MARKET CONCENTRATION IN U.S. MILK PROCESSORS AND HIS INFLUENCE AT PRICE PAID TO COW MILK PRODUCERS

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Abstract

In this paper, we analyzed the influence of the four American biggest milk processors into the price paid to producers from 2002 to 2013. Also, we tried to identify the parameters to explain the change in prices paid to producers. The results suggest a moderate concentration. Besides, the industrial concentration of four biggest firms shows a causal flow on the milk's national price in short time (one year) and that the causal flow in the opposite direction in two years, evidently due to the milk's production cycle, i.e., the insertion of new milk plants producing in the production cycle will have an impact after a relatively long time, which explains the short-term inelasticity. In other hand, we can see that the international prices have an important influence to U.S. prices paid to producers, indicating some auction characteristics of this product, too confirmed by the influence of the variation of industrial concentration of the four biggest milk processors in this country.

Keywords: Milk, Granger Causality, U.S Prices

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1 Introduction

Milk is a one of the most important foods for the man and is a very important industry for society in actuality. According to FAOSTAT (2015), the world produced 1.4 trillion of pounds of cow´s milk in 2013, and the world production increased 37,80% in the last 20 years. The U.S. was the largest cow's milk producer in the world in 2013, producing 201 billions of pounds, accounting for 14.3% of world production, an increase of 31% when compared to 1994.

In the U.S., the farmer-owned cooperatives have an important role in this industry. For example, Severson (2015) quotes that the top 50 dairy cooperatives represent almost 80 percent of the milk market in this country. The American milk industry is highly competitive, although the federal government establishes minimum prices that we must pay to producers.

In this sense, Mansfield & Yohe (1988), quotes that the market is classified in economics as perfect competition, regarding any condition: i) the product sold by any salesman is the same as any other's; and ii) each participant in the market is so small when compared to the market that he cannot affect the product's price. Or yet, in a simpler manner, as stated by Wessels (1997): this is a market that owns a well standardized commodity that is produced by many companies, with no barrier into the market, information equality and identical firms.

The point now is to verify some of the have conditions that make the milk market of this country being classified as competitive and, as such, having an auction-like features. Wessels (1997) adds that in market analysis, there is a key-distinction, in order to identify the cause and the resulting effect; and he adds that in perfect competition its elementary behavior is price - determining both the offer and the demand of such commodity.

In other hand, we can analyze the milk market through of the lenses of Industrial Organization (that was also called Industrial Economy, in Great Britain and Europe). This vision is not recent, where the central focus of this study is: (i) competitive, as the engine of most modern markets, and (ii) the power of monopolies, that interfere with the good results of competition (de Jong & Shepherd, 2007). The Industrial Organization also focuses on the study of public policies, where the first studies analyzed the governmental policies, in order to prevent the existence of monopolies, to eliminate, or at least restrict, the effects of the existing monopolies. The public policy studies mainly include: antitrust policies, in order to prevent or reduce the power of monopoly; regulation, so as to contain the natural monopolies; deregulation, which removes restrictions, hoping that the competition will grow, and the creation of estates that seek to support the public interest when competition does not work.

However, a growing research area, within the Industrial Organization, is identifying the industrial concentration level, where one seeks understanding the relationship between the concentration level and this industry's price/profitability ratio, where much

evidence point to a positive relationship between market concentration and the sector's profitability (Peltzman, 1977). The basic assumption for this purpose is that high concentration enables collusion and, as a consequence, the manipulation of market prices.

The author quotes that the relationship between the market structure and production costs is long known. In this sense, a technological breakthrough in a not concentrated industry can produce a natural monopoly since there will be an increase of the operational efficiency through time, generating competitive advantages for a specific organization. On the other hand, according to the author, the process through which old technology becomes economically obsolete also implies a reduction (or at least no increase) of the offered goods. Whatever force is operating this system, it is crucial to understanding what the concentration level is, so as to control the excessive power of some firms within its industry.

Industrial structure and industrial concentration issues have concerned economists and politicians for at least a century (Jacquemin & Slade, 1989), while the industrial concentration level is tightly connected to the margins firms keep in the market, since competitiveness drops according to the increase of concentration level, creating opportunities for firms to price in a differentiated manner. The market concentration analysis, on the other hand, of a specific industry, stems from the idea of how it is distributed in terms of production and participation of their firms, in a determined market. In this context, Bain & Qualls (1968) define industrial concentration according to property, considering the control of a great proportion of aggregates of economic resources or activities, by a small companies' proportion.

George (1983) states that the industrial concentration regards the size distribution of firms that sell a specific product, with a significant dimension of the market structure, for having an important role regarding a company's behavior and performance. Besides, the number and size distribution of these firms influence the expectations regarding the competitors' behavior. In this context, Possas (1985) comments that the industrial concentration is closely linked to the internal profit accumulation and corporate technical progress.

According to Bain & Qualls (1968) the market structure regards the organizational features that determine the relationships with the agents, being an important part of the competitive environment of firms, in order to influence the competitors' pattern. For the author, this means that the market structure features have a strategic influence on the nature of competition and in determining prices in the market

Considering this problem, and considering the hypothesis that the concentration level increases represent a decrease in the industry competitiveness, creating opportunities for firms to price differently, we established the following research problem: how the concentration level of major American milk processors influences the price paid to milk producers in this country? Additionally, we tried to evaluate the concentration level is co-integrated with the price and if have a Granger's causality in this market.

Alexander (2001) comments that, unfortunately, many market experts still ground their analysis of relations between markets on the very limited concept of correlation. According to the author, modeling the complex interdependencies between assets with such a restrictive tool is like browsing the web on an IBM-AT. Restrictively to the correlation analysis, there is the co-integration test.

The author quotes that if spreads present a reversion to average, then the variables are connected, in the long-term, by a common stochastic trend and, in that case, we can say that prices are co-integrated. According to the author, since Engle & Granger (1987) seminal work, co-integration has become the predominant tool for time series econometrics. In this sense, co-integration has emerged as a powerful technique to investigate multi-varied time series and provides with a solid methodology in order to model long and short term dynamics in a system.

According to Harris (1995), the economic interpretation for co-integration is defined as a set of variables that have a long-term balanced relationship. As a consequence, even if the series might have stochastic trends (i.e., non-stationary), they would move together in time and the difference between them will be stable (i.e., stationary). All in all, the concept of co-integration indicates the existence of a long-term balance for which the economic system converges in time.

Alexander (2001), quotes that the Granger's causality concept does not depend on the existence of co-integration, although it is sufficient. When time series are co-integrated there should be a Granger-like causal flow in the system. Co-integration is not essential for there to be exposed and offset relations: it may be that the causal flows exist between time series because they have some other common features. The term "Granger's causality" means that there is an exposure and offset relation between variables in multi-varied time series. According to the author, it is expected that the exposure and offset relation are present in co-dependent relations that can be observed in many financial markets.

According to Carneiro (1997), the most popular causality test in literature is due to the econometrist Clive Granger, who assumes that the future must not cause the past or the present. For example, if event A occurs after event B, we know A must not cause B. Simultaneously, if A occurs before B, that does not mean that A necessarily cause B. The classic example is the one of rain forecasts by meteorologists. The fact that the forecast happens before the rain does not mean that the weatherman causes it to rain. In practice, we have two-time series, A and B, and we would be interested in knowing if A precedes B, or B

precedes A, or if both A and B occur simultaneously. That is the essence of the Granger's causality test that does not intend to identify a causality relation in terms of its endogeneity.

2 Material and Methodology

Measuring concentration is necessary to analyze the market structure in an industry and, thus, to identify relevant elements in this structure, such as competitiveness and barriers to entrance, among others. These elements interfere in the conduct and performance of these firms, as well as in the structuring of the market itself. In order to address the problem of this research, we analyzed the data using two methods that demonstrate the concentration level of companies in their markets: the Partial Concentration Rate (CR) and the Hirschman-Herfindahl Index (HHI).

2.1 Partial Concentration Rate (CR)

According to Barthwal (2007), market concentration is an important element of market structure which plays a dominant role in determining the behavior of a firm in the market. By market concentration we mean the situation when an industry or market is controlled by a small number of leading producers who are exclusively or at least very largely engaged in that industry. Two variables that are of relevance in determining such situation are: (i) the number of the firms in the industry, and (ii) their relative size distribution. How these two dimensions cause different form of the market structure having vital consequences for the pricing and output decisions of the firms. In this sense, the partial concentration rate index measures the proportion represented by a fixed number of the largest companies of an industry when compared to the total of such an industry. Its calculation is as follows:

$$Cr\ (k) = \sum_{i=1}^{k} Pi \qquad (1)$$

where k is the number of companies that are part of the calculation and Pi = participation of the i-th company in the market.

The index is easy to interpret since it varies from 0 (zero) to 100. The closer it gets to 100, the higher the industry concentration is, i.e., if a small number of companies responsible for a big proportion of production, sales, or employment in the industry, that means that the concentration will be higher. In this research, we will use the measure Cr (4), where the four largest companies will be considered in this analysis. In this context, Bain & Qualls (1968), analyzes the market concentration classifying markets into: Cr (4) equals or higher than 75%: highly concentrated oligopoly; Cr (4) between 50% and 74%: moderately concentrated oligopoly; Cr (4) between 25% and 49%: weakly concentrated oligopoly; and Cr (4) lower than 25%: atomistic.

2.2 Herfindahl-Hirschman Index (HHI)

HHI is defined by the sum of squares of the participation of each company when compared to the industry's total size. This index considers all the companies in the industry and is calculated as follows:

$$HHI = \sum_{i=1}^{n} Pi^{2} \qquad (2)$$

where P is the market share of firm i in the market, and n is the number of firms.

The Herfindahl Index (H) ranges from 1/N to one, where N is the number of firms in the market. Equivalently, if percents are used as whole numbers, as in 75 instead of 0.75, the index can range from 10,000/n, when companies have an egalitarian participation in the market, up to 10,000 (monopoly). The HHI increases, according to the increase of inequality among the companies belonging to the industry, thus being a good indicator of the market situation. Do note that the company size is considered by its squared participation (Pi), i.e., smaller companies have a smaller role in this index.

Thus, the higher the index, the more concentrated the market is, and, as a consequence, smaller the competition among companies is. According to Cetorelli (1999), the market is not concentrated when the HHI value is below 1,000, it is moderately concentrated between 1,000 and 1,800, and it is highly concentrated when it reaches a value higher than 1,800.

In order to answer this research's problem, we carried out a time descriptive research where we used the average prices paid to milk to producers in The USA, deflected by the Consumer Price Index. Another variable of this study was the participation of each firm in the national offer for milk, on a yearly basis from January 2002 to December 2014. Then, we verified the data series' stationarity using a unit root test, where we used the Augmented Dickey-Fuller methodology (ADF). Afterward, we performed the Engle-Granger test in order to co-integrate the yearly deflected milk price and Herfindahl-Hirschman Index (HHI) of each country. In order to verify the possible existence of a causal flow, we performed the causality Granger test on a yearly basis.

3 Results and Discussion

Using the information of USDA/NASS (2015), we obtained the cow milk production in billions of pounds, per State, as shown on Table 1. We can see in this table that only four states (California, Wisconsin, Idaho and New York) produces around 50% of the United States, showing that production is concentrated in these states.

Table 1. Cow milk production, in million pounds, per state between January 2002 and December 2014 and Herfindahl-Hirschman Index and Cr (4) for the cow milk production in the four biggest producers

State	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
CA	42	42	42	41	40	40	41	41	39	38	36	35	35
WI	28	27	27	26	26	25	24	24	23	23	22	22	22
ID	14	14	14	13	13	12	12	12	11	10	9	9	8
NY	13	13	13	13	13	12	12	12	12	12	12	12	12
USA	**206**	**201**	**199**	**196**	**193**	**189**	**189**	**185**	**182**	**176**	**171**	**169**	**170**
CR (4)	47%	46%	48%	48%	48%	47%	48%	48%	47%	47%	46%	46%	46%
HHI	**694**	**665**	**668**	**669**	**665**	**654**	**680**	**730**	**658**	**654**	**651**	**633**	**617**

CA=California; WI=Wisconsin; ID=Idaho; NY=New York ;
Source: USDA/NASS. (2015)

Table 1 shows that both indexes (HHI and Cr (4)) point to a high concentration of the milk production in California, Wisconsin, Idaho and New York, these four states are accounted for 46% of the total cow milk production in 2002, remaining at a level close to 47% in the following years. The Table 1 shows that the cow milk production has grown 21.16% between 2002 and 2014 (from 170 billion pounds to 206 billion pounds in 2014). This growth can be partially explained by the increase of exports. According to USDEC (2014), exports were equivalent to 15.5% of U.S. milk production in 2013, thus implying more pressure on milk demand.

In order to verify the causes of that grown of milk production, we separated in growing productivity and growing of a number of cows, as showed in Table 2. To separate both effects we use the information of 23 selected states and equations (3), (4) and (5):

$$\Delta P = \Delta PPC + \Delta QC \quad (3)$$

$$\Delta PPC = (PPC_t - PPC_{t-1}) \times QC_{t-1} \quad (4)$$

$$\Delta QC = (QC_t - QC_{t-1}) \times PPC_t \quad (5)$$

where ΔP is the variation of the production total in a year, ΔPPC is the effect of variation in productivity per cow and ΔQC is the effect of variation of the quantity of head of cows.

Table 2. Number of cows, production, and productivity per cow, by year, to the 23 selected states between 2002-2014

	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003*	2002*
Cow (thousands)	8,567	8,551	8,500	8,449	8,355	8,409	8,495	8,322	8,246	8,138	8,081	7,775	7,773
Production per cow***	22.3	22.3	22.0	21.6	21.4	20.8	20.7	20.5	20.2	19.9	19.2	19.0	18.9
23 states production	**193.2**	**190.6**	**186.6**	**182.7**	**179.1**	**175.3**	**175.9**	**170.7**	**166.6**	**161.6**	**155.4**	**147.9**	**146.6**
USA production	**206.0**	**201.0**	**199.4**	**196.2**	**192.8**	**189.3**	**189.0**	**185.6**	**181.8**	**175.8**	**170.8**	**169.3**	**170.1**
% 23 states in The USA	94%	95%	94%	93%	93%	93%	93%	92%	92%	92%	91%	87%	86%
Δ of total production	2.5	4.0	3.9	3.6	3.9	-0.6	5.1	4.1	5.1	6.2	7.5	1.3	nd**
Δ per number of cows	0.3	1.1	1.1	2.0	-1.1	-1.8	3.5	1.5	2.1	1.1	5.8	0.1	nd**
Δ per productivity	-0.3	2.9	2.8	1.6	5.0	1.2	1.6	2.5	2.9	5.1	1.7	1.2	nd**

** for 20 selected states ** data not available *** in thousands*
Source: USDA (2015)

Table 2 shows that the number of cows for 23 selected states (Arizona, California, Colorado, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, New Mexico, New York, Ohio, Oregon, Pennsylvania, Texas, Utah, Vermont, Virginia, Washington and Wisconsin) increased 10% (794,000 cows) between 2002 and 2014. This growth implicates in increased 15.87 billions of pounds of milk for this period (sum of Δ per number of cows for this period). The same table shows that the production per cow increased 18% between 2002 and 2014, this growth was responsible by 28.23 billions of pounds of milk and represented 61% of total variation in this period. In Table 3 we show the production of the four largest companies.

Table 3. Production of the 4 largest milk companies in billions of pounds

Company	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
Dairy Farmers America	39.4	39.2	39.0	37.8	37.7	37.6	37.6	36.7	35.9	36.0	35.8	35.1
Dean Foods	26.7	26.5	26.0	26.0	26.0	26.0	26.7	25.3	24.8	24.9	24.9	24.5
California Dairies Inc.	16.9	16.9	16.8	16.9	16.9	17.6	16.9	16.1	15.2	15.2	14.5	14.6
Land O' Lakes Inc.	12.9	13.0	13.0	12.9	12.7	12.5	12.3	12.3	11.9	11.9	12.2	12.2
Total	**95.9**	**95.5**	**94.8**	**93.6**	**93.3**	**93.7**	**93.5**	**90.4**	**87.8**	**88.0**	**87.5**	**86.5**

Data not available for 2014.
Source: IFCN Dairy Report (2014)

On Table 3 we can see that three of four companies (Dairy Farmers America, California Dairies Inc. and Land O' Lakes Inc.) are cooperatives. On the same table, we can see that the four companies were responsible for to process 95.9 billions of pounds of cow milk in 2013 (increased 11% between 2002 and 2013). These results point to a possible moderate concentration in this industry. In table 4 we showed the market share and Herfindahl-Hirschman Index and the international prices paid to producers.

Table 4. Market share and Herfindahl-Hirschman Index of the 4 largest milk companies and U.S. and Europe´s price paid to producers

Company	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002
DFA*	20%	20%	20%	20%	20%	20%	20%	20%	20%	21%	21%	21%
Dean Foods	13%	13%	13%	13%	14%	14%	14%	14%	14%	15%	15%	14%
California**	8%	8%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Lakes Inc.***	6%	6%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%
Total Share	**48%**	**48%**	**48%**	**49%**	**49%**	**50%**	**50%**	**50%**	**50%**	**52%**	**52%**	**51%**
HH-Index	**673**	**676**	**689**	**688**	**710**	**715**	**745**	**725**	**736**	**784**	**790**	**760**
International Price	**20.69**	**16.08**	**19.37**	**16.30**	**12.82**	**18.14**	**20.97**	**10.61**	**10.28**	**9.82**	**8.10**	**6.35**
U.S. Price	**19.61**	**18.52**	**20.14**	**16.10**	**12.27**	**17.55**	**19.20**	**12.64**	**14.88**	**15.86**	**12.10**	**12.05**

** DFA=Dairy Farmers of America ** California = California Dairies Inc. ***Land= O' Lakes Inc.*
Data not available for 2014
Source: IFCN (2013)

On Table 4 we evaluate the market participation of the 4 largest firms for milk processors, from 2002 to 2013, where these firms kept 51% in 2002. In this table, we can see that the industrial concentration level (HH-Index) decreased significantly in this period. In this period (2002 – 2013), the market showed to be moderately concentrated, since in 2013, the four companies represented around 48% of the volume produced. This decreased occurs during the increased of the price paid to milk producers, potentially influenced by the decreased of the power of the companies. In order to verify the impact of this concentration, we analyzed the Granger's causality test between the industrial concentration and the national price of milk paid to producers, from 2002 to 2013.

After the industrial concentration analysis, we applied the unit root test to milk price and milk's domestic offer. According to Gujarati & Porter (1999), stationarity is a necessary condition in order to perform Granger's and co-integration causality tests. In this research, we used the so-called Augmented Dickey-Fuller statistic (ADF), as suggested by Dickey & Fuller (1979), in order to test the presence of a unit root in the series. The results of the unit root tests are shown in Table 5, where we simulated a model, including a constant, a trend and a lag (τ_τ), a model, including a lag and a constant (τ_μ) and a model with no constant and no trend (τ).

Table 5. Results of the Augmented Dickey-Fuller unit root test for the null hypothesis stating that U.S. milk prices and the HH - Index are not stationary

Tτ	Tμ	T	Tτ	τ μ	T
Milk – domestic price			Herfindahl-Hirschman Index		
-7.004***	-0.9675**	-0.5718***	-1.8532***	-0.1999**	-0.01866*

**indicates that the null hypothesis is rejected at a 10% significance. **indicates that the null hypothesis is rejected at a 5% significance. ***indicates that the null hypothesis is rejected at a 1% significance.*

We can see in Table 5 that the null hypothesis stating that milk prices paid to U.S. producers and Herfindahl-Hirschman Index are not stationary was rejected; thus, we performed the Engle and Granger procedure, as shown in Table 6.

Table 6. Engle-Granger test for co-integration of the milk prices paid to U.S. producers with the Herfindahl-Hirschman Index of the 4 largest milk companies, on a yearly basis

	Estimate	Standard deviation	*t* value	Pr(>|t|)
(Interception)	839.812	54.202	15.494	0.000
Prices paid to U.S. producers	-7.264	3.349	-2.169	0.055

The Engle-Granger test showed an adjusted R2 equal to 0.252, where the *p*-value of the f test showed to be significant at a 95% confidence. Note that, in Table 6, the prices paid to producers is co-integrated with the Herfindahl-Hirschman Index of the 4 largest milk companies, on a yearly basis. This cointegration refers to co-movements in milk prices paid to producers and the industrial concentration of the milk processors. According to Alexander (2001), the fundamental aim of cointegration analysis is to detect any common stochastic trends in the price data, and to use these common trends for a dynamic analysis of the correlation, in this case with the HH-Index. The results indicated a linear combination in these series. The cointegration between these series could show insights about the multivariate behavior of variables. In Table 7, we show the Granger's causality test between the national price of milk paid to producers and Herfindahl-Hirschman Index, from 2002 to 2013.

Table 7. Granger's causality test between the national price of milk paid to producers and Herfindahl-Hirschman Index, from 2002 to 2013

	milk [national price] Granger-causes milk [HH-Index]		HH-Index [industrial concentration] Granger- causes milk [national price]	
# lags	*f* Test	R^2	*f* Test	R^2
One	2.10346***	0.28949	4.07285***	0.81583
Two	8.60955***	0.78934	0.99521***	0.83898
Three	0.73374***	0.79566	0.01118***	0.83806

**** significance level 1%; ** significance level 5%; * significance level 7%.*

It is observed that the national price of milk paid to producers Granger causes industrial concentration (HH-Index). Although it there was no for one lag, it became existing and stronger for two lags (R^2 0.79 and p-value equals to 0.02). These results can be explained by two possible reasons: if the price paid for milk producers increases, the costs for processors increases, and if is no possible to pass to final consumers, the rentability of this firms fall and a capacity for new investments are influenced to these four firms. In other hand, these results offer an opportunity for others firms make a new investment in new processors plants of milk, but the decrease of market share of these four firms will occur when this new plants of milk processors comes into operation, possibly in a period greater than one year, because it takes some time for the new plants produces milk on a significant scale. These factors explain the relative inelasticity pointed out for this product.

On the other hand, the industrial concentration (HH-Index) Granger-causes the milk's national price in a significant manner for a next year. In this sense, the change in the industrial concentration reflects a loss of power of these four firms and, as a consequence, the power of manipulation of market prices. This result is particularly important since it denotes an opportunity to the dairy farmers increase their earnings. In order to estimate the effect of the decreased of industrial concentration, we used the ordinary least squares method (OLS), as showed in Table 8. In this analysis, we use the market share of four largest milk companies because is highly correlated with the HH-Index of these companies (correlation=0.9945, sig.=0.9950).

Table 8. Regressors and significance of this least squares model's coefficient to explain the yearly milk prices paid to U.S. producers, using the market share of four largest milk companies and the international prices

Regressors	Coef.	Stand.Error	Sig. *t*- test	VIF	[95% confidence interval]	
Constant	74.0499	34.4543	0.0843		33.9699	114.13
Market Share in *t*-1	-1.5251	0.6802	0.0750	1.021	-2.3577	-0.693
International Price´s	-0.9123	0.2357	0.0117	1.021	0.678	-1.147

We can see in Table 8 that all values for the *t*-test were significant; whereas the White test no rejected the null hypothesis for the model's for no heteroscedasticity (square-chi = 5.4241 and sig. = 0.3663). The Doornik and Hansen's residual normality test (Doornik & Hansen, 2008) no rejected the null hypothesis of equality in data distribution to a normal distribution (square-chi = 5.5002, with *p*-value = 0.0639). The test of autocorrelation is not rejected the null hypothesis for the model (statistics= 0.1374 and sig.= 0.7296), where the null hypothesis indicates no autocorrelation.

The obtained model showed a determination coefficient (adjusted R^2) of 0.821461, i.e., 82.15% of the total variance in the price of milk was explained by the market share (in t-1) of four largest milk companies and the international milk price´s, just like the f test (58.4725 and sig. 0.0003) shows that at least one of the independent variables has an influence on the dependent variable, considering the model to be significant as a whole. We would like to point out that the VIF index points to the non-existence of multicollinearity, since, according to Hair et al.(2006), a very common reference value is that a VIF value greater than 10 denotes high collinearity.

The coefficient of Market Share in *t*-1 was negative, thus indicating that a decreased of 1% of market share of these companies implies an increase a US$ 1.5251 of milk prices paid to producers – this fact corroborates the economic theory. In other hand, the International Prices paid to producers (in this case, we used as a proxy the price paid to the European producers) was a positive, thus indicating that an increased of US$ 1.00 international prices implies an increase a US$ 0.9123 of milk prices paid to U.S. producers. This result indicates a strong influence of international prices of milk in the price paid to U.S. producers. This internationalization of national prices is because an important part of U.S. production (15.5%, in 2013) is exported, especially to Europe.

4 Conclusion

In this work, we sought to empirically verify the cause-effect relation between the milk's price and industrial concentration of four biggest companies of milk processors in the U.S., from 2002 to 2013. Also, we tried to identify the parameters to explain the change in prices paid to producers.

The results from this work suggest that the industrial concentration of four biggest firms shows a causal flow on the milk's national price in short time (one year) and that the causal flow in the opposite direction in two years, evidently due to the milk's production cycle, i.e., the insertion of new milk plants producing in the production cycle will have an impact after a relatively long time, which explains the short-term inelasticity.

In other hand, we can see that the international prices have an important influence to U.S. prices paid to producers, indicating some auction characteristics of this product, too confirmed by the influence of the variation of industrial concentration of the four biggest milk processors in this country.

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