Economics Sanction and Barley Price Regime Change in Iran

Mohammad Mehdi Farsi Aliabadi

Ph.D. of Agricultural Economics, and Senior Researcher of National Water and Agricultural Strategic Research Center (NWASRC) of ICCIMA, Tehran, Iran
Email:mm_farsi22@yahoo.com; ORCID:https://orcid.org/0000-0002-6650-7344

Behzad Fakari Sardehaie
Ph.D. of Agricultural Economics, and Senior Researcher of National Water and Agricultural Strategic Research Center (NWASRC) of ICCIMA, Tehran, Iran
Email:jfakari@gmail.com; ORCID:https://orcid.org/0000-0003-3646-3421

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Abstract

In Iran, barley is considered the second-largest cultivated crop. However, more than 40% of Iran's requirements are imported from the international market. Due to the importance of barley in providing livestock feed and food security, its price variation is a critical issue for Iranian governments. Therefore, in this study, the influence of different determinants of domestic barley price, such as international price, real effective exchange rate variation, price volatility of barley, Russian-Ukrainian armed conflict, and the existence of economic sanctions, has been investigated by applying the Markov-Switching model. The main results indicated that in both states, the real effective exchange rate was the primary determinant of the domestic price. Moreover, the impact of international price in first state is much more powerful than the second state. Also, the results revealed that the persistence of US economic sanctions amplified barley prices in both regimes. According to these findings, the government should eliminate interventions in the barley market by utilizing the preferential exchange rate for importing barley. Moreover, pursuing a political agenda to create a stable political condition and lift economic sanctions should be considered the priority for the government to mitigate the barley price upsurge.

Key Words: Barley Price, Regime Change, GARCH, Markov-Switching

JEL Classification: Q2, Q18, C24

1. Introduction

In last decades, agricultural markets witnessed a significant boom-bust cycle and excessive price volatility from 2006 to 2014 (Guo and Tanaka, 2019; Ott and Ott, 2014), and this trend was the primary critical economic and food security challenge. Moreover, the consequences of food price hikes and exacerbated price volatility can go beyond the economics and food security matters and have social and political repercussions (Priya et al., 2012). Periods of high or low prices are not new; however, in recent years, the magnitude of price fluctuation and its geographical expansion have been substantial (Priya et al., 2012). Therefore, investigating the trend of increasing market instability for agricultural commodity markets and its impact on commodity prices has become a priority on the international agenda (Magrini et al., 2017).

The excessive change in the price of agricultural commodities creates a situation of uncertainty that can have an enormous influence on all the actors, such as consumers, producers, investors, merchants, and government, especially in developing countries (Fakari et al., 2013; Danehsvar Kakhki et al., 2019; Mittal and Hariharan, 2018). Consumers in developing countries spend a considerable share of their income on food; hence, they are sensitive to food price fluctuation (Cedrez et al., 2020; Farsi Aliabadi et al., 2021). On the other hand, the profitability of farming activity and incentives for producers' investment depend on market prices, and producers' decisions face a high degree of uncertainty in such a condition (Cedrez et al., 2020). Additionally, price volatility can generate a higher cost of agricultural commodity trade due to irregularity in the market and inflation pressure (Daneshvar Kakhkiet al., 2019). Therefore, price volatility negatively affects household welfare; Layani et al. (2020) indicated that an additional 1.79 percent of urban households drop below the poverty line due to a 9.8 percent increase in food prices. High Price variation also imposes substantial pressure on the government to control and stabilize the market prices to satisfy the country's food security objectives (Pieters and Swinnen, 2016). Due to these negative impacts, it's essential to identify the nature and reasons for price volatility, which can be helpful in reducing the distractive impact and controlling food prices (Fakari et al., 2016).

The Iranian government has always aimed to prevent price amplification in the agricultural sector due to its negative impact on economic activities. For this purpose, they have implemented a price stabilization policy, where essential commodities such as wheat, sugar, and barley are the central concerns. However, despite the policy, the price of agricultural

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commodities has increased significantly in recent years due to high inflation, currency weakness, and other macroeconomic difficulties. Therefore, it is crucial to identify influential contributors to the rising prices in Iran (Mehdizadeh Rayeni et al., 2022).

A vast number of studies focused on investigating and understanding the determinants of agricultural prices (Dinku and Worku, 2022; Shahid et al., 2021; Steen et al., 2023). It's clear that the joint influence of a plethora of causes generates price variation (Santeramo and Lamonaca, 2019). Biofuel production, energy prices, climate change, condition of financial markets, exchange rate, monetary policies, interest rate, transaction cost, sudden trade restriction, agricultural policies, and increase in food demand are considered as the influential factors that amplified the food prices and its variability (Cinar, 2018; Eissa and Al Refai, 2019; Lanfranchi et al., 2019, Uçak et al., 2022). In the last decade, the influence of exchange rates and international market prices on the dynamics of agricultural food prices in the domestic market has been well documented (Mosavi et al., 2014; Hájek and Horváth, 2016; Clapp et al., 2017; Braha et al., 2019; Lanfranchi et al., 2019; Sadiq et al., 2021). While the exchange rate variation affects the price of imported and exported agricultural commodities and also has significant consequences for countries relative prices (Adekunle and Ndukwe, 2018), the level of the relation among prices in global and regional markets totally depends on market integration and trade policy (Brown and Kshirsagar, 2015; Ganneval, 2016; Bekkers et al., 2017; Baffes et al., 2019;). Therefore, investigating the prices that pass-through exchange rates and international prices for each commodity in each region could be a vital matter for consumers, producers, importers, and policymakers. Alongside these traditional deriving forces, political unrest such as sanctions and war has been considered a substantial factor, which leads to food price inflation and fluctuation in international and domestic markets (Sohag et al., 2023). Since February 2022, the Russian invasion of Ukraine and this armed conflict have become a driving force of price volatility (Nasir et al., 2022). Grain production reduction in these predominant producers, trade restrictions, and fuel and fertilizer price spikes are a few reasons that caused agricultural price instability due to the Russian-Ukrainian conflict (Aliu et al., 2023). Therefore, this factor also should be taken into consideration.

Barley crop is the fourth most important cereal in the world, after wheat, corn, and rice. Nowadays, barley is consumed as animal feed, and around 70% of barley production is utilized for this purpose, 21% for malting, and less than 6% is directly consumed as human food (Tricase et al., 2018). In Iran, barley is the second largest crop by area, averaging 1.6 million hectares over the last five years, with production around 3 million tons (Motamed, 2017).

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Despite a large amount of production, the domestic production does not meet the country's requirement; thus, the deficiency is compensated by import (Daneshvar Kakhki et al., 2019), and in recent years, more than 40% of barley requirements have been imported from international market (AWNRC, 2020).

Due to the importance of barley in providing livestock feed and food security, price variation of barley is a predominant issue for Iranian governments. Moreover, a strong connection has existed between domestic and international markets due to the high share of imports in providing domestic requirements (Sadiq et al., 2021). In this context, the price variation in the global market due to political unrest in major producing countries might lead to significant changes in domestic barley prices (Mohammadi et al., 2016; Daneshvar kakhki et al., 2019). Moreover, other factors which have an influence on barley import, such as exchange rate, trade policy and restriction, and international sanctions, might cause price volatility in domestic prices and have a negative impact on food security (Mohammadi et al., 2016; Hejazi Emamgholipour, 2022; Zamanialaei et al., 2023). Even though some studies have been devoted to investigating the impact of different factors on food price variation, only a few have analyzed the influence of determinants of barley price in the domestic market, and to the best of knowledge no study has paid attention to the possible nonlinear behavior of barley price in Iran. Therefore, the objective of this study is to investigate the influence of international barley price, exchange rate variation, and local barley price volatility on the possible nonlinear behavior of domestic barley price in the era of maximum pressure campaign and Russian-Ukrainian military conflict to present a suitable approach for price management.

2. Material and Methods

This study has used time series data to investigate the possible regime change in barley prices under the US maximum pressure camping. For this purpose, a four-step procedure has been developed. In the first step, the time series should be tested to check the presence of the unit root test. For this purpose, we employed the Augmented Dickey-Fuller (ADF), Phillips-Perron, and Augmented Dickey-Fuller with structural break tests. If the series has a unit root, differencing should continue until the series becomes stationary. In the second step, Iran's barley price fluctuation should be extracted. To this end, an ARMA (Autoregressive Moving-Average Model) should be applied to Iran's barley price. Then, an LM (Lagrange Multiplier) test is conducted on the residual of the estimated ARMA model to check the ARCH (Autoregressive Conditional Heteroscedasticity) effect (Fakari et al., 2013). If the ARCH effect

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exists in the residual, the ARCH/GARCH (Generalized Autoregressive Conditional Heteroscedasticity) models will be applied to extract the domestic barley price volatility. The next step depends on the results of the unit root tests. If the variables are stationary in the first level, we can move to the last step and estimate the Markov-switching (MS) model. However, if the variables become stationary only after the first difference, then the Johanson co-integration test should be applied to check the existence of the Co-integration vector. Finally, if a co-integration vector exists, the Markov-switching model can be estimated.

2.1.Methods

2.1.1. ARCH/GARCH Methods

In order to calculate Iran's Barley price volatility, first, the ARMA model should be estimated. The ARMA(p,q) (Autoregressive Moving-Average Model) general form includes a combination of the autoregressive and the moving average model and has been presented in equation (1).

$$y_t = \alpha + \sum_{i=1}^{p} \beta_i y_{t-i} + e_t \qquad (1)$$

The residual term (e_t) in equation (1) follows a moving average specification presented in equation (2).

Constant variance during the time is one of the main assumptions of classic econometric methods. However, in many cases, this assumption is not achievable or logical. In order to overcome this restriction, Engle (1982) and Bollerslev (1986) presented the ARCH/GARCH model. In this model, two equations are estimated for the mean and variance to model the volatilities. The basic equation for GARCH (q,p) is presented in equations (3) and (4).

$$\begin{aligned} y_t &= \mu_t + \sigma_t z_t \\ \mu_t &= \alpha + \sum_{i=1}^{k} \beta_i x_{i,t} \end{aligned} \qquad i_t \sim NID(0,1) \qquad (2)$$

$$\sigma_t^2 = \tau_0 + \sum_{i=1}^{q} \tau_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \theta_i \sigma_{t-i}^2 \qquad \varepsilon_t \sim NID(0, H_t) \qquad (3)$$

In the first equation, Y_t is the conditional mean which depends on explanatory variables that are shown by $X_{i,t}$, and Z_t is the residual term. The second equation is the variance equation, and the coefficients should be estimated. Equation (4), σ_t^2 is a linear function of its past values (σ_{t-1}^2) and the past values of squared innovations (ε_{t-1}^2) (Engle and Bollerslev, 1986).

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2.1.2. Markov-Switching Method

Many economic time series variables exhibit nonlinear behavior associated with the events or abrupt changes in government policies (Hamilton, 2018). In recent years, economic variables such as agricultural commodity prices showed a complex and nonlinear behavior, and it is difficult to capture the multiple states correlation that existed between these variables using the linear relationship of a single state (Lie et al., 2019; Kalligeris et al., 2021). To this end, this paper designed a relationship measurement model based on the Markov-switching approach, which can measure the multi-state dependence structure between dependent and independent variables.

Hamilton (1989) introduced the Markov-Switching models for time series. It is a powerful method for parameter estimation when economic variable behaves differently in different states of nature or regimes (De la Torre-Torres et al., 2020). In other words, the MS model permits the time series variables to exhibit periodic shifts in their observed behavior between two regimes. The features of different regimes, such as regime duration and transition possibilities, have been determined endogenously (Valera and Lee, 2016). This study has assumed that domestic barley price switches between two unobservable states. Furthermore, it is supposed that the transition from one state to the other follows a Markov process, and the time transition and the duration in each state are random.

In this study, the following model is specified:

$$DBP_t = C_s + X_t\alpha + Z_t\beta_S + \epsilon_{St} \tag{4}$$

Where DBP_t represents the barley price in the domestic market, t accounts for time (month), and S represents the unobserved states (s= 1,2). C_s is a state dependence intercept, X_t is a matrix of state invariant variables, Z_t is a matrix of state-dependent variables, and $\epsilon_{St} \sim iidN(0, \sigma_s^2)$ is the error term. The model also can be written in the following order:

$$DBP_t = \begin{cases} C_1 + \sum_{i=1}^{n} \alpha_i DBP_{t-i} + \beta_{11} WP_t + \beta_{21} RER_t + \beta_{31} VDP_t + \beta_{41} MPC_t + \beta_{51} RUC_t + \epsilon_{1t} & If\ s = 1 \\ C_2 + \sum_{i=1}^{n} \alpha_i DBP_{t-i} + \beta_{12} WP_t + \beta_{22} RER_t + \beta_{32} VDP_t + \beta_{42} MPC_t + \beta_{52} RUC_t + \epsilon_{2t} & If\ s = 2 \end{cases} \tag{5}$$

The conditional transition probability to switch from regime I in the current month to regime j in the next month is presented in the equation (7).

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$$\Pr(S_{t+1} = j|S_t = i) = P_{ij} \quad (6)$$

Therefore, the two-state model used in this study will lead to the following probability matrix:

$$\begin{bmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{bmatrix} \quad (7)$$

With $P_{11} + P_{12} = 1 \; and \; P_{21} + P_{22} = 1$

2.2. Data

The data used in this study consist of the monthly barley price of Iran's domestic barley price, international barley price, the real exchange rate, and barley price volatility in the domestic market from August 2009 to September 2023. This period was chosen because it covers the different US sanction regimes during the agricultural price escalation. Moreover, this period includes the international price spike of 2010-2011 and 2019-2020, which might lead to interesting results. The price of barley in the domestic market, the Real Effective Exchange Rate, based on the Consumer Price Index, and international barley prices are from the Statistical Centre of Iran (Statistical Center of Iran; Price index database, 2023) and IMF (IMF Data Base, 2023) respectively. The price volatility of barley in the domestic market is extracted from its time series using the ARCH/GARCH method. The index of geopolitical conflict, which can be considered an index of armed conflict between Russia and Ukraine, has been adapted from the study of Caldara and Iacoviello (2022). Finally, a dummy variable was considered in the analysis to capture the impact of the US maximum pressure campaign on domestic barley prices. Descriptions of the variables are presented in Table 1.

Table 1. Description of the variables

Name	Definition
DBP	Barley price in Iran domestic market
WP	Barley price in International Market
RER	Iran real effective exchange rate
VDP	Barley price volatility in Iran's domestic market
RUC	The average geopolitical risk of Russia and Ukraine adapted from Caldara and Iacoviello (2022).
MPC	Dummy variable equal to 1 during maximum pressure campaign and 0 otherwise

Source: Authors Definition

According to the statistics presented in Table 2, the prices of domestic barley have experienced significant fluctuations over time. In August 2009, the recorded price for domestic barley was

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2004 Rials per ton, and it had increased to 111476 by September 2023, showing an average monthly growth rate of 2%. The minimum price for barley was recorded in March 2010, while the maximum price was registered in March 2023. The high standard deviation indicates that the domestic barley price has been extremely unstable.

Table 2. Statistics of the variables

Variables	Measurement Unit	Mean	Maximum	Minimum	Std. Dev.
DBP	Rial per metric ton	24224.86	121353	1777	32699.65
WP	US$ per metric ton	151.48	262.95	83.04	52.88
REER	index	155.15	502.52	80.89	100.2
RUC	index	-0.16	1.71	-1.48	0.59

Source: Authors Calculation

It should be noted that all the variables are transformed to logarithmic form for further investigation.

3. Results

The results of the ADF, and the Phillips-Perron, and ADF with the structural breaks unit root test are presented in Table 3. The results of all tests determined that the variables, except the Russian-Ukrainian conflict, were not stationary at the level. However, the unit root test revealed that the variables were stationary at the first difference.

Table 3. Results of unit root tests

		ADF			
Variables	t- Statistic	Result	Variables	t- Statistic	Result
DBP	-1.38	No Stationary	Δ(DBP)	-4.8*	Stationary
WP	-1.92	No Stationary	Δ(WP)	-8.65*	Stationary
RER	-1.9	No Stationary	Δ(RER)	-9.53*	Stationary
RUC	-4.28*	Stationary			
		PP			
DBP	-1.84	No Stationary	Δ(DBP)	-10.71	Stationary
WP	-1.63	No Stationary	Δ(WP)	-8.85	Stationary
RER	-1.95	No Stationary	Δ(RER)	-10.24	Stationary
RUC	-3.97*	Stationary			
		ADF with Break			
DBP	-2.65	No Stationary	Δ(DBP)	-10.34	Stationary
WP	-3.24	No Stationary	Δ(WP)	-9.57	Stationary

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RER	0.8	No Stationary	Δ(RER)	-11.38	Stationary
RUC	-3.98*	Stationary			

Source: Authors Calculation, *, ** and, *** indicate the level of significance for 1, 5 and, 10 percent.

The results of the mean equation, ARCH effect test, and GARCH estimation of domestic barley price are presented in tables 4. According to AIC (Akaike information criterion) and SIC (Schwarz information criterion) criteria, the ARIMA (2,1,0) was chosen as the best mean specification model. Then, the ARCH effect test was conducted, and its results revealed the existence of Heteroscedasticity. Therefore, the ARCH/GARCH model should apply to capture the domestic barley price volatility.

Table 4. Mean equation, Heteroscedasticity Test and GARCH estimation of domestic barley price

Mean Equation: ARIMA(2,1,0)				
Variables	Intercept	AR(1)	AR(2)	Goodness of Fit
DBP	0.23*	0.17*	-0.19*	Adjusted R2= 0.79 AIC= 2.13 SC=2.06
Heteroscedasticity Test: ARCH				
	F-statistic= 5.97*			Obs*R-squared=5.83*
ARCH (1)				
	Intercept	RESID(-1)^2		Goodness of Fit
DBP	0.03*	0.17*		Adjusted R2= 0.86 AIC= 2.33 SC=2.24

Source: Authors Calculation; *, ** and, *** indicate the level of significance for 1, 5 and, 10 percent.

The domestic barley price volatility index is extracted from the GARCH model and presented in Figure (1). the main result indicates that the index experienced significant changes from November 2011 to November 2012 and intensified from May 2020 to May 2022. In Iran, the real exchange rate volatility can intensify the volatility of imported commodities such as barley. Moreover, since May 2020, the intensification of barley price volatility could be traced back to the impact of the U.S. maximum pressure campaign policy and the elimination of the preferential exchange rate policy.

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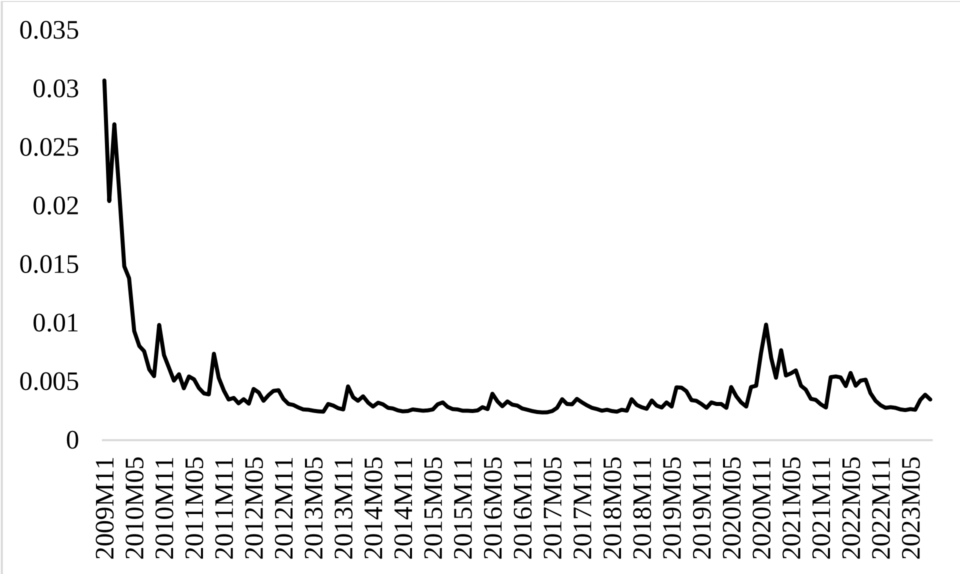
Figure 1. Trend of domestic barley price volatility index



Source: Authors Calculation

Johanson's Co-integration test result indicated that all the variables are Co-integrated. Therefore, the level variables are employed to estimate the Markov-Switching model. The results of model estimation for two regimes are presented in Table 5.

The estimated coefficients for barley world price in both regimes indicated that this variable imposes a positive and statistically significant influence on domestic barley price. According to the results, a percent increase in world barley price increases the domestic price by 0.87 and 0.1 %. This result is to the findings of Moghadasi et al. (2011), Yousefi and Moghadasi (2013), Brown and Kshirsagar (2015), Bekkers et al. (2017), and Daneshvar Kakhki et al. (2019). A comparison between the first and second state parameters indicated that the influence of world price declined significantly in the second regime. It is worth noting that State 1 is approximately simultaneous with the absence of economic pressure, and State 2 is virtually concurrent with the intensive economic sanction. In the first state, the government is less sensitive to controlling the prices; therefore, the domestic and international commodity markets are related significantly, and the world price is the significant determinant of domestic prices. However, during the maximum pressure campaign or intensive economic sanction, the government becomes more sensitive to price variation of essential commodities such as barley, and the price transmission from the international to the domestic market is considerably weak.

Based on the results, a real effective exchange rate has a positive and statistically significant impact on domestic barley prices. To be more specific, a percent increase in real effective

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exchange rate increases the domestic price by 1.67 and 1.97 % in the first and second regime, respectively. These results are in agreement with the results of Mohammadi et al. (2015), Ghahremanzadeh et al. (2020), Shahid et al. (2021), and Sokhanvar and Bouri (2022). The estimated coefficients for dependent variables indicated the contribution of the real exchange rate is considered high in the formation of domestic barley prices in both states. Moreover, the influence of this variable in the second state intensified. It is worth noting that the availability of exchange rates through the formal market has become arduous during state 2. Moreover, the alternative mechanism for providing the exchange rate with the multiple exchange rate not only does not ease access but also aggravates an extra cost to traders because of the intensification of administrative bureaucracy. Therefore, the real exchange rate has a more powerful impact in this state.

The domestic price volatility of barley also imposes a positive and statistically significant influence on domestic prices in both states. The results also indicated that a percent increase in barley price volatility results in a growth in domestic barley prices with a magnitude of 0.36 and 0.2 % in the first and second regimes, respectively. Comparing the estimated coefficients in different regimes revealed that the barley domestic price volatility imposed a more powerful impact in the first state. As it has been mentioned earlier in the first state, the government was not sensitive to price variation of essential commodities, and price volatility management was not the main administration priority; therefore, the domestic price fluctuation imposed a more powerful impact on barley price.

Table 5. Markov-Switching estimation results for barley domestic price

Dependent Variable Domestic Price		
Variables	Regime 1	Regime 2
Intercept	2.01*	3.25*
WP	0.87*	0.1***
RER	1.67*	1.91*
VDP	0.36*	0.20*
MPC	0.1**	0.24*
RUC	0.01Ns	0.07**
Goodness of Fit		
AIC= -0.88, SC=-0.76, DW=-0.60		

Source: Authors Calculation; *, ** and, *** indicate the level of significance for 1, 5 and, 10 percent.

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The maximum pressure campaign also has a positive and statistically significant impact on domestic barley prices, which is consistent with the results of Ghahremanzadeh et al. (2020). While the influence of the maximum pressure campaign in the first state is not substantial, the impact in the second state is much more influential. During the maximum pressure campaign, the average domestic price of barley was 0.24 % higher than the rest of the period. In other words, in this era and previous economic sanctions from 2012 to 2015, due to the higher cost of imports and excessive difficulty of purchasing from the international market, price management in the domestic market turned into a struggling issue for the government and the domestic market faced higher prices relative to the first state. Therefore, lifting the economic sanctions is an essential deriving force that could help to decrease and stabilize the barley price.

Finally, the Russian-Ukrainian conflict does not impose a statistically significant influence on domestic barley prices in the state 1. Throughout the second state, the impact of armed conflict on domestic barley prices in Iran is positive and statistically significant; however, its impact is not substantial. This result is predictable because the dependency of Iran on Ukraine and Russia is relatively low (Zhang et al., 2023).

Table 6. Regime properties for domestic barley price

	Coefcient	Standard error
Transition probabilities		
P_{11}	0.966	0.019
P_{12}	0.033	0.019
P_{21}	0.039	0.02
P_{22}	0.960	0.02
Duration		
State 1	30.12	17.86
State 2	25.54	13.1

Source: Authors Calculation

The properties of the two regimes are presented in Table 6, which shows that the transition probability for regime change is significantly low. The regime transition probability from regime 1 to 2 is 0.033, while the likelihood of regime changes from regime 2 to 1 is 0.039. Furthermore, regime 1 lasted longer than regime 2. The results indicated that regime 1 lasted 30 months, while the second stat continued for almost 25 months.

The transition probability of the first regime is depicted in Figure 2. It reveals that state 1 is prevalent from November 2009 to July 2013, and again, it becomes dominant from March 2016

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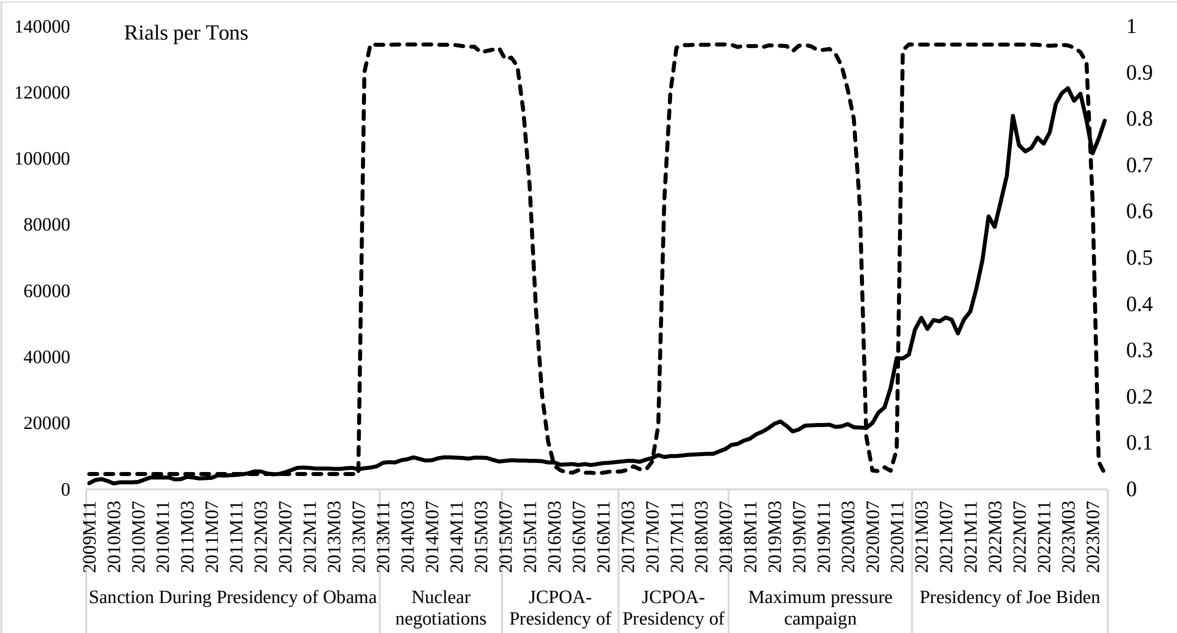
to July 2017. The results indicate that the first regime prevails when the economic sanctions are lifted or not pursued by the US government.

Figure 2. Transition probability of state 2 for domestic barley price



Source: Authors Calculation

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4. Conclusion and Policy Implication

This study assessed the impact of main factors on barley prices, including global prices, exchange rates, domestic price volatility, and geopolitical conflict during the US maximum pressure campaign. For this aim, the Markov-switching approach has been applied to capture the possible non-linear behavior of the barley price from August 2009 to September 2023. The main results determined that a real effective exchange rate is a dominant deriving factor in domestic barley price formation in both regimes. Moreover, the barley price in the international market, domestic price volatility, and maximum pressure camping are driving forces of domestic barley prices. However, the contribution of global barley prices and the domestic price fluctuation has been diminished in the second state, while the influence of maximum-pressure camping has been exacerbated.

Based on the results, the government policy for stabilization of essential commodity prices through utilizing the preferential exchange rate. This policy should also weaken the weak connection between local and international markets. However, the study findings indicated that this policy does not mitigate the price variation in both regimes. Therefore, the government should have confined its intervention in the exchange market to the price stabilization proposed.

Moreover, since the increase in the domestic price volatility led to barley price intensification, the government should design a price volatility and mitigation system based on the facilitation of public procurement and management of governmental reserve to reduce the domestic price fluctuation by securing the supply of the barley in local markets in the case of demand surplus.

Finally, according to the results, the persistence of US economic sanctions amplified barley prices. Therefore, the Iranian government should pursue a political agenda to create a stable political condition and lift the economic sanctions by compromising their nuclear program. Based on the results, following this program should be considered the main priority for the government to mitigate a price upsurge.

This study faced some limitations that could be addressed to provide more precise results. First, there is a data limitation toward a monthly sanction index. In other words, calculating a more accurate sanction index could lead to a more precise assessment. Moreover, application of more flexible time series models such as state-space which estimates the yearly coefficients could lead to a more comprehensive assessment.

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