than the average fresh potato price received by potato producers. While the potato production cost fell in the range of $4.63 to $5.23 per cwt, the average fresh potato price was only $3.89 per cwt (Table 5).

[10] Colorado is the only state among the nine analyzed states where both fall and summer potato production takes place. Interaction of these two seasonal markets is likely to affect the pattern of the potato price level and volatility in this state relative to other states.

[11] The University of Idaho Department of Agricultural Economics and Rural Sociology conducts yearly surveys of potato producers to collect detailed information on potato production costs. The results of these surveys are summarized in the reports published as part of Agricultural Economics Extension Series in the mentioned Department. In this study we use potato production cost data presented in Patterson (2004, 2008) and Patterson and Smathers (2005, 2006).

In summary, high level of potato price volatility and low grower returns that do not always cover potato production costs coupled with the largest potato production area in the country led to a decision of a number of Idaho potato growers to organize their industry by founding the United Fresh Potato Growers of Idaho, a marketing cooperative.

Structure of Idaho Potato Industry

The Idaho potato industry consists of potato growers, potato shippers and potato processors.

Potato Producers

Analysis of the size distribution of potato farms and the potato marketing value distribution reveal that the large share of potato production is concentrated on the large potato farms (Table 3 and Table 4)[12]. Approximately 70% of all potato acres and potatoes produced are concentrated in 27% of all farms; this group is represented by 218 farms with 2,000 and more acres each (Table 3). The next group of farms, those with 1,000 to 1,999 acres, represents 25% of all potato farms and 19% of all potato acres and potato production. Therefore 86% of all potato acres and all potato production are concentrated in the farms with more than 1,000 acres representing 52% of all potato farms. Consequently, 48% of all potato farms produce 14% of all potatoes on 14% of all potato acres in Idaho.

Table 3: Distribution of Idaho Potato Farms by Size

	Number of acres (% share in the total)				
	Total	1-259	260-999	1,000 to 1,999	2,000 or more
Farms	818	113 (13.8)	281 (34.4)	206 (25.2)	218 (26.7)
Acres	364,229	4,659 (1.3)	46,852 (12.9)	70,832 (19.4)	241,886 (66.4)
Cwt* (1,000)	129,597	1,491 (1.2)	16,551 (12.8)	25,100 (19.4)	86,363 (66.6)

Data source: 2002 Census of Agriculture.
* 1 cwt (hundredweight) = 100 pounds.

Table 4: Distribution of Idaho Potato Farms by Potato Marketing Value

Item	All farms	$1,000,000 or more	$500,000 to $999,999	$250,000 to $499,999	$100,000 to $249,999	10,000 to 99,999
Farms	818	325 (39.7)	191 (23.3)	144 (17.6)	92 (11.2)	53 (6.5)
Acres	364,229	290,319 (79.7)	47,848 (13.1)	18,879 (5.2)	5,868 (1.6)	1,297 (0.4)
Cwt* (1,000)	129,597	105,069 (81.1)	16,052 (12.4)	6,335 (4.9)	1,764 (1.4)	375 (0.3)

Data source: 2002 Census of Agriculture.
* 1 cwt (hundredweight) = 100 pounds.

[12] This analysis is based on the latest available Census of Agriculture data (2002).

In terms of the potato marketing value, 325 farms (40%) generate more than $1 million and these farms' shares in all potato acres and all potato production are about 80%. Approximately 23% of all potato farms are those with potato marketing value of $500,000 to $999,999; it is produced on 13% of all potato acres and constitutes 12% of potato production. Therefore, approximately 94% of all potato marketing value is concentrated in 63% of all potato farms and 6% of all potato marketing value is concentrated in 37% of all potato farms.

Potato Shippers

Potato shippers operate potato packing sheds and are represented by independent shippers and potato growers-shippers. Given that potato production is concentrated in large farms, some large potato growers are also potato shippers. While Idaho has had a long history of independent packing sheds, the current trend is toward larger, grower-owned sheds (Patterson et al 2005). Potato packing activities allow potato growers to capture additional benefits by adding value (i.e. packing and shipping) to the grown potatoes. Given the large size of some potato farms, establishing a potato packing business is a profitable strategy for them. There is a trend toward increasing consolidation of packing sheds in response to the consolidation among buyers and the growing importance of large retailers.

Packing sheds play the intermediate role between farmers and consumers. Packing sheds add value by washing, grading and packing potatoes for shipment to large distributors and large retailers who serve consumers. Fresh potato standards have to be satisfied before potatoes leave packing sheds[13]. A crucial distinction is made between size A potato tubers and non-size A tubers. The former are typically greater than 6 ounce, and the latter are less than 6 ounce and greater than 4 ounce. Size A potatoes are packed in 50-pound cartons, while non-size A tubers are placed in consumer packs. The number of tubers in the cartons must fall within specified standards. The number of potatoes per carton is from 40 to 120. The "Grown in Idaho" seal is a highly recognized trademark that potato shippers affix to potato bags and boxes.

There are 33 licensed fresh potato shippers and 4 licensed potato brokers in Idaho (Idaho Potato Commission web-page). There are 48 potato distribution businesses listed as members in the Idaho Grower Shippers Association and there are 48 associated members representing various businesses involved in distribution of potatoes and associated services (storage, packaging, transportation, insurance, marketing, etc) (Idaho Grower Shippers Association web-page).

[13] United States Standards for Grades of Potatoes (1991) establish the requirements for different grades of potatoes.

Potato Processors

The two largest potato processing sectors represented in Idaho are production of frozen potato products, primarily French Fries, and production of dehydrated potato products, primarily flakes and granules. Processing companies produce frozen and dehydrated potato products for food service use and for retail sales. There are 11 potato processors in Idaho (Idaho Potato Commission web-page); the largest of them with the longest history of involvement primarily in frozen potato product processing in Idaho are J.R. Simplot Company, McCain Foods and ConAgra Foods. The Idaho processing plants of these three companies represent approximately a quarter of the US fry plant capacity (Patterson et al 2005). Basic American Foods and Idaho Fresh Pack Corporation (Idahoan) dominate the dehydration sector.

Processing companies producing frozen potatoes use pre-season contracts to ensure a steady supply of potatoes with specified requirements for quality. Dehydrators typically rely on the fresh potato market off-grades potatoes and also use contracts with growers and potato shippers (packing sheds).

Given that the number of potato processors is small relative to the number of potato producers, and processing companies possess oligopsony market power[14], growers of processing potatoes are represented by a bargaining association. For many years the Potato Growers of Idaho carried out this role. In recent years, the Southern Idaho Potato Cooperative (SIPCO) has represented interests of processing potato growers by negotiating the terms and conditions of yearly potato contracts with potato processors.

The Organizational Structure, Programs and Strategies of the United Fresh Potato Growers of Idaho [15]

The United Fresh Potato Growers of Idaho (the United) was formed in November 2004 and that time represented 85% of fresh potato growers in Idaho. The goal of the cooperative is to stabilize supply of fresh potatoes in Idaho in order to provide fair returns to potato growers. A key to successful implementation of this goal is participation of other potato producing states. The United Potato Growers of

[14] Oligopsony is a type of market structure where the number of buyers is small relatively to the number of sellers, which allows buyers to have market power over the price of input bought. Therefore, potato processing companies have market power over the price of potatoes that they buy from numerous potato producers. According to the U.S. International Trade Commission, a four-firm concentration ratio among buyers of frozen potatoes is 80% (Richards et al 2001). This means that the four largest potato processors buy approximately 80% of all processing potatoes grown in the country. A rigorous quantitative analysis of a degree of oligopsony power in the processing potato industry is presented in Richards et al (2001).

[15] This section is based on the information presented in various newsletters available on the United Fresh Potato Growers of Idaho web-page.

America was organized in March 2005 and that time represented 70% of fresh Russet potato growers in the country. These events let to formation of potato cooperatives with similar objectives in other potato growing states and in Canada.

The fresh potato market is strongly affected by processing potato and seed potato markets. Cooperation with the process and seed potato growers is crucial for the success of the United. Seed potato growers joined the United Fresh Potato Growers of Idaho as a seed district. In summer 2005, Southern Idaho Potato Cooperative (SIPCO) representing processing potato growers in Idaho joined the United as an independent district. The United/SIPCO share in all produced in Idaho potatoes was 80% that time; the SIPCO members represented 80% of all processing potato production and the United members represented 85% of all fresh and seed potato production in the state. The United and SIPCO have a common marketing agency. United "manages" the SIPCO members' fresh potato acres and SIPCO "manages" the United members' processing potato acres.

To perform its objective, the United Fresh Potato Growers of Idaho developed and started enforcing a set of programs and policies that targeted both production and marketing of fresh potatoes (i.e. potato supply management program). The level of potato production is controlled through implementation of two policies. First, before the beginning of a planting season, the potato production is controlled by enforcing the acreage management program, which is implemented through the bid buy down program. Secondly, during the potato growing season, before harvest, the production is monitored over time and accurate yield prediction is performed; this is implemented through a series of field digs. The marketing programs include coordinating potato shipments throughout a marketing year (i.e. potato flow control program), providing marketing information to potato growers and implementing secondary marketing strategies. The latter are intended to remove excess supply of already produced potatoes.

Coordination of Potato Production

The first year acreage management program was implemented in spring 2005 and by June 2005 the number of planted fresh potato acres was reduced by approximately 15% (26,000 acres) relative to 2004 (the base year). The program proceeded in two phases. First, a group of largest potato growers voluntary and with no compensation reduced their planted area by 11,000 acres (15% on average). Secondly, the first ever buy bid down program was implemented. Potato growers were submitting bids on how much they needed to be compensated in order not to plant, and the United Fresh Potato Growers of Idaho accepted the best bids. This helped affordably reduce potato acreage. The first year bid buy down program was financially supported by the United Potato Growers of America. Currently the program is enforced according to the recommended planting guidelines as approved by both the United Fresh Potato Growers of Idaho and United Potato Growers of

America Boards of Directors. These guidelines are also supported by all United Potato Growers of America Cooperatives.

The 2007-2008 United Acreage Reduction Program establishes the following rules[16]. The basic potato acreage assessment is $50 per base acre. A cooperative member or any grower willing to participate in the program has two options. The first option is to reduce potato planting area by 15% relative to the 2004 year base. This option would be a payment in kind and the grower owes no cash if he reduces the planting area by exactly 15%. The second option is to reduce potato acreage by less than 15% relative to the 2004 year base. In this case, the grower is assessed a pro-rated percentage of $50 per acre on all his base acres. This money is used to "buy out" acres elsewhere in Idaho. Growers who decide to expand without base are assessed $100 per acre on all acres (expansion plus base acres).

Base acres are acres that had potatoes planted on them since the 2003-2004 crop year, regardless of whether or not these acres were registered with the United. Acres without base are those that did not have potatoes planted on them since the 2003-2004 crop season. Planting on acres without base is considered a "mindless expansion" as this strategy takes advantage of the improved market conditions facilitated by the programs implemented by the United.

If a grower is willing to expand, the following strategies are possible. First, he can buy or rent acres with base. In this case, the grower has to participate in the United's programs (i.e. reduce planting by 15% or pay a pro-rated $50 per acre assessment). Secondly, the grower can plant his full 2004 base by paying $50 per acre. The collected money will be used to buy acres elsewhere in Idaho. Thirdly, the grower can buy or rent acres without base or accelerate the normal rotation of crops resulting in planting acres without base. This type of behavior is considered to be illegitimate and against the mission of the United because it leads to over production and represents the threat to the success of the United. A disincentive to this type of conduct (i.e. "mindless expansion") is that in this case the grower has to pay $100 per acre on all acres (base plus expansion acres).

Coordination of Potato Marketing

The main components of the marketing program of the United are the potato flow control throughout a marketing year and exchange of marketing information. Before the cooperative was organized, uncoordinated potato flow to the fresh potato market often resulted in over supply of potatoes leading to low potato prices and high potato price volatility.

[16] This summary is based on information presented in the 2007-2008 United Acreage Reduction Program basic definitions and ground rules.

To control the quantity of potatoes supplied to the market throughout a marketing year, the United instituted the potato flow control program in January 2006. Warehouses participating in this program represent more than 75% of the state's potato packing capacity. Warehouses enter information on the capacity, stocks and pack-outs on the web-page of the United on a regular basis. This information along with other information (prices, demand and supply trends, weather, etc.) is discussed during the conference calls twice a week at the state level and once a week at the national level. The results of these discussions are summarized in a price advisory which is posted on the internet. The price advisory information is used as the pricing strategy for the coming week.

Another marketing activity of the United is negotiation of potato contracts with processors. For example, in 2006 crop year, members of the United who entered the contracts with the dehy companies received an additional 25-cent premium to the price received by non-members, which was $3.00 for Russet Burbank and $2.75 for Russet Norkotah.

To remove excess supply of already produced potatoes, the United implements secondary marketing programs. An effectively executed secondary marketing strategy at the beginning of 2005 removed approximately 8% of potato stock from the market. A 2004 year potato surplus was diverted to charities, food banks and as dehydrated potatoes used for humanitarian services. One of the successfully used marketing opportunities was winning the USDA procurement contracts.

Hypotheses

The effects of the potato supply management program are reflected in the behavior of fresh potato prices, as prices are indicators of the effectiveness of economic performance of market players like the United. If programs and policies of the United were effective, than the pattern of fresh potato price behavior in the period when the United is in the market is different from the pattern of price behavior in the period before the cooperative was organized.

The effective implementation of the acreage management program targeting the number of potato acres planted is expected to result in higher fresh potato prices. Therefore, our first hypothesis to be tested is that fresh potato prices are higher during the period when the United is in the market relative to the period before the United was organized.

The effective implementation of marketing strategies, in particular, the potato flow control throughout a marketing year, is expected to result in less volatile fresh potato prices. Therefore, our second hypothesis is that fresh potato price volatility is

lower during the period when the United is in the market relative to the period before the United was organized[17].

Data and Descriptive Statistics

Data

Two different sources of data are used in the analysis. First, we use Idaho monthly fresh potato prices received by potato growers; these prices are for the period of January 2003 – January 2008. Given that Idaho has the largest share in the national potato production, we also use the US monthly fresh potato prices for the same period, that are likely to reflect the effects of the United's programs and policies. These prices are reported by the National Agricultural Statistics Service, and represent prices aggregated across all potato varieties and all potato grades. The prices are reported in $ per hundredweight (cwt).

Secondly, we use weekly shipping point prices for Russet Burbank reported by the Agricultural Marketing Service. These are the prices received by entities involved in potato shipping (i.e. potato growers-shippers and independent potato shippers). The shipping point under consideration is Upper Valley Twin Falls-Burley, District Idaho, which is the major potato shipping point in Idaho. As mentioned earlier, Russet Burbank is the major potato variety produced in Idaho and it represents almost 50% of all potato acres planted nationally. As there are different prices associated with different grades of potatoes, we decided to analyze the most demanded grade, US No.1[18]. In particular, we focus on size A 70 counts and size A 80 counts. These potatoes are sold in 50 pounds cartons containing 70 potatoes and 80 potatoes, respectively. The US No.1 potato size A 70 count is 9-15 ounces and size A 80 count is 8-13 ounces. These prices are measured in $ per a 50 pound carton. The shipping point prices are collected for the period of October 2002 to March 2008. The Agricultural Marketing Service reports a low and a high price corresponding to each week; in our analysis we use the average of these two prices.

Descriptive Statistics

The descriptive statistics for the analyzed prices are presented in Table 5 and the price-series are presented on Figure 3 and Figure 4. The price level and price volatility are calculated for a period before the United was organized (the pre-coop

[17] The most recent industrial organization studies focusing on illegal collusive conduct developed theories and tested a hypothesis suggesting that that price variance during collusion may be lower than during non-collusive periods; some empirical support to this hypothesis was found (Athey et al 2004, Connor 2005, Harrington and Chen 2006, Abrantes-Metz et al 2006, Bolotova et al 2008).
[18] The US Standards for Grades of Potatoes (1991) distinguish the following grades of potatoes: US Extra No.1, US No.1, US Commercial, US No.2 and Unclassified. One of the major differences among these grades is in terms of the diameter and weight of potato tubers.

Table 5: Descriptive Statistics –US and Idaho Monthly Fresh Potato Prices and Idaho Weekly Shipping Point Prices

Period	US	ID (the minimum and maximum potato production cost* is in the parentheses; $/cwt**)	Russet Burbank	
			70s	80s
	monthly prices ($/cwt)		weekly prices ($/50 lbs carton)	
Price level				
Pre-coop period	7.78	3.89 (4.63 - 5.23)	8.86	7.73
Coop period	10.19	6.63 (5.17 – 5.96)	10.11	9.87
Coop Price/Pre-Coop Price	**1.31**	**1.70 (1.10 -1.16)**	**1.14**	**1.28**
Overall Sample	8.89	5.15	9.44	8.72
Price variance				
Pre-coop period	2.27	1.12	4.97	2.85
Coop period	3.21	0.56	3.53	3.20
Coop Variance/Pre-Coop Variance	**1.42**	**0.50**	**0.71**	**1.12**
Overall Sample	4.12	2.73	4.67	4.14
Coefficient of variation				
Pre-coop period	0.19	0.27	0.25	0.22
Coop period	0.18	0.11	0.19	0.18
Coop CV/Pre-Coop CV	**0.95**	**0.41**	**0.76**	**0.82**
Overall Sample	0.23	0.32	0.23	0.23

Data sources: National Agricultural Statistics Service and Agricultural Marketing Service.
Coefficient of variation is calculated as the ratio of standard deviation to the mean.
The US and Idaho monthly fresh potato prices: the pre-coop period is January 2003 – September 2005 and the coop period is October 2005 – January 2008. The total number of observations is 61; the pre-coop period is represented by 31 observations and the coop period is represented by 28 observations.
The Idaho Russet Burbank weekly shipping point prices: the pre-coop period is mid-October 2002 – mid-August 2005 and the coop period is October 2005 – mid-March 2008. The total number of observations is 257; the pre-coop period is represented by 138 observations and the coop period is represented by 119 observations.
* Potato production costs are calculated using information presented in Patterson (2004, 2008) and Patterson and Smathers (2005, 2006).
** 1 cwt (hundredweight) = 100 pounds.

period) and for a period when the United is in the market (the coop period). In the case of the US and Idaho monthly prices, the pre-coop period is January 2003 – September 2005 and the coop period is October 2005 - January 2008. In the case of the weekly shipping point prices, the pre-coop period is mid-October 2002 to mid-August 2005, and the coop period is October 2005 – mid-March 2008. A newmarketing year usually starts in September – October and ends in late August following year. No potato shipping occurs during a few weeks around August – September.

The pre-coop period is chosen such that approximately the same number of observations is available for the pre-coop and coop periods. In the case of the US and Idaho monthly fresh potato prices, the total number of observations is 61; the pre-coop period is represented by 31 observations and the coop period is represented by 28 observations. In the case of Russet Burbank weekly shipping point prices, the total number of observations is 257; the pre-coop period is represented by 138 observations and the coop period is represented by 119 observations.

Although the United was formally organized in November 2004, we consider that fresh potato prices started to reflect the effects of the United's policies and programs in October 2005, when the new marketing season began. This explains our decision on using October 2005 as a date distinguishing the pre-coop and coop periods. Descriptive statistics analysis provides evidence suggesting that the average price during the coop period is higher than the average price during the pre-coop period. The Russet Burbank 70 counts weekly prices increased from $8.86 per a 50 lbs cartoon in the pre-coop period to $10.11 per a 50 lbs carton in the coop period. The Russet Burbank 80 counts weekly prices increased from $7.73 per a 50 lbs cartoon in the pre-coop period to $9.87 in the coop period. The Idaho fresh potato monthly

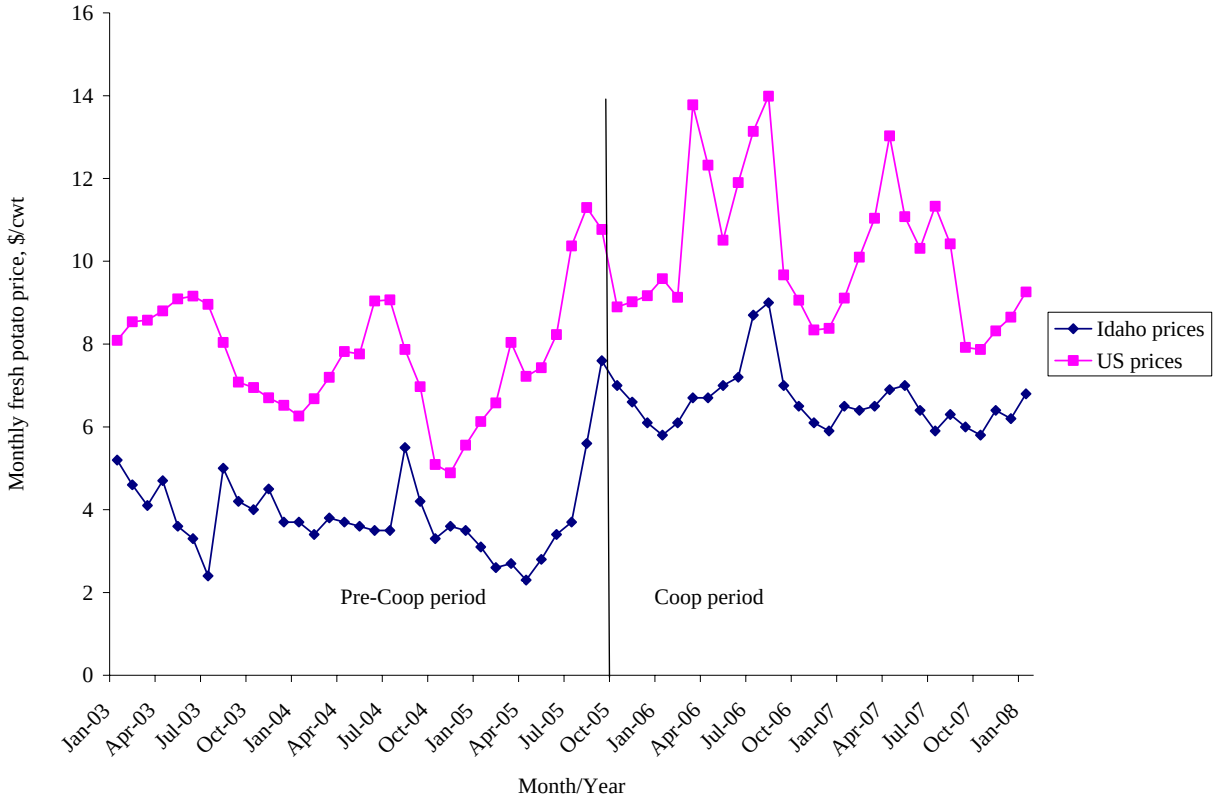

Figure 3: US and Idaho Monthly Fresh Potato Prices, January 2003 – January 2008
Data Source: National Agricultural Statistics Service.

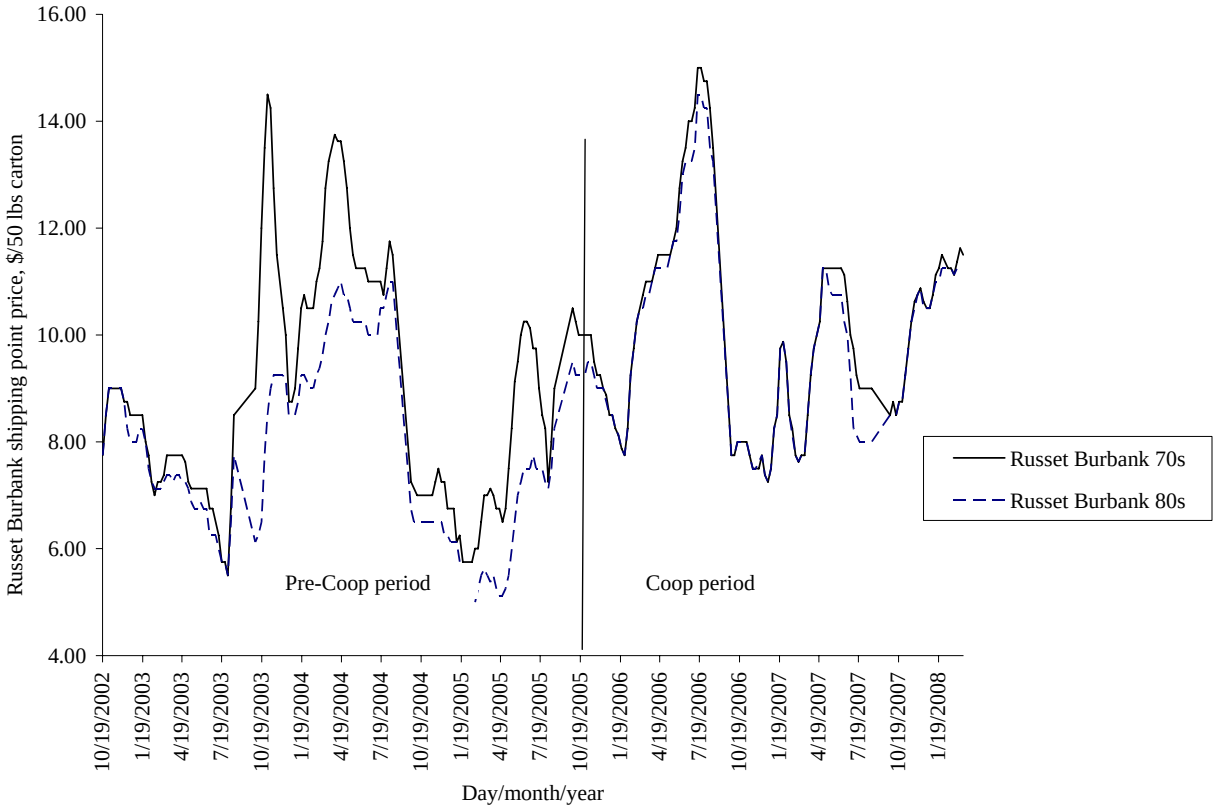

Figure 4: Idaho Russet Burbank Weekly Shipping Point Prices, October 2002 – March 2008
Data Source: Agricultural Marketing Service.

prices increased from $3.89 per cwt in the pre-coop period to $6.63 per cwt in the coop period, and the US fresh potato monthly prices increased from $7.78 per cwt to $10.19 per cwt.

The evidence on the price variance change between the pre-coop and coop periods is mixed; it depends on the price-series under consideration and the statistic used to calculate the price variance. We use two statistics to calculate the price variance effect; these are the variance and coefficient of variation. The coefficient of variation is the ratio of standard deviation to the mean; therefore, it takes into account both the mean and variance effects. In the case of all analyzed price series, coefficients of variations are smaller in the coop period relative to the pre-coop period, which suggests that prices are less volatile in the coop period relative to the pre-coop period. As for the variance, Idaho monthly fresh potato prices and Russet Burbank 70 counts weekly shipping point prices exhibit lower variance in the coop period relative to the pre-coop period. In contrast, US monthly fresh potato prices and

Russet Burbank 80 counts weekly shipping point prices exhibit higher variance in the coop period relative to the pre-coop period.

If we compare the US and Idaho monthly fresh potato prices, the magnitude of the price mean and price variance changes is higher for Idaho rather than for the US. While the US monthly fresh potato price increased by 31%, the Idaho fresh potato prices increased by 70%. Furthermore, while the US fresh potato price variance increased by 41%, the Idaho fresh potato price variance decreased by 100%.

The identified changes in the price level and price variance may not be due solely to the impact of the United. Other important market factors were likely to contribute to these changes, and increasing potato production cost represents the most significant factor. To conduct a more precise evaluation of the effect of the United on fresh potato price behavior, we attempt to isolate the effect of changes in the potato production costs by comparing the potato price increases with the potato cost increases during the analyzed periods (Table 5).

In our analysis we use the 2004 potato production cost as a proxy for the pre-coop period potato production cost; this year represents the highest level of potato production costs during the pre-coop period. A proxy for the coop period potato production cost is calculated as the average over the last three years (i.e. 2005-2007). We observe that the potato production cost increases between the pre-coop and coop periods, and the cost increase falls in the range of 10% to 16% (Table 5). Using the Idaho monthly fresh potato prices, we conclude that while the fresh potato prices received by growers increase by 70% on average, potato production costs increase by 10%-16% on average (Table 5). Consequently, approximately 54% to 60% in the Idaho monthly potato price increase is due to other than potato production cost market factors, and the impact of the United is likely to be the most significant factor explaining the identified price increases.

Descriptive statistics corresponding to the yearly data on potato production and prices in the nine leading potato producing states and the US (Table 2) also provide some evidence suggesting that the average level of production was lower and the average level of price was higher in the coop period relative to the pre-coop period. Another important observation is that both the production and price volatility is considerably lower in the coop period relative to the pre-coop period. If we compare the average price volatility during the coop period across the nine analyzed states, Idaho apparently has the lowest potato price volatility, while during the pre-coop period Idaho had one of the highest potato price volatilities.

We should note that the analyzed yearly data are associated with the total potato production, both fresh and processing. However, given that fresh and processing markets are connected, the identified changes in the yearly data are likely to reflect some effects of programs and policies of the United Fresh Potato Growers of Idaho,

United Potato Growers of America and other potato cooperatives with similar objectives.

In summary, there is evidence suggesting that fresh potato prices were higher and less volatile in the coop period relative to the pre-coop period. To conduct a more critical evaluation of the identified changes in the price level and volatility and test the statistical significance of these effects, we use econometric analysis.

Empirical Models

To quantify the effect of the programs and policies of the United Fresh Potato Growers of Idaho on fresh potato price behavior (price level and price volatility), we use extended versions of the traditional autoregressive conditional heteroscedasticity (ARCH) model and the generalized autoregressive conditional heteroscedasticity (GARCH) model[19]. A distinct feature of these time-series econometric techniques is that they allow for simultaneous estimation of the conditional mean and conditional variance processes over time[20].

The original ARCH(m) model is represented by equations [1] and [2] and the original GARCH(r,m) model is represented by equations [1] and [3][21]. Equation [1] describes the conditional mean process and equations [2] and [3] describe the conditional variance process in the ARCH and GARCH models, respectively. If these models are applied to analyze prices, then the current price level (p_t) is modeled as a function of the past prices (conditional mean equation) and the current price variance (h_t *or* u_t^2) is modeled as a function of the past price variances (conditional variance equation).

[1] $p_t = \psi_0 + \psi_1 p_{t-1} + \psi_2 p_{t-2} + ... + \psi_m p_{t-m} + u_t$ [22]

[2] $u_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-2}^2 + ... + \alpha_m u_{t-m}^2 + w_t$ [23]

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[19] The ARCH model was originally introduced by Engle (1982) and was generalized by Bollerslev (1986).

[20] The models assume that unconditional variances are homoscedastic and conditional variances are heteroscedastic and depend on the variances in previous periods.

[21] A noise process u_t satisfying the variance equation [2] is described as an autoregressive conditional heteroscedastic process of order *m*, denoted as ARCH(m). Correspondingly, GARCH(r,m) describes the *r*-th and the *m*-th orders of the two components of the autoregressive conditional variance processes specified in equation [3].

[22] u_t is a white noise, $E(u_t) = 0,\ E(u_t u_s) = \sigma^2$ for $t = s$ and 0 otherwise.

[23] w_t is a new white noise process, $E(w_t) = 0,\ E(w_t w_\tau) = \lambda^2$ for $t = \tau$ and 0 otherwise. The sufficient stationarity (regularity) condition requires $\alpha_0 > 0$ and $\alpha_j \geq 0$ for all $j \leq m$.

[3] $h_t = \xi + \delta_1 h_{t-1} + \delta_2 h_{t-2} + ... + \delta_r h_{t-r} + \gamma_1 u_{t-1}^2 + \gamma_2 u_{t-2}^2 + ... + \gamma_m u_{t-m}^2$ [24]

To analyze the effects of policies and programs of the United on the fresh potato price level and volatility, we extend the traditional ARCH and GARCH models to allow for structural shifts due to the cooperative's policies and programs[25]. We introduce a binary variable ($Coop_t$) in both the conditional mean and conditional variance equations[26]. This variable is equal to 1 if a price observation belongs to the coop period and it is equal to 0 if a price observation belongs to the pre-coop period[27].

The estimated ARCH and GARCH models with a structural shift due to the effects of the United are represented by equations [4] and [5] and equations [4] and [6], respectively. Equation [4] describes the conditional mean process and equation [5] describes the conditional variance process in the extended ARCH(1) model applied to the US and Idaho monthly fresh potato prices. Equation [4] describes the conditional mean process and equation [6] describes the conditional variance process in the extended GARCH(1;2) model applied to the Russet Burbank weekly shipping point prices[28].

[4] $p_t = \psi_0 + \psi_1 p_{t-1} + \lambda p_{t-1} Coop_t + \chi Coop_t + u_t$

[5] $u_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \eta Coop_t + w_t$

[6] $h_t = \xi + \delta_1 h_{t-1} + \gamma_1 u_{t-1}^2 + \gamma_2 u_{t-2}^2 + \mu Coop_t$

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[24] $u_t = \sqrt{h_t} v_t$ and v_t is i.i.d. with a zero mean and a unit variance. The sufficient stationarity (regularity) condition requires $\xi > 0$, $\delta_i \geq 0$ for all $i \leq r$, $\gamma_j \geq 0$ for all $j \leq m$ and $\sum_{t=1}^{r} \delta_t + \sum_{t=1}^{m} \gamma_t \leq 1$.

Calculation of the sequence of conditional variances { h_t } for *t=1* to *t=T* requires their pre-sample values. They are calculated as a sample average of the squared predicted residuals for each pre-sample observation in the T sequence (Bollerslev 1986; Hamilton 1994).

[25] Bolotova et al (2008) used a similar approach to examine the impact of illegal collusion on price level and volatility in the US citric acid and lysine markets.

[26] We assume that this binary variable acts as an intercept and as a slope shifter in the conditional mean equation.

[27] The discussion of the pre-coop and coop periods is presented in a previous section presenting descriptive statistics analysis.

[28] ARCH and GARCH models are alternative empirical techniques. A number of ARCH(m) and GARCH(r;m) models was applied to each price series and results were compared. The reported results are those for the models with the best fit.

ψ_0, ψ_1, λ, χ are the conditional price mean equation coefficients to be estimated; α_0, α_1, η are the ARCH model conditional price variance equation coefficients to be estimated, and ξ, δ_1, γ_1, γ_2, μ are the GARCH model conditional price variance equation coefficients to be estimated. χ is a coefficient measuring the effect of the United on the fresh potato price level. η and μ are the coefficients measuring the effect of the United on the fresh potato price variance in the ARCH and GARCH model, respectively.

If the United is effective in enforcing its policies and programs, we would expect the estimated coefficient for the coop binary variable in the conditional price mean equation to be positive. Furthermore, we would expect the estimated coefficient for the coop binary variable in the conditional price variance equation to be negative.

Estimation Results

The ARCH and GARCH estimation results are presented in Table 6. The ARCH (1) model was used to analyze the US and Idaho monthly fresh potato prices. The GARCH (1;2) model was used to analyze the Russet Burbank weekly shipping point prices. The estimated coefficients have expected magnitude and many of them are statistically significant.

Table 6: The ARCH(1) and GARCH(1;2) Models Estimation Results – US and Idaho Monthly Fresh Potato Prices and Idaho Weekly Shipping Point Prices

Variable	US	ID	Russet Burbank	
			70s	80s
	monthly prices ($/cwt*)		weekly prices ($/50 lbs carton)	
	ARCH(1)	ARCH(1)	GARCH (1;2)	GARCH (1;2)
The mean equation: the dependent variable is price level				
Lagged price (PL)	0.919[a] (9.15)	0.543[a] (3.04)	0.966[a] (40.85)	0.969[a] (78.68)
PL*Coop	-0.346[a] (-1.87)	-0.220 (-0.97)	-0.049[a] (-2.05)	-0.051[a] (-4.12)
Coop binary variable (Coop)	**3.564[a] (1.98)**	**2.526[a] (2.24)**	**0.579[a] (2.68)**	**0.591[a] (5.67)**
Constant	0.750 (0.95)	1.757[a] (2.60)	0.309[c] (1.43)	0.288[a] (2.80)
The variance equation: the dependent variable is price variance				
Constant	0.648[a] (3.62)	0.444[a] (2.95)	0.280 (0.89)	0.018[a] (3.32)
Squared error, 1st lag	-0.002 (-0.02)	0.760[a] (2.18)	0.009 (0.38)	-0.011[a] (-6.70)
Squared error, 2nd lag			-0.015[b] (-1.47)	-0.002[a] (-2.07)
Conditional variance, 1st lag			0.280 (0.34)	0.923[a] (30.69)
Coop binary variable (Coop)	**1.443[a] (2.40)**	**-0.336[a] (-2.19)**	**0.001 (0.03)**	**0.011[a] (3.53)**
Log-Likelihood function value	-87.63	-59.54	-237.84	-195.71
Number of observations	60	60	256	256

The entries in the cells are the estimated coefficients with the Z-statistics in the parentheses.
[a] The estimated coefficient is statistically significant at a 10 percent level of probability of Type I error using a two-sided Z-test. Ho: ß=0 and Ha: ß≠0. The Z-statistic rejection regions are (-∞;-1.64] and [1.64; ∞).

[b] The estimated coefficient is statistically significant at a 10 percent level of probability of Type I error using a one-sided Z-test. The null hypothesis Ho: ß>0 is rejected in favor of the alternative hypothesis Ha: ß≤0. The Z-statistic rejection region is (-∞; -1.28].
[c] The estimated coefficient is statistically significant at a 10 percent level of probability of Type I error using a one-sided Z-test. The null hypothesis Ho: ß<0 is rejected in favor of the alternative hypothesis Ha: ß≥0. The Z-statistic rejection region is [1.28; ∞).
[*] 1 cwt (hundredweight) = 100 pounds.

The major interest is on the interpretation of the coefficient for the Coop binary variables in the price mean and price variance equations. These coefficients measure the hypothesized effects of the programs and policies of the United Fresh Potato Growers of Idaho on the fresh potato price level and volatility. The estimated coefficients for the Coop binary variables in all four price equations are positive and statistically significant. The magnitude of this coefficient across the four analyzed price series seems to be affected by the level of data aggregation and by the units of measurement. The magnitude of the coefficient is higher in the case of monthly prices ($ per cwt) and is lower in the case of weekly shipping point prices ($ per a 50 lbs carton).

According to the ARCH (1) model applied to the Idaho monthly fresh potato prices, the United policies and programs are likely to contribute to a $2.53 per cwt increase in price between the pre-coop and coop period. As Idaho has the largest share in the US value of production and similar policies on stabilization of potato supply started being enforced in other states the same year, these actions were likely to contribute to a $3.56 per cwt increase in the US level fresh potato price between the pre-coop and coop periods. The Russet Burbank weekly shipping point prices under consideration (70 and 80 counts 50 pounds cartons) increased by almost $0.6 per a 50 pounds carton between the pre-coop and coop period. All these price increases are statistically significant. Therefore, we find empirical support to our hypothesis suggesting that enforcement of the potato supply stabilization program by the United resulted in an increase in the fresh potato prices.

As for the effect of the United's potato supply stabilization program on the fresh potato price volatility, the empirical results are mixed and depend on the price series under consideration. The fresh potato price variance is lower in the coop period relative to the pre-coop period only in the case of Idaho monthly fresh potato prices, and this effect is statistically significant. The US level monthly fresh potato prices exhibit a higher price variance in the coop period relative to the pre-coop period and this effect is statistically significant. These monthly price series variance effects are consistent with the descriptive statistical analysis results.

In the case of the Russet Burbank weekly shipping point prices, 80 counts price series exhibits a higher price variance in the coop period relative to the pre-coop period and this effect is statistically significant. This shift in variance is similar to the descriptive statistical analysis results. The Russet Burbank 70 counts price

series exhibits a higher price variance in the coop period relative to the pre-coop period, but this difference in price variance is not statistically significant. Further, we can interpret this result as a failure to reject the null hypothesis of a non-positive variance shift under a one-sided test of the variance hypothesis. In summary, there is some limited empirical evidence suggesting that the fresh potato price variance is reduced due to implementation of the potato supply management program.

Conclusion

High potato price volatility, decreasing demand for fresh potatoes and potato prices below the cost of production led to a decision of a number of Idaho potato growers to organize United Fresh Potato Growers of Idaho, a marketing cooperative. The United was founded in November 2004, representing 85% of fresh potato growers in Idaho. The goal of the cooperative is to stabilize the supply of potatoes in order to provide a fair level of returns to all potato growers.

We evaluate the effectiveness of the programs and policies of the United. We analyze the patterns of price behavior during two periods, before the cooperative was organized and during the period when the cooperative is in the market. Prices are indicators of the economic performance of market players like the United. If the United enforced its programs effectively, then fresh potato prices would reflect these effects. We use monthly Idaho and US fresh potato prices and weekly Idaho Russet Burbank potato prices to conduct this analysis.

The major program implemented by the United is the potato supply stabilization program which targets both production and marketing of fresh potatoes in Idaho. The fresh potato production is coordinated through the potato acreage management program and the fresh potato marketing is mostly coordinated through the potato flow control program.

If the potato acreage management program targeting the number of potato acres planted was implemented effectively, then we would expect to observe a fresh potato price increase. Currently the cooperative reduces the number of potato acres planted relative to 2004 year. Given that potato industry participants face the inverse demand schedule, a reduction in the number of potato acres would lead to a fresh potato price increase. We find strong empirical support to this hypothesis. Idaho monthly fresh potato prices were 70% higher in the coop period relative to the pre-coop period.

This price increase is not totally due to the actions of the United. Increasing potato production costs are likely to contribute to the identified price increase. Following the most conservative evaluation of potato production costs, we found that the potato production cost increases between the coop and pre-coop periods fell in the

range of 10% to 16%. Consequently, approximately 54% to 60% in the monthly Idaho fresh potato price increase is due to other than potato production cost market factors, and the impact of the United is likely to be the most significant factor explaining the observed price increase.

If the potato flow control program coordinating the flow of potatoes to the market throughout the marketing year is effective, then we would expect it to impact the fresh potato price volatility. In addition, exchange of marketing information and secondary marketing programs would contribute to this effect. In particular, effective implementation of these programs would lead to a lower level of potato price volatility. We find some empirical support to this hypothesis. Idaho monthly fresh potato prices were less volatile during the coop period relative to the pre-coop period. Furthermore, before the cooperative was organized, Idaho had had the most volatile potato prices as compared to other major potato growing regions in the country. During the period when the United was in the market, Idaho had the least volatile prices.

Given that Idaho is a dominant player in the US potato industry and other potato growing regions started following similar strategies, the US level monthly fresh potato prices are likely to reflect the effects of the United and cooperatives with similar objectives. We find that the US monthly fresh potato prices were 31% higher in the coop period relative to the pre-coop period; the national level effect is weaker than the Idaho level effect.

Therefore, based on empirical evidence presented in the paper, we conclude that programs and strategies of the United Fresh Potato Growers of Idaho directed toward stabilization of potato supply in Idaho have been effective thus far. The programs implemented by the United led to higher prices and a reduced price risk for Idaho potato growers. As indicated by the US monthly fresh potato prices, all potato growers received higher prices since 2005, after the acreage management program started being implemented in several potato growing regions in the country.

We do not argue that the identified changes in the fresh potato price level and volatility were totally due to the efforts of the United and similar cooperatives. Other factors, such as potato yield variation, increase in potato production costs and changes in the domestic and foreign demand may have contributed to the observed effects. However, by analyzing a wide array of related economic variables and connecting the patterns of their behavior to the programs and strategies of the United, we believe that the United Fresh Potato Growers of Idaho and potato growers cooperatives with similar objectives were successful in accomplishing their goals and impacted the fresh potato price level and volatility during the period of 2005-2008, which benefited all potato growers.

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