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Iran's Maize Import Policy Based on the Exchange Rate Volatility and Price Expectation

Mandana Zanganeh Soroush
PhD in Agricultural Economics, University of Sistan and Baluchestan, Iran
Mosayeb Pahlavani*
Department of Economics, University of Sistan and Baluchestan, Iran

Abstract
The present study has made an attempt to discuss the effects of exchange rate volatility and price expectation on maize imports in Iran from 1980 to 2013. In doing so, using the EGARCH technique for time series econometrics, price volatility variables for both exchange rate and final price have been calculated, and the time series for these variables have been extracted. Additionally, in regard to the expected import price, the related time series has been extracted using Hodrick-Prescott filter (HP).

The empirical results indicate that exchange rate volatility and price volatility have had no significant effects on maize import, which is due to the fact that maize is a basic commodity and is imported by the official currency, therefore domestic price volatilities and the exchange rate do not have significant effects on maize imports. However, by freezing the exchange rate and not allocating official currency, the possibility of the exchange rate volatility affecting maize imports exists and this issue could affect the whole country's food security.

Keywords: Exchange Rate Volatility, Price Expectation, Import, Structural Break, Maize

JEL Classification: Q17, F13, F31

* Corresponding Author: pahlavani@eco.usb.ac.ir

1. Introduction

The fact that maize is the third most used agricultural product in the world after wheat and rice (Kazemnejad and Gilanpour, 2013) is a testament to its importance. It is also the main used input for both dairy and meat cattle, poultries, etc. and plays a fundamental role in the country's food products such as chicken and egg. Due to maize's high consumption level, any change in its price has a direct effect on the final price of products such as chicken, egg and other animal products. According to statistics in 2012, United States of America, China, Brazil, European Union, Argentina, and Mexico are the largest maize producers in the world. America, Brazil, Argentina, and Ukraine were the biggest maize exporters in 2012 while on the other hand countries like Japan, Mexico, European Union, and South Korea were the biggest importers in the world, and Iran sits on the seventh place after them. (Haghighat et al., 2014).

Iran's economy, as a developing country, also shows a great dependency on the imports of agricultural products, especially cereal and sugar. Meanwhile, the high demand for maize, given its multiple usages, has forced the government to meet these requirements through imports.

Maize consumption in Iran has always been on the rise during the past 40 years, with its total amount rising from 2.5 million tons in 2001 to about 5 million tons in 2011. According to statistics from Ministry of Agriculture, in the market year of 2009-2010 more than 239 thousand hectares were cultivated for maize, which produced 2 million and 149 thousand tons corn in the country, and according to Islamic Republic of Iran's Customs, in 2009 more than 3.800 million tons and in 2010, 3.275 million tons maize were imported to the country to compensate the shortage in production. In other words, on average only half of the domestic demand is produced inside the country. Therefore, due to the imports of this product and the high impact of this variable on domestic production, maize import policy is very crucial for agriculture, and understanding the factors influencing this product's import plays an important role in providing decisive policies for meeting its domestic demand.

Studying the import trend of the country shows that the country's exchange and trade policies have always been under the heavy influence of oil exports revenue. The government's reliance on oil revenue has led to them adopting an import facilitation policy. The consequences of such prolong policies for Iran's agriculture are manifested in the sharp rise in imports' volume, reduction of investment on this particular matter, keeping the prices for agricultural products low, lack of real support for domestic production compared to imports, and an increase in agricultural products' exports due to the high demand. Furthermore, the relative stability of oil revenues has institutionalized some behaviors in the country's exchange and trade systems which have led to a lack of any serious effort to reform the traditional structure of agricultural sector. A glance at the history of exchange and trade policies shows that the same policies continue to exist with little difference even after the Revolution; meaning with improvements in oil revenues, the move towards import facilitation policies has intensified and on the contrary, less attention has been given to non-oil exports. (Komeijani et al., 2001)

Iran's trade policies have also faced a lot of inconsistencies. Adopting import facilitation policies, government's strict control over imports, adjustment and trade liberalization, and the permanent oscillation of these policies are some of the most obvious aspects of Iran's trade policies. Trade policies in the agricultural sector are mainly in favor of imports and because the import of strategic products is controlled by the government, trade policies' orientation and especially tariff and non-tariff barriers have not shown a logical support for domestic production. Overall, the exchange and trade policies have faced many swings, and all the factors together are heavily in favor of imports and have created a steady circumstance for importing agricultural products, and are completely against the policies announced for supporting domestic production, which have led to a hidden tax on domestic production of agricultural products.

Ethier (1973) states that exchange rate volatilities should have a negative effect on the international trade. Frequent volatilities along with continued uncertainty over the real exchange rates can, by creating an unstable and uncertain situation for benefits of international exchanges, reduce trade and cause inactivity in capital flows by reducing investment in foreign activities, and indirectly affect resource allocation and the government's policies, because with disturbance of the real exchange rate's stability, the investment process becomes illogical and optimal resource allocation will not be possible.

According to the above discussion, it can be claimed that one of the most important challenges at macroeconomic level, is the effects of exchange rate volatilities on macroeconomic variables. The importance of analyzing this issue stems from the point that changes in relative prices can have a big role in determining the import behavior of developing countries including Iran. Also, most studies on the relationship between exchange rate volatilities and trade have been performed on developed countries and have usually targeted the trade industry and very few of them have actually focused on the agricultural trade. Therefore, studying the effects of exchange rate volatilities on Iran's maize import and the impact of price expectations, which are crucial and significant matters, are our main objectives in this study.

The remaining of the paper relies on the reviews of literature in Section 2. Section 3 specifies the conceptual discussion of the model and empirical results are reported and analyzed in Section 4. Section 5 represents conclusion and policy implications.

2. Literature Review

In 1970s, when the major currencies of the world switched to a floating exchange rate system from the previous fixed regime, the effects of exchange rate volatilities on trade flows became a popular research topic. Early theoretical contribution (Ethier, 1973) on effects of exchange rate volatilities on trade flows asserts that exchange rate volatilities have a negative effect on volume of trade if traders are not aware of how exchange rate volatilities can affect their expected profit.

According to the findings of empirical literature, the effect of exchange rate volatilities on trade flows is ambiguous. In this section the findings of some empirical studies are briefly discussed. From the earlier empirical studies (Akhtar and Hilton, 1984), it was evident that exchange rate volatilities have a negative impact on exports. Akhtar and Hilton used a polynomial distributed lag method in OLS estimation for the USA and Germany over the period of 1974-1981 and concluded that exchange rate volatilities reduce international trade. According to their model in the export equation, foreign income, foreign capacity utilization and relative prices are independent variables; and in import equation, domestic income, the ratio of foreign to domestic capacity utilization and relative prices are independent variables. Their findings show significantly negative effects of volatility on US imports, and German exports and imports but no effects on US exports.

Gotur (1985) used the same methodology as Akhtar and Hilton (1984) with certain modification for UK and Japan. In his study the sample period was changed to account for lag structure and the rate of change of the exchange rate was incorporated. As Akhtar and Hilton (1984) asserted, German exports and imports have been negatively impacted, but Japanese exports are positively affected, and the other trade variables were not affected.

However, both of the above mentioned studies suffer from spurious regression problem because none of them accounted for integrating properties of variables (Bahmani-Oskooee and Hegerty, 2007).

Negative effects of exchange rate volatilities on trade flows are confirmed in recent studies. Arize et al. (2008) studied the relationship between real exchange rate volatility and export volume in the short and long run in eight South American countries and concluded significant negative effects.

Chou (2000) showed the negative effects of real effective exchange rate (REER) volatility on export volume for trade flows of industrial materials, minerals and fuel, and manufactured goods. However, the relation was not significant for foodstuffs. A significant negative relationship was also found between exchange rate volatilities and export supply for all the G7 countries and their partners for twenty one industries (Péridy, 2003).

Few empirical studies show a positive relationship between exchange rate volatilities and international trade flows (McKenzie and Brooks, 1997; Poon and Stapleton, 2005), while a number of studies found no significant effect of exchange rate volatilities on trade flows (Kenen, 1983; Bailey et al, 1986; Thursby, 1987; IMF, 2004). As a result, the relationship between exchange rate volatilities and trade flows is mixed and inconclusive. This inconclusive relationship is explained by the fact that exchange rate volatility is an 'inadequate indicator' of price risks faced by firms since an increase in exchange rate volatilities may not necessarily increase real domestic currency price volatilities (Smith, 1999).

IMF (2004) has observed that while exchange rate fluctuations have increased during the currency and balance of payments crises of 1980s and 1990s, there has not been any increase, on average, in such volatilities between the 1970s and the 1990s. It also found some empirical evidence of negative relationship between exchange rate volatility and trade. However, such a negative relationship is not robust and it concludes that if exchange rate volatility has a negative effect on trade, this effect would appear to be fairly small and is not robust.

Unlike many studies on the effects of exchange rate volatilities on overall trade, the impact of exchange rate and other volatilities on agricultural trade has been less studied (Cho et al. 2002; Kandilov, 2008; Zhang et al, 2010). Cho et al. (2002) found that the real exchange rate uncertainty has had a significant and negative impact on agricultural trade across ten developed countries and the negative impact on agricultural trade was more significant compared to other sectors.

Kandilov's (2008) results showed that agricultural exports from developing countries are much more vulnerable to exchange rate volatilities and the exchange rate volatility effect on the export value is largest for developing countries compared to developed countries. Since developing countries use vehicle currency (U.S. Dollar) in their trades, only exchange rate volatility of the vehicle currency (U.S. Dollar), not the exporter-importer currency, matters for developing country exporters (Kandilov, 2008)

The effects of exchange rate volatility on fresh tomato imports into the United States from Mexico were studied by Jaramillo-Villanueva and Sarker (2009). They concluded that exchange rate fluctuations have a positive effect on trade flows, while volatility of the exchange rate has a significant negative effect on trade flows.

Zhang et al. (2010) found that although commodity price and freight cost volatilities have no significant impact on traded volume of soy bean between U.S. and Brazil, but play important roles in determining U.S. soy bean trade with China. Possibility of hedging and market power is considered as two important factors which determine the effects of volatilities on trade.

Tandrayen-Ragoobur and Emamdy (2011) in their empirical research studied the negative effects of exchange rate volatility on exports of Mauritius. The results of this study for the period of 1975-2007 indicated that real export has a relationship with foreign economic activities and also with Real Effective Exchange Rate. Also, in the short run, the exchange rate volatility has a positive and significant effect on exports.

Kashi et al. (1997) by studying the effects of exchange rate uncertainty on the two-way flow of agricultural products between United States of America and OECD countries for the period of 1970-2010 and using the gravity model, showed that exchange rate volatilities and the real exchange rate have negative and significant effects on the overall trade flow, and the exchange rate volatilities tend to affect the agricultural sector more and the real exchange rate affects non-agricultural sectors.

Finally, Serenis et al. (2011) in his study "Exchange Rate Volatility and Foreign Trade: The Case for Cyprus and Croatia", has analyzed the effects of exchange rate volatilities on exports between Cyprus and Croatia between 1990 and 2012. The model used in this study is VECM. The results showed that exchange rate volatilities reduced exports between the two countries in the mentioned period.

3. The Models

In the present study Hooper and Kohlhagen (1978) model is used for specifying the import demand function for Iran's imports of Maize. They have developed in their study the model for individual firm's import of goods in terms of exchange rate volatility. In the present study, in addition to exchange rate volatility, commodity price volatility is also included in the model. However, in Zhang's study (2010) in which he developed Hooper and Kohlhagen model, exchange rate volatility, price, and shipping costs were also accounted for. Hooper and Kohlhagen assume in their model that a firm uses the imported goods as input for production of end products. Importers are faced with a linear demand function for their goods (Q) in which case the demand function is considered as an increasing function of domestic revenue (Y), the substitute prices (PD) and also as a decreasing function of price:

$$Q = aP + bPD + cY \tag{1}$$

In their model, they assume a two-phase structure where in the first phase the firm receives the order for its products and readies the orders for its imported inputs. In the second phase, it receives its ordered inputs and does the payments for its inputs and ship costs and then receives the money for its produced goods.

The firms determine the level of their product in a way to maximize its utility which is an increasing function of expected profit and a decreasing function of profits' standard deviation. According to this equation, with an increase in the expected profit, individuals' utility has vastly increased and the risk, due to being a radical function, will decrease the individuals' utility. Optimization of the firm is considered as follows:

$$Max\ U(\pi) = E(\pi) - \gamma(V(\pi))^{1/2} \tag{2}$$

where U is the overall utility, π equals profit, E represents expected value, V indicates variance, and γ is the relative calculation of risk preferences. $\gamma > 0$ indicates risk aversion, $\gamma = 0$ shows risk neutral and $\gamma < 0$ represents risk seeking.

The firm's profit function in terms of domestic currency is defined as follows which is a function of sales price, production unit's costs, and costs of importing inputs:

$$\pi = Q * P(Q) - UC * Q - HM * iQ \tag{3}$$

In the above equation Q is the production value, P is the domestic price of the firm's every production unit, H is the weighted average of the cost of foreign currency for the importer, M is the cost of importing inputs, and i is the fixed ratio of imports to total product.

If the value of required imports is to generate the value of Q from production, then q can be defined as follows:

$$q = iQ \tag{4}$$

In this model it is assumed that the importer can reduce the exchange rate risk and commodity price in the futures market. It is assumed that the firm considers the fix share ($\propto$) in the futures market with the futures exchange rate (R) and asks for the remaining share ($1-\propto$) from exchange rate in the spot market ($\tilde{R}$). Therefore, H can be defined as follows:

$$H = (1-\propto)R + \propto \check{R} \tag{5}$$

$\tilde{P}$ is the futures market price of goods in foreign currency:

$$M = \tilde{P} \tag{6}$$

By placing the mentioned equations in the function of importers' benefits, we'll have

$$\pi = Q * P(Q) - UC * Q - [(1-\alpha)R + \alpha\tilde{R}]\tilde{P} * iQ \tag{7}$$

In this model, excluding the expected variables which are distinguished by a tilde, other variables are identified. The variance of the firm's benefit is derived as follows, which shows how to calculate the variance of a high profit function.

$$V(\pi) = [(1-\alpha)R.iQ]^2\sigma_{\tilde{P}}^2 + (\alpha iQ)^2\sigma_{\tilde{R}\tilde{P}}^2 \tag{8}$$

In the above equation, $\sigma_{\tilde{P}}^2$ and $\sigma_{\tilde{R}\tilde{P}}^2$ are variances of $\tilde{P}$ and $\tilde{R}\tilde{P}$ respectively.

By placing the above equation in the maximizing function, we'll have:

$$U = QP(Q) - UC.Q - E(H)E(\tilde{P}).iQ - [(1-\alpha)^2R^2\sigma_{\tilde{P}}^2 + \alpha^2\sigma_{\tilde{R}\tilde{P}}^2]^{1/2}\gamma iQ \tag{9}$$

Using the first phase's condition for the above equation related to the production value, we have:

$$\frac{dU}{dQ} = Q\left(\frac{dP}{dQ}\right) + p(Q) - UC - E(H)E(\tilde{P})i - [(1-\alpha)^2R^2\sigma_{\tilde{P}}^2 + \alpha^2\sigma_{\tilde{R}\tilde{P}}^2]^{1/2}\gamma i = 0 \tag{10}$$

By placing the value of $\frac{dP}{dQ}$ from ($Q = aP + bPD + cY$) we'll have:

$$\left(\frac{Q}{a}\right) + p(Q) - UC - E(H)E(\tilde{P})i - [(1-\alpha)^2R^2\sigma_{\tilde{P}}^2 + \alpha^2\sigma_{\tilde{R}\tilde{P}}^2]^{1/2}\gamma i = 0 \tag{11}$$

By placing q=iQ in the above equation, we'll have:

$$q = \left(\frac{i}{2}\right)(aUC + bPD + cY) + \left(\frac{ai^2}{2}\right)[E(H)E(\tilde{P})i + \gamma[(1-\alpha)^2R^2\sigma_{\tilde{P}}^2 + \alpha^2\sigma_{\tilde{R}\tilde{P}}^2]^{1/2} \tag{12}$$

According to *Bohnstedt* and *Goldberger (1969)* $\sigma_{\tilde{R}\tilde{P}}^2$ equals:

$$\sigma_{\tilde{R}\tilde{P}}^2 = E(\tilde{R})^2\sigma_{\tilde{P}}^2 + E(\tilde{P})^2\sigma_{\tilde{P}}^2 + \sigma_{\tilde{R}\tilde{P}}^2 \tag{13}$$

Therefore:

$$q = \left(\frac{i}{2}\right)(aUC + bPD + cY) + \left(\frac{ai^2}{2}\right)[[(1-\alpha)R + \alpha E(\tilde{R})]E(\tilde{P})i + \gamma[(1-\alpha)R^2\sigma_{\tilde{P}}^2 + \alpha^2[E(\tilde{R})]^2\sigma_{\tilde{P}}^2 + \alpha^2[E(\tilde{P})]^2\sigma_{\tilde{R}}^2 + \alpha^2\sigma_{\tilde{R}\tilde{P}}^2 \tag{14}$$

If $\gamma > 0$ then it must be:

$$\frac{dq}{d\sigma_{\tilde{P}}^2} = \left(\frac{ai^2}{2}\right)[\gamma[(1-\alpha)R^2 + \alpha^2\{E(\tilde{R})]^2 + \alpha^2\sigma_{\tilde{R}}^2\}] < 0 \tag{15}$$

$$\frac{dq}{d\sigma_{\tilde{R}}^2} = \left(\frac{ai^2}{2}\right)\alpha^2\gamma[\{E(\tilde{P})\}^2 + \sigma_{\tilde{P}}^2\} < 0 \tag{16}$$

Therefore if the importers are risk averse, increase in exchange rate or commodity price volatility leads to a decrease in level of imports.

If the importers are risk neutral, exchange rate volatility or commodity price will not affect the import demands. In case of risk seeking, exchange rate volatility or imported commodity price will also increase.

Assuming homogeneity of firms, import demands can be calculated using the following collected import demand's function:

$$Q^d = f(UC, PD, Y, E(\tilde{R}), E(\tilde{P}), \sigma_P^2, \sigma_R^2, \sigma_{RP}^2) \tag{17}$$

Accordingly, the used econometric model will be as follows:

$$\begin{aligned} Log(IM_t) = \alpha_0 \log(ERV_t) \\ + \alpha_1 \log(PV_t) \\ + \alpha_2 \log(Y_t) \\ + \alpha_3 \log(IP_t) \\ + \alpha_4 \log E(p_{t+1}) \\ + \alpha_5 \log(ER_t) + e_t \end{aligned} \tag{18}$$

Therefore, import (IM_t) is a function of exchange rate volatility (ERV_t), price volatility PV_t, GDP (Y_t), import price (IP_t), expected import price $E(p_{t+1})$, and exchange rate (ER_t). All variables are measured at time t. The required data for estimation of the model are extracted from World Bank Indicators (WDI) and FAO Organization and the time series used in this study is from 1980 to 2013.

In the present study, Zivot-Andrews (1992) unit root test with an unknown structural break is used for analyzing the stationary of the variables. Zivot-Andrews believe that endogenously determining a potential structural break does not necessarily conclude the existence of a structural break, it rather suggests that if the structural break in economy has occurred, the probability of it occurring endogenously in the designated time will be high. In this test, the null hypothesis of a variable being unit root is evaluated when the structural break is not included in the model, but the alternative hypothesis states that the time series has a stationary trend with a structural break. In this method, similar to Perron's, three kinds of change are considered: change in intercept, change in slope, and simultaneous change. Models used by Zivot and Andrews with an endogenous structural break are as follows:

$$y_t = \hat{\mu}^A + \hat{\theta}^A DU_t(\hat{T}_b) + \hat{\beta}^A{}_t + \hat{\alpha}^A y_{t-1} + \sum_{j=1}^{k} \hat{C}_j{}^A \Delta y_{t-j} + \hat{e}_t \tag{19}$$

$$y_t = \hat{\mu}^B + \hat{\beta}^B{}_t + \hat{\gamma}^A DU_t(\hat{T}_b) + \hat{\alpha}^B y_{t-1} + \sum_{j=1}^{k} \hat{C}_j{}^B \Delta y_{t-j} + \hat{e}_t \tag{20}$$

$$y_t = \hat{\mu}^C + \hat{\theta}^C DU_t(\hat{T}_b) + \hat{\beta}^C{}_t + \hat{\gamma}^C DT(\hat{T}_b) + \hat{\alpha}^C y_{t-1} + \sum_{j=1}^{k} \hat{C}_j{}^C \Delta y_{t-j} + \hat{e}_t \tag{21}$$

Equation (19) shows a structural change in intercept. Model B examines the break during the trend and in model C the simultaneous change in intercept and in trend is considered. Among the models presented, model C is more comprehensive and less restrictive (Zivot and Andrews,1992)

For other unit root tests with the presence of a structural break, Perron's IO and AO models (1994 and 1997) for analyzing structural breaks can be mentioned. In AO model or Additive Outlier, the attention is paid to sudden changes in mean, and in IO or Innovational Outlier, gradual changes in the time series are more important. The models presented by Perron (1997) and Perron (1994) are also considered in this study. In his research, Perron has considered his two models of IO1 and IO2. In IO1 model gradual changes in intercept are used and in IO2 model, gradual changes in both intercept and slope are allowed as:

$$x_t = \mu + \theta DU_t + \beta t + \delta D(T_b)_t + \alpha x_{t-1} + \sum_{i=1}^{k} c_i \Delta x_{t-i} + e_t \tag{22}$$

$$x_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \delta D(T_b)_t + \alpha x_{t-1} + \sum_{i=1}^{k} c_i \Delta x_{t-i} + e_t \tag{23}$$

Also in AO model similar to IO model, equations' successive estimations are obtained. Testing for presence of a unit root in AO model's framework is done using Perron's two-step procedure.

First, the trend's sentence is removed from the series:

$$y_t = \mu + \beta t + \gamma DT_t^* + \hat{y}_t \tag{24}$$

The following equation is used for estimating the slope's change:

$$\hat{y}_t = \alpha \hat{y}_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \tag{25}$$

Since neglecting the structural break can invalidate statistical results of the unit root tests, therefore neglecting this issue can also pose problems for co-integration test's results. As a result, if co-integration tests do not allow applying structural changes, they can indicate a false co-integration relationship. Accordingly, in this study co-integration tests are used to analyze co-integration of variables within the used model (Perron, 1997).

The co-integration tests used in this research are the Gregory-Hansen co-integration test (1996) which uses various forms for modeling structural breaks. In this test residuals are used for testing and the co-integration relationships in the presence of a structural break are analyzed. In this test, the null hypothesis indicates absence of a co-integration relationship and the alternative hypothesis indicates a co-integration relationship in the presence of a structural break. In this test the break time is endogenously put into the model:

$$y_{it} = \alpha_0 + \alpha_1 D_{tb} + \beta y_{2t} + e_t \qquad (26)$$
$$y_{it} = \alpha_0 + \alpha_1 D_{tb} + \beta y_{2t} + \gamma t + e_t$$
$$y_{it} = \alpha_0 + \alpha_1 D_{tb} + \beta_1 y_{2t} + \beta_2 y_{2t} D_{tb} + e_t$$

In the first equation the model for change in intercept is taken into account. In the next equation the model for change in intercept and trend are considered and in the last equation the full break model is included which is considered in the dummy variable. The proposed statistic by Gregory-Hansen are as follows, according to which the break point is also determined as follows:

$$Z_{\propto}^{*} = infZ_{\propto}(b) \qquad b \in t \qquad (27)$$
$$Z_t^{*} = infZ_t(b) \qquad b \in t \qquad (28)$$
$$ADF^{*}(b) = \inf ADF(b) \qquad b \in t \qquad (28)$$

One of the classic assumptions of linear regression models is assuming homogeneity of variance, which means the conditional variance of the disturbing sentences is constant. Generally, although violation of the assumption of homogeneity of variance occurs more in cross-sectional data, individuals like Engle and Craig found evidences in their studies that the variance of disturbing sentences in time series models is more unstable than usually assumed. The results of Engle's research showed that in inflation models, the forecast error has a cluster pattern (this shows a form of heteroscedasticity in which the variance of forecast error is dependent on the value of the disturbing sentence of the previous period). Under these circumstances, he suggested his models of autoregressive conditional heteroskedasticity (ARCH) as substitutes for common time series processes.

One of the models which enables the asymmetric effects of previous error terms on conditional error variance, is the exponential GARCH model (EGARCH). One of the problems of standard GARCH models is that we have to somehow ensure the positivity of all the coefficients. Nelson (1991) has modeled h_t in a way that there's no necessity in applying non-negativity constraints, therefore the negativity of coefficients is possible here.

The following equation is an EGARCH model:

$$\ln\left(\delta_t^2\right) = \alpha_0 + \sum_{i=1}^{p} \alpha_i \left|\frac{\varepsilon_{t-1}}{\delta_{t-i}}\right| + \sum_{j=1}^{q} \beta_j \ln\left(\delta_{t-j}^2\right) + \sum_{i=1}^{p} \gamma_t \left(\frac{\varepsilon_{t-i}}{\delta_{t-i}}\right) \qquad (29)$$

4. Empirical Results

In order to estimate the above mentioned model, first the required variables for estimation should be created. Therefore, for a proxy of exchange rate volatility, EGARCH model for variable of exchange rate's growth is used. The results associated with the estimated model for this variable are shown in Table 1. According to the results, the volatility generated by exchange rate's positive shocks has a greater effect on generating volatility compared to the negative shocks.

Table 1: EGARCH model for exchange rate variable

Exchange rate growth	coefficient	Standard deviation	t-statistic
C(1)	.068158	1.552586	.0438997
AR(1)	.600232	.181800	3.301611
C(3)	-1.684745	.814682	-2.067978
ABS(RESID(-1)/@SQRT(GARCH(-1)))	-.200334	-.521663	.3840295
RESID(-1)/@SQRT(GARCH(-1))	.819654	.342708	2.391696
LOG(GARCH(-1))	.598091	.174345	3.430505
R-Squared:	.303547		
Adjusted R-Squared:	.289334		

Source: Author

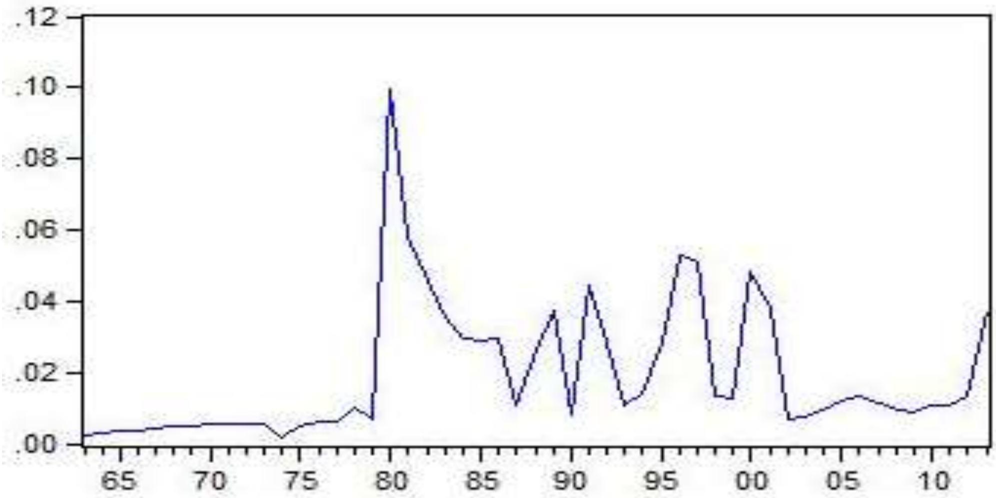

Figure 1: Exchange rate volatility in Iran 1960-2013

Source: Authors

Table 2: EGARCH model for import price variable

Exchange rate growth	coefficient	Standard deviation	t-statistic
C(1)	.027328	.005715	4.781850
AR(1)	.112518	.002026	55.53885
C(3)	-1.024391	.280559	-3.651252
ABS(RESID(-1)/@SQRT(GARCH(-1)))	-3.453283	.554675	-6.225781
RESID(-1)/@SQRT(GARCH(-1))	.616864	.326886	1.887092
LOG(GARCH(-1))	-.082312	.284736	-.289082
R-Squared:	-.004842		
Adjusted R-Squared:	-038337		

Source: Authors

The exchange rate volatility generated by the estimation is shown in Figure 1. As can be seen, the highest exchange rate volatility is in 1980 which is at the time of the onset of war in Iran.

For generating an indicator of import price volatility, EGARCH model for variable of import price growth is used. Estimation of the intended model is presented in Table 2. As can be seen in the below table, positive price shocks have greater effects on generating import price volatility compared to negative shocks.

Using the estimated model in Table 2, import price volatility was extracted and the associated results are shown in Figure 2. As can be seen, the highest import price volatility for maize was in 2002.

The expected prices for maize import prices should also be proxied for estimation of the model. For this purpose, Hodrick-Prescott filter is used. The results of using Hodrick-Prescott filter for extracting expected import price are shown in Figure 3.

Due to generating the intended variables in the model, estimation of the studied model can be possible. Therefore, first by using unit root tests in the present of structural breaks, the stationarity of the intended variables are analyzed. Results of the Zivot-Andrews and Phillips-Perron tests are shown in Table 3. The null hypothesis in both tests is the existence of a unit root in the presence of a structural break. The below tests' results indicate that there are non-stationary variables in the model.

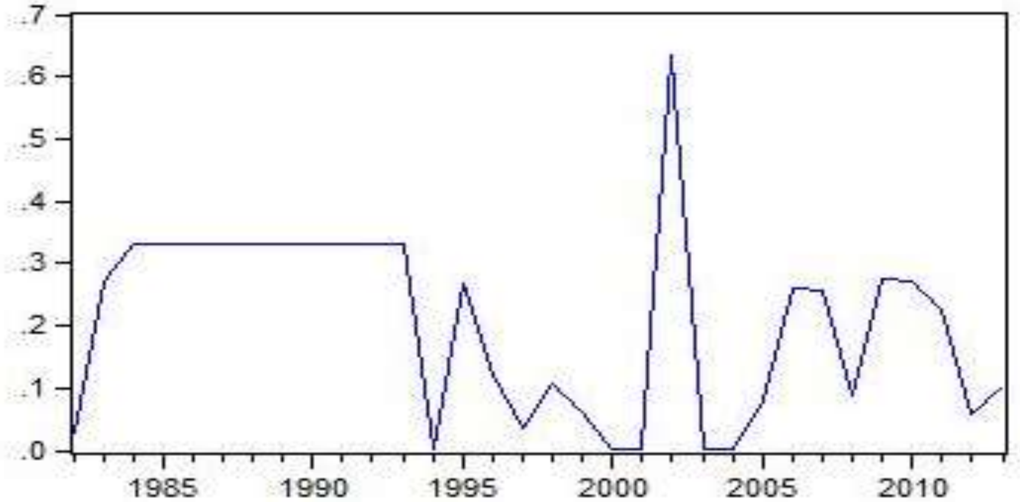

Figure 2: Maize import price volatility 1980-2013
Source: Authors

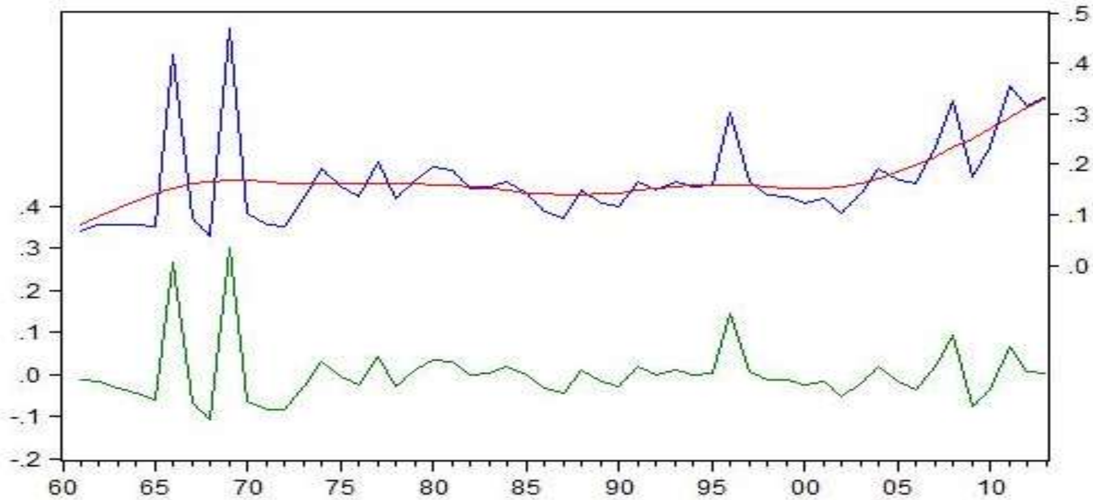

Figure 3: Expected import prices using Hodrcik-Prescott filter 1960-2013
Source: Authors

Table 3: The results of Perron and Zivot-Andrews unit root tests of 1980-2013

Unit root test	Log(IM)	Break Point	1%	5%	%10
Perron-AO	-3.445000	1992	-5.92	-5.23	-4.92
Perron-IO	-5.395601	2003	-6.32	-5.59	-5.29
Zivot-Andrews	-3.459365	1993	-5.34	-4.93	-4.58
	Log(ER)	Break Point	1%	5%	%10
Perron-AO	-3.416335	2005	-5.92	-5.23	-4.92
Perron-IO	-2.894065	1994	-6.32	-5.59	-5.29
Zivot-Andrews	-3.310055	2005	-5.34	-4.93	-4.58
	Log(IP)	Break Point	1%	5%	%10
Perron-AO	-4.128870	2006	-5.92	-5.23	-4.92
Perron-IO	-4.918300	1996	-6.32	-5.59	-5.29
Zivot-Andrews	-2.288854	2007	-5.34	-4.93	-4.58
	Log(p_{t+1})	Break Point	1%	5%	%10

Perron-AO	0227733	1991	-5.92	-5.23	-4.92
Perron-IO	-4.078598	1996	-6.32	-5.59	-5.29
Zivot-Andrews	.617493	1992	-5.34	-4.93	-4.58
	Log(P)	Break Point	1%	5%	%10
Perron-AO	-5.003804	1985	-5.92	-5.23	-4.92
Perron-IO	-4.946553	1985	-6.32	-5.59	-5.29
Zivot-Andrews	-4.744044	2002	-5.34	-4.93	-4.58
	Log(ERV)	Break Point	1%	5%	%10
Perron-AO	-4.738261	2001	-5.92	-5.23	-4.92
Perron-IO	-5.149801	2001	-6.32	-5.59	-5.29
Zivot-Andrews	-5.147157	2002	-5.34	-4.93	-4.58
	Log(PV)	Break Point	1%	5%	%10
Perron-AO	-8.861174	1994	-5.92	-5.23	-4.92
Perron-IO	-8.718921	1994	-6.32	-5.59	-5.29
Zivot-Andrews	-7.346027	1994	-5.34	-4.93	-4.58

Source: Authors

Due to the existence of non-stationary variables during the time period, it should be ensured that the estimated regression is not biased, and for doing so, the Gregory-Hansen co-integration test is used. As can be seen in Table 4, in the presence of a structural beak in 2001, by changes in intercept, co-integration between the model's variables is confirmed thus the intended model can be estimated.

Table 4: Gregory-Hansen co-integration test

	ADF	**Za**	**Zt**
Level Shift	-7.924771	-42.17983	-8.055768
Break year	2001	2001	2001

Source: Authors

The results of the model's estimation are shown in Table 5. According to the results, maize import price has had a negative and significant effect on Iran's maize import during the studied period. Therefore, with increase in import price, maize import will decrease. But, for expected import price, a positive but statistically insignificant relationship was concluded. The reason for this is that if the expected prices increase, the individuals will import more but for this product, this effect hasn't been significant. The variable coefficient of the per capita income is positive and statistically significant; indicating that with increase in the country's per capita income, the country's maize import has also increased which is consistent with expectations. With increase in the per capita income it can be expected that purchasing power also increases therefore more import is done. In case of the exchange rate, a positive and significant effect is noted, which indicates that increase in the exchange rate has not led to decrease in the country's volume of maize import. The reason for this can be that maize is a basic commodity and is imported by the official exchange rate and although the exchange rate in the country is rising, this has not led to a decrease in this product's import.

For exchange rate volatility variables and import volatility, a significant effect on maize import was not seen, and the reason for this is that due the fact that maize is a basic commodity and is imported by the official exchange rate, therefore the import price volatility and foreign currency price volatility have not had significant effects on this product. The coefficient of determination for the estimated model indicates that 85 percent of changes in maize import can be explained by the estimated model, which indicates a reasonable explanatory for the model. Also, Durbin-Watson statistic rejects the presence of first-order *autocorrelation* between the model's disturbing elements.

Table 5: Model estimation results using Gregory-Hansen co-integration test in the presence of a structural break

Dependent variable: Log(IM)	coefficient	Standard deviation	t-statistic
Log(E)	.129367	.058350	2.217100
Log(IP)	-.500405	.238451	-2.098560
Log(IPE)	1.082007	.755988	1.431249
Log(YP)	2731.498	.535381	2.798516
Log(EV)	.0663775	.081905	.778649
Log(PV)	.005132	.013356	.384250
C	2.785745	4.930658	.564984
R-Squared:	.859848		
Adjusted R-Squared:	.213509		
Durbin-Watson Stat:	2.175765		

Source: Authors

5. Conclusion and Policy Implication

In this study, for maize import policy based on exchange rate volatility and price expectations with a structural break approach, the appropriate model for discussing the issue was presented. In general, the test results confirmed co-integration between the model's variables in the presence of the 2001 structural break.

According to the empirical results obtained, an increase in import price has had a negative effect on the country's maize import but the expected import price has not had a significant effect on the country's maize import. Furthermore, the per capita income has had a positive and significant effect on the country's maize import which is consistent with theoretical expectations. However the exchange rate variables, exchange rate volatility, and price volatility have not had significant effects on the country's maize import. This is due to the fact that maize is a basic commodity and is imported by the official currency, therefore domestic price volatilities and the exchange rate do not have significant effects on the country's maize import. Finally by freezing the exchange rate and not allocating official currency, the possibility of the exchange rate volatility affecting maize imports exists and this issue could affect the whole country's food security.

Therefore, due to Iran's dependency on maize import and the inverse relationship between production and the volume of import, what matters in reducing maize's import volume is to plan for increasing the domestic production. Accordingly, in order to support domestic producers, the government needs to reduce the production costs, adopt a subside policy, and create a direct relationship between producers and consumers to build the foundation for producing a quality and affordable product. By doing so, not only they can supply the domestic needs by means of production, but also the amount of foreign currency spent on this product's imports decreases.

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