J. Agr. Sci. Tech. (2018) Vol. 20: 857-867

Price Transmission Analysis in Iran Fluid Milk Market

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ABSTRACT

This study investigates the price transmission in the Iranian fluid milk market. We applied a Markov-switching vector error correction model on the monthly price data from March 2003 to December 2015 to allow for multiple regime shifts in the relationship between farm and retail prices. According to Granger Causality Test, there is one side causality relation from producer's price to consumer's price. Due to the existence of positive price asymmetry in farm-retail price transmission, the retail prices would incline more quickly in response to increases in farm price than to its decreases, implying serious welfare losses to the consumers. Main results show existence of a positive price asymmetry in the market. In the long run, price transmission is perfect, while in the short run, price adjustment between two market levels is asymmetric. On the other hand, retailers benefit from any shock that affects supply or demand conditions.

Keywords: Farm and retail prices, Markov-switching model, Price asymmetry.

[DOR: 20.1001.1.16807073.2018.20.5.3.3]

INTRODUCTION

In recent years, price transmission analysis spatially or vertically among separated markets has increasingly been drawn by methods that account not only for common non-stationary but also for nonlinear dynamics in co-integration relationship of price series. An important sign of the market power to be referred to is the existence of price asymmetries, indicating an unbalanced relationship between price increases and decreases for a product in the farm and retail markets. If the price transmission is asymmetric among the specific stages of the supply chain, the price changes will not be affected quickly at the production level through the processing and/or retail level. Furthermore, price asymmetries could be negative or positive, depending on their consequences. A positive (negative) price asymmetry occurs when a decrease (increase) is not immediately transmitted in prices at the farm level; whereas, an increase (decrease) would influence final consumer rapidly (Meyer and von Cramon-Taubadel, 2004; Vavra and Goodwin, 2005).

Asymmetric price transmission is crucial because it influences welfare negatively (Meyer and von Cramon-Taubadel, 2004; Hahn, 1990). Prices allow producers and consumers to decide synchronously, and also leave the doors open for scarce resources to be allocated influentially. The transition from a planned to a market economy mostly gets price liberalization come into play. However, price liberalization not only improves resource allocation but also brings about higher price instability in comparison with an administrative system with fixed prices. This is especially true for farm prices which are characterized by relatively high volatility, being mainly overshadowed by some key

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factors such as: seasonality, weather effects, and inelastic demand and supply of the agricultural products. The policymakers often intervene into the markets to reduce price volatility. In Iran, government plays a critical role in setting dairy products' prices.

According to Peltzman (2000), both competitive and oligopolistic market structures simply can never be pointed to as a cogent reason for presence of asymmetric price transmission; hence, it could not get market power recited. However, a great deal of research has implied market power, as the most important cause for intense transmissions of price increases (Bernard and Willet, 1996; Aguiar and Santana, 2002). As indicated by Peltzman (2000), asymmetric price transmission is a rule rather than the exception, and scholarly works mostly have revealed that asymmetric price transmissions are quite common, especially in agriculture (Meyer and von Cramon-Taubadel, 2004; Frey and Manera, 2007). For example, Goodwin and Holt (1999) noted that the direction of causality in agricultural supply chains flow from the farm to the retail level. Asche *et al.*, (2007) found a high degree of price transmission in the supply chains as well as integrated markets for Salmon fish. According to Bernard and Willet (1996), downward movements in wholesale price are passed on more quickly to growers in contrast with increasing wholesale price through broiler industry in the US, where the concentration ratio of the processors were high over 1983-1992 , the industry is vertically integrated and the production is mostly done under contracts. Vavra and Goodwin (2005) understood that there was a significant asymmetry in the farm, wholesale and retail chain, in the US beef, chicken, and egg industries.

Once we consider the dairy products, an empirical literature has shown similar results regarding the existence of asymmetric price transmission. Serra and Goodwin (2003), for instance, found limited asymmetries in sterilized milk in the Spanish dairy industry, while Capps and Sherwell (2005) observed that decreasing milk prices would be adjusted slowly, though the mentioned adjustment is strongly expedited when it comes to jumping milk prices at the farm level in the seven cities of US. Lass (2005) discovered that retail milk prices do not change as much as price increases and decreases, consequently, it would lead to an increase in marketing margin, according to evidence of short-run price asymmetries in the retail milk price in the northeast of US. Fernández-Amador *et al*. (2010) analyzed the dairy sector in Austria and found asymmetries in price transmission of milk products. Other researchers recognized similar asymmetries by applying different econometric methodologies; Acosta and Valdes (2013) in Panama, Falkowski (2010) in the Polish fluid milk sector, and Rezitis and Reziti (2011) in the Greek milk market have carried out this prodigy.

This study investigates the price asymmetry in Iranian fluid milk market. Although price asymmetry has been regarded as a popular field for most of agricultural economists, it is not being scrutinized practically. Moreover, due to its effect on community health, increasing the share of milk in Iranian households' food expenditure is of high priority for government and that's why it has been directly involved in milk price setting in recent decades. Hence, the type and magnitude of relationship between farm and retail price of milk is an important question from policy making point of view that can contribute to better management of milk marketing process. The selling price of milk with standard quality at the farm gate was around 12,000 Rial (0.33 USD), but, the price of retail milk in the market shelves was around 16,200 Rial per liter (0.45 USD), in Iran, December 2015 (Central Bank of Iran, Nov. 2017). It reflects that Iran government has paid attention especially to milk retail price among food program items to be sure that most people have access to milk, as an important protein source.

Since the price relations are presumably affected by the numerous policy changes during the observation period, the method must be able to capture the structural breaks which might result from the frequent changes. Hence, we apply a Markov-switching vector error correction model, enabling us to examine these structural breaks in the price adjustment process. We identify different regimes which correspond to different parameters for the short-run and long-run price adjustments and, likewise, for the residual variances. These regimes allow us to explain the vertical price transmission in transition periods and, finally, discuss the regime probabilities and the relation among market structures. From the milk producers' side, this study provides helpful information on sensitivity of producers' welfare with respect to any change in milk retail price that may arise from subsidy reduction.

An Overview of Fluid Milk Production Trend

In the World

Milk production globally is derived from cows, buffaloes, goats, sheep and camels. During the five years analyzed (2002 to 2007), world milk production annually rose (by 13 percent) to 697 million tons, making for an aggregate increase of 81 million tons or 15 million tons per annum. China, India and Pakistan are mentioned as the countries which had almost two third of the figure; additionally, the remaining contribution belonged to Brazil, Egypt, New Zealand, Turkey and, the US. Together, these eight countries, totally got approximately 85 percent of all milk volume growth provided over 2002 to 2007, (IFCN-2008).

According IFCN (International Farm Comparison Network) Dairy Report 2008, the major milk production regions are:

- Southern Asia: 23 percent of global production, mainly India and Pakistan.
-EU: 21 percent, mainly Germany and France.
-US: 12 percent
-CIS: 10 percent, mainly the Russian Federation and Ukraine.
-Latin America: 10 percent, mainly Argentina, Brazil, Colombia and Mexico.
-East and Southeast Asia: 8 percent mainly China and Japan.
-Africa: 5 percent, mainly Egypt, Kenia, South Africa and Sudan.
-Oceania: 4 percent.

Table 1.Milk production by region over 1989-2014 (million tons).

Region		Annual growth (percent)	
	1989	2014	1989-2014
Developed countries	378.6	253.9	-1.2
- Former centrally planned economies	146.8	76.2	-1.8
- Other developed countries	232.8	177.7	-0.9
East and Southeast Asia	10.1	57.7	18.1
- China	6.4	49.8	26.1
- Rest of the East and Southeast Asia	3.7	7.9	4.4
Latin America and the Caribbean	40.7	81.8	3.9
- Brazil	14.7	35.3	5.4
- Rest of the Latin America	26.1	46.5	3.0
South Asia	68.0	200.5	7.5
	51.4	146.3	7.1
- India			
- Rest of South Asia	16.6	54.2	8.7
Total	497.4	593.9	0.75

Source: FAOSTAT (2017).

-Near and Middle East: 4 percent, mainly Iran and Turkey.

Figure 1, shows the evolution of milk production in developed and developing countries over the past several decades. As can be seen, milk production related to developing countries has grown more sharply, in contrast with developed countries. Developing countries have contributed much more compared to the developed ones, since late 1980s. Centrally planned economies have suffered a sharp decline in production at the beginning of the transition process, while production in the rest of the developed world has grown only slowly.

As Table 1 demonstrates, different countries have contributed variously. The real growth pole of this arena among developing countries has been South Asia, being jumped monotonously. Today, India is considered as a third largest developing country in the field of milk production providing 16 percent of global production. Latin America and the Caribbean is the second-largest regional producer, although it has had a slower trend in comparison with South Asia. East and Southeast Asia, especially China, have experienced dramatic pace of milk production over the past decade, whereas, regional production levels are still lower than South Asia and Latin America.

In Iran

Iran is one of the most important milk producers in the Middle East. The total milk production annually is approximately more than 10 billion liters (Ministry of Jehade Keshavarzi, 2017). About 90 percent of this figure comes from cows and the rest goes to goat, sheep, and buffalo. As shown in Table 2, milk production was 2.8 million tons in 1982 and after a decade with 4.29 percent annual growth reached to more than 4 million tonnes. Milk production exceeded 5.7 million tons and experienced an annual growth of 4.25 percent in 2002. In 2011, the total production exceeded 10 million tons, 58 percent increase in comparison with 2002. The annual per capita consumption of milk and milk products changed from 69 liters in 1982 to 95-100 liters in 2007; a figure that was lower than European countries.

Generally speaking, production cost of milk is high in Iran and raw milk producers work with low-profit margin, mainly due to

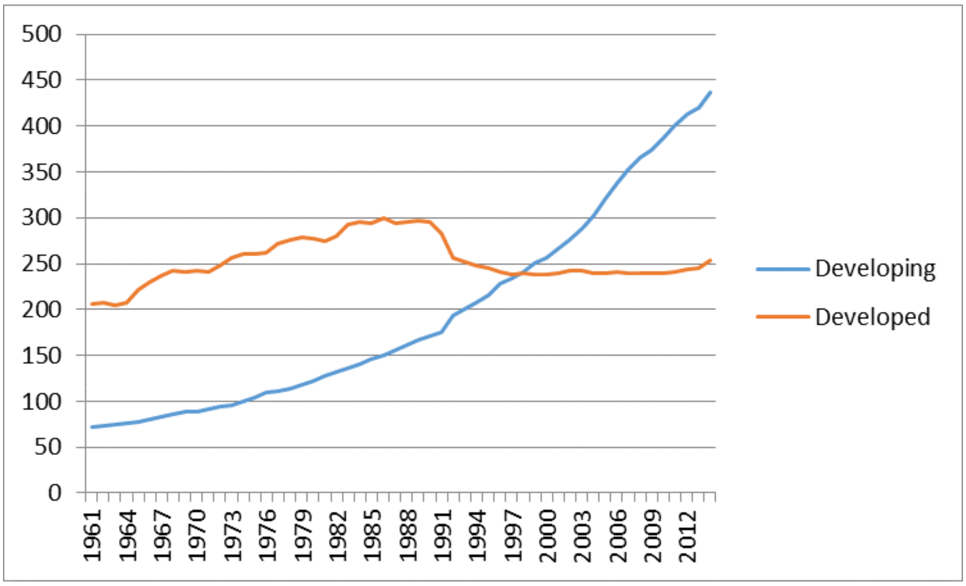

Figure 1. World milk production over 1961- 2012 (million tons).

Table 2. Milk production trend in Iran, 1982-2011.

Year	Production (000 tones)	Growth (%)
1982	2800	-
1992	4035	41.4
2002	5748	25.4
2007	8772	36.4
2010	9552	8.9
2011	10700	12

Source: Ministry of Agriculture-Jihad.

the costs of feed and other services. Production based on contract is common in the dairy sector and the producers sell their raw milk to major processors; consequently, there is a high concentration of processors. This indicates that raw milk producers encounter an unfair competition in the market. Also, price is mainly determined independently by the industrial processors without any regard of production cost. However, the producer revenue consists of sale of the milk and the animal which naturally would make the cost of production undoubtedly important.

One of the discontents of the raw milk producers is that rise in raw milk price is significantly lower than that of production cost. The competitive environment for drinking milk in Iran remained unite and consolidated in 2015, as several key manufacturers were able to effectively cover most of the country. However, state-owned Pegah Dairy Company, which has subsidiaries in most of the provinces of Iran, could remain the market leader, accounting for 25% of sales value. The company is active mainly in fresh milk and benefits from a wide distribution network. A total of 17 companies are responsible for the processing of raw milk and other dairy products in Iran while another 27 companies are responsible for sales and exports. These companies get the largest distribution chain for dairy products formed in the country. Thus, it is easily understood that the value is acquired not in the production stage but in later stages of the supply chain. In other words, the real winners are not the producers but those holders who are in the last rings of supply chain, where the goods are delivered to final consumers.

This study was aimed to investigate the price asymmetry in Iranian fluid milk market.

MATERIALS AND METHODS

Markov-Switching Vector Error Correction Model

The Markov-Switching Vector Error Correction Model (MSVECM) is a special case of the general Markov-switching vector autoregressive model which was initially proposed by Hamilton (1989) for analyzing the US business cycle. The applicability of this model is, however, not restricted to this specific research question; consequently, it can be viewed as a general framework for analyzing times series with different regimes whenever the corresponding state variable is not observed. Krolzig (1996, 1997) developed the MSVECM as a special case of the more general Markov-switching vector auto-regression model, whereas Hall *et al*. (1997) deployed MSVECM to deal with house prices in the United Kingdom. Twenty nine Applications of the model are mainly found in business cycle and financial research, e.g., Krolzig and Toro (2001), Francis *et al*. (2003) or Spagnolo *et al*. (2004), the latter suggesting further applications. Krolzig *et al*. (2002) and Krolzig and Toro (2001) use the MSVECM to analyze business cycles with a special emphasis on employment. Technical and mathematical complexities may be noted as sole limitation of this approach in practical applications.

The MSVECM can be characterized as a TAR (Threshold AutoRegressive) model with exogenous determination of the states, that is, the regimes are not mentioned as a function of the analyzed price series themselves but, as an external determinant which do not have to be observed. Such determinants might act as general driving forces of trade, prices and a

[DOR: 20.1001.1.16807073.2018.20.5.3.3]

number of further economic variables. Here, we exploit MSVECM to analyze vertical market integration between farm and retail levels of Iran fluid milk market. If the markets are integrated, a long-run relationship between the prices must exist. Emerging price changes in any level strongly tie with both short-run dynamics and the deviation from the long-run equilibrium, thus, the familiar vector error correction model would provide a congruent representation of the data generating process. However, coming into being frequent policy adjustments and changes in the net trade position, hierarchically structural changes gradually would emerge which renders the simple error correction model into an incongruent representation. According to the state of the system, MSVECM with shifts in some of the parameters, can be expected to be more appropriate in this setting:

$$\Delta P_t = \alpha_0(s_t) + \alpha(s_t)(\beta' p_{t-1}) + D_1(s_t)\Delta P_{t-1} + D_2(s_t)\Delta P_{t-2} + ... + D_k(s_t)\Delta P_{t-k} + \varepsilon_t \quad (1)$$

Where, $p_t = (p^f_t, p^m_t)$, is the vector of market prices for farm (superscript f) and retail (superscript r), respectively, α_0 denotes the vector of intercept terms, α is the vector of adjustment coefficients, β is the co-integrating (long-run equilibrium) vector, Δ indicates first differences, and $D_1, D_2, ..., D_k$ are matrices of short-run coefficients. The vector ε_t contains the residual errors of the farm and the retail equations. The state variable s_t, where $s_t = 1, …, M$, indicates number of M possible regimes governing the MSVECM at time t. However, the state of the system is not observed, the most general specification would make the probability of being in state s_t dependent on the entire history of regimes s_{t-1} and, on the history of all the variables in the RHS of Equation (1). This general specification would leave the system unidentified unless some constraints would be imposed. The basic idea of a Markov-switching model is to assume an ergodic Markov process for the probabilities of observing a certain state, consequently, the probability for s_t depends only on s_{t-1} and a matrix Π of transition probabilities.

$$\Pr(s_t \mid s_{t-1}, \Delta P_{t-1}, \beta' p_{t-1}) = \Pr(s_t \mid s_{t-1}, \Pi) \quad (2)$$

An element π_{ij} of Π gives the transition probability from state i to state j. Hence, the sum of each row of Π must be equal to 1. Thus, the number of unknowns in Π is equal to M (M-1).

The vector β does not vary between systems since the long-run equilibrium relation is assumed to be constant over time. However, the intercept term in Equation (1) changes over time so that there may be regime dependent changes in the margin. The estimation of the MSVECM is based on the maximum likelihood principle. The maximum of the likelihood function consists of the parameters in Equation (1), corresponding to dummy variables which indicate the value of the state variable s_t and transition probabilities p_{ij}. Krolzig (1997) advocated use of variant Expectation-Maximization algorithm (Dempster *et al*., 1977). This iterative procedure breaks the maximization down into two steps. Firstly, the state parameters and transition probabilities are estimated conditionally on a set of starting values for the coefficients in Equation (1). In the second step, the latter parameters are updated using the first order conditions for the maximization of the likelihood function with respect to the error correction model parameters. This sequence is repeated until the procedure converges, i.e. the state parameters no longer change between two subsequent iterations. The estimation procedure is available in the MSVAR package (Krolzig, 1998) for the matrix programming language Ox.

RESULTS AND DISCUSSION

Data and Unit Root Tests

The estimation results are based on 153 monthly observations (March 2003 to

December 2015) which point to average Producer Milk Price at farm (PMP) and Retail Milk Price (RMP) levels in Iran. Figure 2 gives an overview of the development of the price series. Due to strong consumer supportive policies, milk was delivered to consumers at prices near the producers' price before 2006. -

As a prerequisite for the co-integration analysis, we firstly established time series properties of the price series (in natural logarithm). The usual ADF test statistic is supplemented with an additional unit root test. For the latter test, we used Philips-Perron unit root test (Table 3).

Co-Integration Analysis

Initially, we applied the usual Johansen trace test for integrated variables. Test results illustrated that there was a long-run equilibrium relationship between the two price series. The long-run relationship (including a constant term) is given in Equation (3).

$LnRMP_t = -0.53+1.09\ LnPMP_t$ (3)

Stdv (0.13) (0.02)

Equation (3) recites that one percent increase in producer price will accompany 1.09 percent rise in retail price. Moreover, price transmission is significant. The corresponding adjustment coefficients in equation (standard errors in parentheses) are -0.14 (-2.76) for the consumer price and 0.01 (0.26) for the producer price. Deviations from the long-run equilibrium are obtained from the normalised co-integrating vector with respect to the retail price, both adjustment coefficients have the expected sign. Hence, the adjustment process which would incline to the long-run equilibrium, takes places through price changes for retail, being corrected within 7 months.

Markov-Switching Vector Error Correction Model

The estimated parameters of the final MSVECM are presented in Table 4. One interesting feature is drop in the speed of adjustment coefficients in comparison with the simple VECM. In this model, we assume that relationship between variables follows different structures in various periods. In this condition, individual periods are called

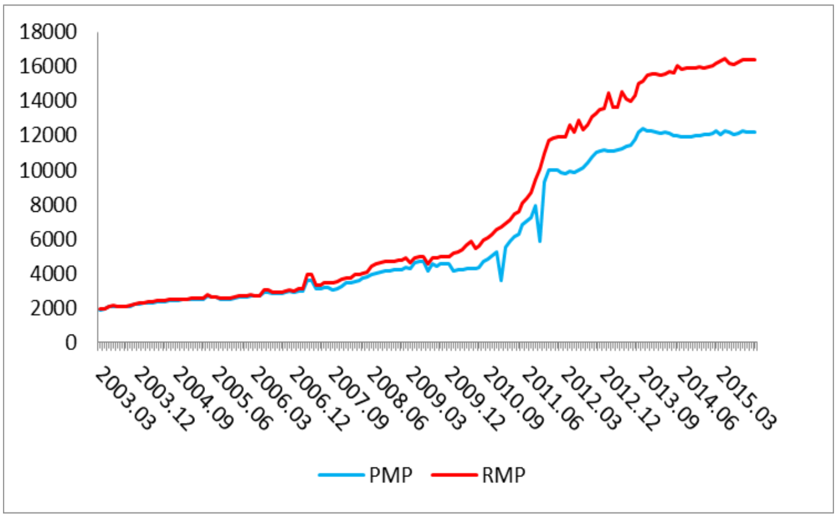

Figure 2. Evolution of fluid milk farm and retail prices in Iran (Rial kg^{-1}). PMP and RMP stand for producer and retail milk price, respectively. Source: FAO statistics database.

Table 3. Results of unit root tests.

	Augmented Dickey-Fuller			Philips-Perron		
Variable[a]	Test statistic	Specification	Probability	Test statistic	Specification	Probability
LnPMP	-2.4	3 Lags, constant, trend	0.38	-1.98	Constant, trend	0.60
LnRMP	-2.39	5 Lags, constant, trend	0.39	4.81	-	1.00
ΔLnPMP	-3.46**	2 Lags, constant	0.04	-9.97***	Constant, trend	< 0.0001
ΔLnRMP	-3.32**	4 Lags	0.04	-10.82***	Constant	< 0.0001

[a] *PMP* and *RMP* stand for Producer and Retail Milk Price, respectively. ** and ***: Denote significance at 5 and 1 percent, respectively.

Table 4. Markov-switching vector error correction model results.

Variable	Regime 1		Regime 2	
	ΔPMP_t	ΔRMP_t	ΔPMP_t	ΔRMP_t
Constant	-0.013	0.063	-0.013	0.063
ΔPMP_{t-1}	0.619 *	0.293 *	0.038	-0.039 *
ΔPMP_{t-2}	-0.208 *	-0.017	0.410 *	0.048
ΔPMP_{t-3}	0.432 *	0.044	0.508 *	0.068
ΔRMP_{t-1}	-0.299 *	-.030	-0.173	0.236 *
ΔRMP_{t-2}	0.043	0.51 *	-0.035	0.097
ΔRMP_{t-3}	-0.295	-0.221 *	-0.224 *	0.001
ECT_{t-1}	0.008	-0.041 *	0.004	-0.041
σ_ε	0.0056	0.0034	0.0170	0.0052

Source: Research findings. *: Significant at 5%.

regime. We used LR statistic so as to illustrate preference of nonlinear to linear model. The result demonstrates that the nonlinear model is adapted with the data.

The number of regimes and lags were determined according to Akaike information criterion. Therefore, a model with two regimes and three lags was finally chosen and estimated. Adjustment pace, residual standard errors and the resulting margin in the long-run relation (which may be calculated from the estimated coefficient for the regime-specific constant and the corresponding adjustment rate coefficient estimation) allowed a more detailed interpretation of the single regimes to be put. Two regime equations are as follows:

Regime 1

$$LRMP_t = -0.46+1.08\ LPMP_t \quad (4)$$

stdv (0.12) (0.01)

Regime 2 :

$$LRMP_t = -0.05+1.09\ LPMP_t \quad (5)$$

stdv (0.04) (0.004)

Table 5 contains the transition probabilities from regime s_{t-1} to regime s_t. Figures 0.95 and 0.97, in transition matrix, indicate the probability of lack of change in regimes. It is found that the two regimes are persistent i.e. lasting for a longer period of time, although regime 2 seems a little more persistent. Expected duration of both regimes was 20.53 and 33.17 which indicated the same result as regimes persistent.

Here, regime 2 points to data that relates to

Table 5.Transition matrix for the estimated MSVECM.

	Regime 1	Regime 2
Regime 1	0.95	0.05
Regime 2	0.03	0.97

Source: Research findings.

2003 until the end of 2006 and, also, 2013 to 2015; whereas, those following regime 1, refer to first of 2007 till the end of 2012. Thus, the type of relationship between the two series is dependent on policy actions that government adopts during the period. In other words, one should consider different relations prevailing in different periods and this is the novelty of current study in comparison with previous researches.

CONCLUSIONS

This paper analyzed vertical market integration for Iranian fluid milk market over the years 2003-2015. The analysis of the basic vector error correction model using Dickey-Fuller and Philips-Perron tests confirmed the structural instability of the model. So, we explore the usefulness of the Markov-Switching Vector Error Correction Model (MSVECM) for the case. We exploit this model in order to analyze market integration using 153 monthly observations from March 2003 to December 2015. The MSVECM specification was distinguished to be congruent representation which underlies the process, for the series of logarithmic price with three lags (in differences) and two regimes. This model assists appropriately in touching our goals i.e. we could separate impact of government policies on type and size of association between the two price series of interest. The results of this paper corroborate the view that retailers can exercise significant market power, as evidenced by asymmetric price responses in Iranian fluid milk market. From the milk producers' side, this study provides helpful information on sensitivity of producers' welfare with respect to any change in milk retail price that may arise from subsidy reduction. Due to the existence of positive price asymmetry in farm-retail price transmission, the retail prices would be inclining more quickly to increases in farm price than to decreases, implying serious welfare losses to the consumers. This result is also consistent with the empirical evidence of a significant market power in the milk market.

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تحلیل انتقال قیمت در بازار شیر ایران

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چکیده

این مقاله انتقال قیمت در بازار شیر ایران را بررسی می کند. مدل تصحیح خطای برداری مارکف سوئیچینگ با استفاده از داده‌های ماهانه قیمت شیر از فروردین ۱۳۸۲ لغایت آذر ۱۳۹۴ برآورد شده است. الگوی فوق اجازه بررسی ارتباط چند رژیمی بین قیمت تولیدکننده و قیمت خرده فروشی را می دهد. بر اساس آزمون علیت گرنجر یک رابطه علی یک طرفه از قیمت تولیدکننده به قیمت خرده فروشی تایید گردید. بدلیل وجود انتقال قیمت نامتقارن مثبت بین مزرعه و خرده فروشی، افزایش قیمت سریعتر از کاهش قیمت از سطح مزرعه به سطح خرده فروشی منتقل شده و این امر باعث زیان رفاهی مصرف کنندگان می شود. نتایج اصلی نشان می دهد یک رابطه مثبت نامتقارن در بازار وجود دارد. در بلند مدت انتقال قیمت بصورت کامل انجام می شود ولی در کوتاه مدت تعدیل قیمت بین دو سطح بازار نامتقارن است. به عبارت دیگر خرده فروشان از هر شوکی که شرایط عرضه و تقاضا را تحت تاثیر قرار می دهد منتفع می شوند.

[DOR: 20.1001.1.16807073.2018.20.5.3.3]