Iranian Journal of Economic Studies, 8(1) 2019, 185-206

Shiraz University

Iranian Journal of Economic Studies

Journal homepage: ijes.shirazu.ac.ir

The Dynamics of Exchange Market Pressure and Inflation in Iran: Regime Switching Approach

Sayed Yahya Abtahi[a*], Elham Amrollahi Bioki[b]

a. Department of Economics, Yazd Branch of Islamic Azad University, Yazd, Iran.

b. Department of Economics, Science and Research Branch of Islamic Azad University, Tehran, Iran.

Article History

Received date: 30 June 2019
Revised date:28 December 2019
Accepted date: 28 December 2019
Available online: 15 January 2020

JEL Classification:
C32
E52
F31
F41

Keywords:
Exchange Market Pressure
Inflationary Dynamics
Markov Switching Vector Autoregressive Model
Monetary Policy
Threshold Vector Autoregressive Model
Iran

Abstract

This study was an attempt to analyze the dynamic reaction of the exchange market pressure (EMP) to different states of the foreign exchange market and inflation in the Iranian economy during 1988:4-2017:4. To this end, the EMP index was calculated using Edwards's (2002) and Kumah's (2007) formulae. By considering inflation as the threshold variable and using Threshold Vector Autoregressive (TVAR) model, the results showed that lagged variables had no significant effects on EMP in a low inflation regime, but inflation had significant effects on EMP in a high inflation regime. The results of using the Markov Switching Vector Autoregressive (MS-VAR) model showed that in EMP and INF equations, the autoregressive coefficients in all lags and in both regimes were significant; this emphasizes the stability of the estimated VAR model. Based on the results of the MS-VAR equations, the results of the Granger Causality Test showed that when the EMP switched to a high regime, the inflation would have a significant impact on the EMP, but in the regimes where the EMP was at a low level, the inflation was not the cause of the EMP. EMP in low inflation regimes could also affect inflation while EMP was not the cause of inflation in high inflation regimes. Therefore, the policymakers should note that increasing EMP, even in low inflation regimes, can lead to pressure on prices. On the other hand, an increase in the foreign reserves causes the EMP to switch to a high regime; then, the inflationary pressures at any level of the inflation rate can exacerbate the exchange market pressure, and policymakers would be unable to control the currency market. Thus, if the EMP is controlled, the effects of inflation on the EMP will be discontinued, and this is a key point for policymakers.

1. Introduction

Following the financial crises in Southeastern Asia, Argentina, Mexico, and Russia, economists started to analyze the Exchange Market Pressure (EMP) using different theoretical and empirical models (Kumah, 2007). There are numerous definitions for the exchange crisis, but such crisis is generally

∗ abtahi@iauyazd.ac.ir
DOI: 10.22099/ijes.2019.34098.1585

described as a speculative attack on the value of domestic currency which can either lead to a sharp decline in the value of domestic currency or a strong support for the domestic currency offered by the monetary authorities through selling foreign exchange reserves or increasing the interest rate (Weymark, 1995). A crucial index which is widely used in studying exchange crises is the EMP index.

Girton and Roper (1977) proposed the concept of the EMP index firstly. They called the total changes in the exchange rate and the changes in the foreign reserves as the Exchange Market Pressure and also considered equal weights for the two components. In fact, Girton and Roper presented the EMP using a simple balance-of-payments monetary model. Then, Roper and Turnovsky (1980) and Turnovsky (1985) developed the EMP index. They used a small open economy model and developed an original model by implementing a simple monetary approach and considering the IS-LM framework and perfect mobility of the capital. Contrary to Girton and Roper, they did not consider equal weights for the components of the EMP. The most notable studies on the EMP index have been conducted by Weymark (1995, 1997a, 1997b, 1998). She adopted the EMP index as a combination of exchange rate changes and intervention in the exchange market. Based on Eichengreen et al. (1994, 1995), the EMP index is a linear combination of interest rate difference, the percentage of changes in the bilateral exchange rates, and the percentage of changes in foreign exchange reserves. Contrary to the Weymark’s approach, the index of exchange market pressure is calculated using the sample variances of the three components.

Investigating the exchange rate in Iran in the years after the revolution during 1979 to 2001 indicated that a two-tier exchange rate system, consisting of an official exchange rate and an unofficial exchange rate, usually prevailed, but after that, the unification of exchange rate policy was approved in 2002, Iran’s foreign exchange rate system switched to managed floating exchange rate system. During these years, the gap between the official exchange rate and the unofficial exchange rate usually increased and, eventually, the monetary authorities were made to fill this gap using exchange rate shocks. The official exchange rate was adjusted in 1992 and 2002. In 2010, the gap between the official and unofficial exchange rates started and in 2012 reached its highest point with more than 300% difference. There were several reasons contributing to this gap. According to the Islamic Parliament Research of Iran report, the reasons can be divided into two groups, namely supply and demand. Considering supply, the main reason is the international sanctions against Iran, especially those targeting the oil industry and the Central Bank. With regard to demand, the main reasons deal with the reduced interest rate of bank deposits and speculative motivation. Due to the above-mentioned aspects, it can be expected that during the years when the gap between the official and unofficial exchange rates was increasing, the monetary authorities increased the exchange rate to fill this gap and the result was increased pressure on the exchange market. It can be stated that at the beginning of the1990s, the pressure of the exchange market increased; then, the pressure became stable in the 2000s and again started to increase from 2011 to 2013. The exchange market pressure does not change even if the exchange rate and the foreign exchange reserves increase. This happens when the foreign exchange reserves of a country is in a good condition. Exchange rate changes have important effects on macroeconomic variables, such as domestic output, unemployment, inflation, and the balance of payments. With the rise in the inflation rate, the value of the domestic currency decreases and the exchange market pressure increases, but when the objective of the exchange rate stability shifts to inflation targeted by the central bank, the market pressure on domestic currency increases and inflation decreases and there would be an inverse relationship between the exchange market pressure and inflation. As a result, the impact of inflation on the currency market pressure will be ambiguous. Therefore, the inflation variable can be an explanatory variable of the non-linear behavior of the exchange market pressure.

The purposes of this study were as follows: First, Following Edwards's (2002) and Kumah's (2007) method, we derived the Exchange Market Pressure (EMP) index in Iran's economy as a nonlinear phenomenon. Secondly, this study was aimed to investigate the effects of inflation on EMP in different inflationary environments in the Iranian economy using the threshold vector autoregressive (TVAR) model. Finally, the dynamics of the exchange market pressure and inflation were analyzed using the Markov switching Vector Autoregressive (MS-VAR) model.

The rest of this article is set up as follows. The second part deals with the literature. The third part clarifies the theory, and the fourth part presents the model. The fifth section shows the results produced from model estimation, and the last part concludes the results and presents some policy recommendations.

2. Literature Review

Gochoco and Bautista (2005) studied the impacts of monetary policies in the Philippines using the VAR technique and the data from 1990:1–2000:4. To do so, they used monthly data from domestic credit variables, EMP, and also the differences between the treasury bonds in the Philippines for 91 days and in the U.S. for 90 days during 1990-2000. The results showed that contractionary monetary policy decreased the EMP. Bird and Mandilaras (2006) studied the relationship between the financial imbalance and exchange rate fluctuations in Latin American and Eastern Asian countries during 1970-2000 using a weighted index of EMP. The results showed that in Latin America, the financial imbalance had a significant effect on EMP while this was not the case in Eastern Asia. De Macedo et al. (2009) compared the EMP in five African countries during 1996-2005 and the index was calculated using the method developed by Eichengreen et al. (1994, 1995). Using EGARCH-M model, the results showed that the increase in the monetary expansion put upward the pressure on the exchange rate while a real decline in the exchange rate could lead to a decrease in EMP index. Lestano (2010) used SVAR to study the EMP in Indonesia using quarterly data from 1981:4-2004:4. The results showed that the relationship between EMP and domestic credit was positive, but the effects of production growth and the money multiplier on EMP were negative. Using Girton and Roper's (1977) method, Kemme and Lyakir (2011) calculated the Exchange Market Pressure (EMP) index for the Czech Republic. They used monthly data from 1995–2006 and two VAR models. The results suggested that in the first model, the growth rate of the domestic credit which corresponded to the fixed exchange rate system was meaningless, but it was meaningful and positive in the managed floating exchange rate system. They also suggested that the interest rate differential in the fixed system was meaningful while it was meaningless in a managed floating system. Pandy (2012) used Girton-Roper's definition of exchange market pressure to investigate the impact of monetary policy on the Nepalese exchange rate. The findings showed that the domestic credit was against the expectations while the sign for the multiplier coefficient complied with the theory; other variables did not have a meaningful effect. The results from quarterly data suggest the variables are meaningful, especially domestic credit and the money multiplier. Using Eichengreen et al.'s (1994, 1995) method, Ziaei (2012) calculated the exchange rate market pressure index in Iran during 2003-2010. They also used the SVAR model to determine the effects of this index on credit to the private sector, consumer price, and budget deficit. The results of the SVAR model showed that any sudden shock to the exchange market pressure could increase the consumer price index and budget deficit but reduce the domestic credit. Moreover, although the effect of the exchange market pressure index on domestic credit is weak, the effect of domestic credit on exchange market pressure is considerable. Using Weymark's (1995) model, Gilal and Chandio (2013) investigated the exchange market pressure and intervention indices for Pakistan during 1976-2005. The results showed that the demand for real money and price equation was unstable. The effects of structural changes on parameter constancy were investigated using Kalman's filter approach. The evidence showed downward pressure and active Central Bank intervention. Hadian and Ojimehr (2014) used a smooth transition autoregressive model (STAR) to study the behavior of EMP in Iran's economy during 1990:1-2011:3. To do so, the EMP was calculated using a model-independent approach. The results of the estimation showed that the EMP was nonlinear and that Iran's exchange market experienced pressure from domestic currency value appreciation or depreciation during the studied period. Baghjari et al. (2014) investigated the EMP index during the period 1989:1-2012:4. The results showed that the expansionary monetary policies could lead to high pressure on the exchange rate. Also, the effect of money multiplier on the exchange market pressure was positive while the variables, such as domestic production and crude oil price, had a negative effect on it. Franco et al. (2014) used an operational instrument to analyze EMP in Angola. The Angolan economy specifications, such as closed financial accounts, a partially controlled current account, and a highly dollarized economy, had a direct impact on the demand of foreign currency, leading to the creation of a specific model for Angola. The model, logically, provided an index for the exchange market rate pressure (EMP) and included changes in the exports and imports, foreign interest rate, inflation, and the change in the foreign reserves. In this research, the EMP index was calculated using Eichengreen et al.'s (1994) as well as Klassen and Jager's (2011) frameworks. Khiabani and Ghaljei (2014) investigated exchange regimes and the EMP in an exporting economy. Their findings indicated that staying in the depreciation regime was more stable than staying in an appreciate regime. Fiadora and Biekpe (2015) studied the impact of monetary policy on EMP in a number of developing countries in sub-Saharan Africa. In their study, most of the sub-Saharan Africa countries had negative net export. Using a dynamic panel data model and including twenty countries in sub-Saharan Africa during 1991-2010, the study proved the hypothesis, based on which a contractionary monetary policy could lead to more powerful currency and vice versa. The results suggested a negative and significant relationship between monetary policy and EMP, meaning that implementing contractionary monetary policy could decrease EMP. Also, there was a significant relationship between the levels of public debt, the balance of the current account, and aggregate output, on the one hand, and between terms of trade and EMP, on the other hand. Using Eichengreen et al.'s (1995) and Girton and Roper's (1977) methods and considering a panel including forty countries in the period of 1997-2010, Gilal and Byrne (2015) investigated the effects of financial and trade liberalization on the exchange market pressure index. The results showed that the capital account openness corresponded to Eichengreen et al.'s (1995) and Girton and Roper's (1977) methods in developed economies and to the Girton and Roper's (1977) method in the emerging markets. The difference observed in the openness of the capital account for the developed economies and emerging markets may be due to the development of financial sectors in the developed countries.

Table 1 shows the summary results of previous research studies. What distinguishes this study from previous studies is that:

- Following Edwards's (2002) and Kumah's (2007) approach, the Exchange Market Pressure (EMP) index was derived as the average of changes in the exchange rate and reserves.
- This study investigated the impact of inflation and money growth on the nonlinear behavior of the EMP index using the TVAR model. Also, this study was also aimed to analyze the dynamics of EMP and the relationship between EMP and inflation. MS-VAR model was used to investigate the dynamics via impulse-response functions and nonlinear Granger causality.

Table 1. A summary of the literature review

Authors	Calculate EMP	Econometrics Model
Gochoco & Bautista (2005)	Girton & Roper (1977)	Vector Auto-Regressive (VAR)
Bird & Mandilaras (2006)	$FXMP = \alpha(dlogXR) + \beta(dlogIRD) - \gamma(dlogRES)$	Least Squares Dummy Variables (LSDV)
De Macedo et al. (2009)	Eichengreen et al. (1994, 1995)	Exponential Generalized Autoregressive Conditional Heteroscedastic -Mean (EGARCH-M)
Lestano (2010)	Girton & Roper (1977)	Structural Vector Auto Regression (SVAR)
Kemme & Lyakir (2011)	Girton & Roper (1977)	Vector Auto-Regression (VAR)
Pandy (2012)	Girton & Roper (1977)	Auto Regression Distributed Lag (ARDL)
Ziaei (2012)	Eichengreen et al. (1995) and Bird & Mandilaras (2006)	Structural Vector Auto-Regression (SVAR)
Gilal & Chandio (2013)	Weymark (1995)	Kalman filter approach, time-varying parameter
Hadian & Ojimehr (2014)	Model- Independent approach	Smooth Transition Auto-Regression (STAR)
Baghjari et al. (2014)	Girton & Roper (1977)	Structural Vector Auto-Regression (SVAR)
Franco et al. (2014)	Eichengreen et al. (1994) and Klassen & Jager (2011)	Ordinary Least Square (OLS), Probit and Logit
Khiabani & Ghaljei (2014)	Kumah (2007)	Markov Mean- Switching Heteroskedastic Vector Auto-Regressive (MSMH(2)-VAR(2))
Fiadora & Biekpe (2015)	$EMP_{it} = \beta_i + \beta_1 MPR_{it} + \beta_2 RGDP_{it} + \beta_3 CABA_{IT} + \beta_4 PKFL_{it} + \beta_5 PD_{it} + \beta_6 TOT_{it} + \varepsilon_{it}$ EMP: Exchange rate pressure; MPR: Central bank policy rate; RGDP: Real GDP; CABA: Current account balance; PKFL: Private capital flows; PD: Public debt	Dynamic Panel Model
Gilal & Byrne (2015)	Eichengreen et al. (1995) and Girton & Roper (1977)	Least Square Dummy Variable (LSDV)

3. Theoretical Background

The monetary phenomenon that causes an excess demand for or supply of domestic currency is introduced as EMP. EMP causes appreciation or depreciation of the currency; therefore, monetary authorities use monetary tools to stem disruption (Kumah, 2007). According to Kumah (2007), the pressure of the exchange market can be categorized into three main pressures, namely, the pressure caused by increased currency value, the pressure caused by declined currency value, and the normal movements of the exchange rate. As presented in Table (2), e_t is the domestic price of a unit of foreign currency and R_t is the foreign exchange reserves, such that Δe_t demonstrate the percent changes in the exchange rate and ΔR_t shows the percent changes in the foreign exchange reserves. Table (2) shows that the exchange market pressure has a nonlinear behavior; thus, nonlinear econometric methods should be used when analyzing it (Ibid).

Table 2. Characterizing exchange market pressure

	Appreciation ($\Delta e_t < 0$)	Depreciation ($\Delta e_t \geq 0$)
Accumulating Reserves ($\Delta R_t > 0$)	Appreciation pressure	Normal exchange rate–Money relationship
Decumulating Reserves($\Delta R_t \leq 0$)	Normal exchange rate–Money relationship	Depreciation pressure

***Source**: Kumah (2007)*

To do so, Kumah (2007) assumed that the real money balance ($m_t^d - p_t$) was a linear-logarithmic function of income (y_t) and the interest rate (i_t). He presented the following pattern:

$$m_t^d - p_t = \alpha y_t - \beta i_t + v_t \quad (1)$$

where α, β, and v_t are income elasticity of money, interest semi elasticity of money, and an unanticipated money demand shock variable, respectively. By considering perfect transition from domestic prices to the exchange rate where purchasing power parity (PPP) is kept unchanged and the conclusion of the uncovered interest rate parity (UIP) is considered when deciding over the individuals' portfolio, one can replace the domestic price (p_t) and the domestic interest rate (i_t) with ($e_t + p_t^*$) and $\left(i_t^* + \mathrm{E}(\Delta e_{t+1}|\mathrm{I}_t)\right)$, respectively. Therefore, Equation (1) could be modified as Equation (2):

$$m_t^d = (e_t + p_t^*) + \alpha y_t - \beta\left(i_t^* + E(\Delta e_{t+1}|I_t)\right) + v_t \quad (2)$$

where p_t^* is the foreign price and i_t^* is foreign interest rate while e_t is the official exchange rate (the domestic currency price based on foreign currency) and E is expectations operator. Therefore, $\mathrm{E}(\Delta e_{t+1}|\mathrm{I}_t)$ describes the future exchange rates based on the information on the current term. In general, the phrase in the first brackets explains the purchasing power parity (PPP) while the second brackets reflect the equality of uncovered interest rate parity (UIP). Assuming that the monetary coefficient is one, the domestic money supply is yielded by aggregating domestic credits d_t and foreign reserves r_t, which are all shown in Equation (3):

$$m_t = d_t + r_t \quad (3)$$

Moreover, it is supposed that monetary authorities intervene in the exchange market by purchasing or selling exchange:

$$\Delta r_t = -\chi \Delta e_t \quad (4)$$

In Equation (4), the parameter x shows the amount of intervention by the Central Bank in the exchange market. Therefore, monetary policymakers intervene in the foreign exchange market by selling or purchasing foreign currencies considering the fact that the exchange rate changes stem from the pressure caused by increasing or decreasing the money value.

Taking into consideration the first difference through Equations (2) and (3) and noting that $E(\Delta e_{t+1}|I_t)$ can be re-specified as $E(e_{t+1}|I_t) - e_t$, the changes in the demand for and supply of money equations can be measured as follows:

$$\Delta m_t^d = \Delta e_t + \Delta p_t^* + \alpha \Delta y_t - \beta E(\Delta e_{t+1}|I_t) + \beta \Delta e_t + \Delta v_t \quad (5)$$

$$\Delta m_t^s = \Delta d_t + \Delta r_t \quad (6)$$

By equalizing Equations (5) and (6) aimed at balancing the money market and also by using Equation (4), the equilibrium exchange rate can be yielded as a function of the macroeconomic variables and that of the degree of intervention regulated by the Central Bank, as manifested in Equation (7):

$$\Delta e_t = \frac{1}{(1+\beta+\chi)} \left(-\Delta p_t^* - \alpha \Delta y_t + \beta \Delta i_t^* - \beta\left(E(\Delta e_{t+1}|I_t)\right) + \Delta d_t - \Delta v_t\right) \quad (7)$$

Based on Equation (7), the exchange rate changes highly depend on the coefficient χ, since when the coefficient moves towards extremes (either positive or negative), the changes in the exchange rate will be zero ($\lim_{\chi \to \pm} \Delta e_t = 0$). We see that such a thing occurs in systems with invariable exchange rates. If the coefficient moves towards $-\infty(\chi), \to -\infty)$; then, the changes in the exchange rate will move from upside towards zero, meaning that the Central Bank intervenes in the exchange market by purchasing foreign currencies when the national currency is weakened. On the other hand, when the coefficient moves towards $+\infty(\chi), \to \infty)$; then, the changes in the exchange rate will move from down towards zero, meaning that the Central Bank intervenes in the exchange market by purchasing foreign currencies when the national currency value is boosted. If the intervention coefficient is zero ($\chi = 0$), the changes in the exchange rate will be totally floating. Moreover, the values of the intervention coefficient from zero to extreme signify a moderate intervention and indicate a well-managed floating system. Furthermore, when $\chi < -(1 + \beta)$, the intervention would be leaning against the wind while when $-(1 + \beta) < \chi < 0$, the changes in the exchange rate will be too big (Ibid).

Considering the relationship between the Central Bank and the exchange rate movement, we can follow Weymark's (1998) conclusion that the EMP is a linear combination of percentage changes of the exchange rate (Δe_t). The changes in the foreign currency reserves to the monetary base (Δr_t) could be shown as in Equation (8):

$$EMP_t = \Delta e_t + \eta \Delta r_t \quad (8)$$

The coefficient η is assumed to be zero. The index for EMP will be defined by Equation (8) if the monetary authorities intervene in the foreign exchange market.

By substituting Equations (4) and (8), a nonlinear relationship will be formed between η and χ:

$$EMP_t = (1 - \eta\chi)\Delta e_t \quad (9)$$

In Equation (9), $\eta \in [-1,0)$ shows the foreign reserve elasticity of exchange rates, and χ is the degree of intervention by the Central Bank.

Lack of continuity in the EMP caused by its nonlinear essence is due to discrete changes in the exchange rate process, and such discontinuity defines what type of regime to choose. Therefore, contrary to linear methods which introduce the EMP through Equation (8), the nonlinear aspect of the EMP can be presented as in Equation (10) based on what Kumah (2007) referred to:

$$EMP \begin{cases} < 0, \chi \neq 0, \chi \in (-(1+\beta), \infty), \Delta e_t < 0 \rightarrow \textit{appreciation pressure} \\ = 0, \chi = 0 \rightarrow \quad \textit{normal exchange rate movement} \\ > 0, \chi \in (-\infty, -(1+\beta)), \Delta e_t > 0 \rightarrow \quad \textit{depreciation pressure} \end{cases} \quad (10)$$

Considering Table (1) and Equation (10), market pressure can be determined through three regimes: A depreciation regime, an appreciation regime, and a regime of normal exchange rate movements. The depreciation regime of national currency happens when the changes in the exchange rate are non-negative $(\Delta e_t \geq 0)$ and the changes in the foreign reserves are non-positive $(\Delta R_t \leq 0)$. In such a case, it is said that there is high pressure on the exchange rate. The appreciation regime of the national currency happens when the changes in the exchange rate are negative $(\Delta e_t < 0)$ and the changes in the foreign reserves are positive $(\Delta R_t > 0)$. In such a case, it is said that there is low pressure on the exchange rate. The normal regime of exchange rate movements happens either when the changes in the exchange rate are non-negative $(\Delta e_t \geq 0)$ and the changes in the foreign reserves are positive $(\Delta R_t > 0)$ or when the changes in the exchange rate are negative $(\Delta e_t < 0)$ and the changes in the foreign reserves are non-positive $(\Delta R_t \leq 0)$. The normal regime of the exchange rate movements showing the floating exchange rate regime indicates that monetary authorities have no control over the market.

4. Empirical Methodology

Threshold Vector Autoregressive (TVAR) and the Markov switching vector autoregressive (MSVAR) models are the extensions of Linear VAR models, which have regime-specific parameters. The stochastic variable S_t shifts regime and this, in turn, changes the parameters that characterize the time series:

$$y_t = \mu_{S_t} + \sum_{j=1}^{p} A_{jS_t} y_{t-j} + u_t \quad (11)$$

In threshold models, the value of an observable variable, known as threshold variable, determines regimes (see Tong, 1983) while in the Markov switching models, the regimes are introduced with the Markov process in the latent variable framework (see Hamilton, 1990). In what follows, we focus on the methodology of forecasting that we adopted for the threshold and Markov switching models.

4.1 Threshold Vector Autoregressive (TVAR) model

Threshold Vector Autoregressive model (TVAR) (Tong, 1983) defines S_t and assumes that K values depend on the value of a threshold variable z at time $t{-}d$:

$$S_t = \begin{cases} 1 & \text{if } Z_{t-d} \leq Z_1^* \\ 2 & \text{if } Z_1^* < Z_{t-d} \leq Z_2^* \\ \vdots & \\ K & \text{if } Z_{K-1}^* < Z_{t-d} \end{cases} \quad (12)$$

where $\{Z_1^*, Z_2^*, \ldots, Z_{K-1}^*\}$ are K−1 thresholds, and the positive integer d is the lag of threshold variable which is observable. Therefore, in order to infer which regime occurs at any given point in time, thresholds $\{Z_1^*, Z_2^*, \ldots, Z_{K-1}^*\}$ have to be estimated.

The TVAR model in (11) has sets of parameters $\{\mu_K, A_{1K}, A_{2K}, \ldots, A_{pK}, \Omega_{uK}\}$ for each regime that have to be estimated. For this purpose, a two-step procedure is employed. In the first step, the threshold values $\{Z_1^*, Z_2^*, \ldots, Z_{K-1}^*\}$ have to be estimated which are the signs of the model's non-linearity. In the second step, the parameters of the resulting K VARs have to be estimated through Conditional Least Squares. The estimation of the threshold values that are related to the first step involves a multivariate extension of the procedure described in Chan (1993) and Hansen (2000) and adopted by Tsay (1998), with the special case of p=1 (only one lag) and K=2 (two regimes and one threshold). The TVAR model with two regimes can be written as follows:

$$y_t = \begin{cases} \mu_1 + A_{11}y_{t-1} + \Omega_1^{1.2}\upsilon_t & \text{if } Z_{t-d} < Z_1^* \\ \mu_2 + A_{12}y_{t-1} + \Omega_2^{1.2}\upsilon_t & \text{if } Z_{t-d} \geq Z_1^* \end{cases} \quad (13)$$

where $\upsilon_t \sim IID(0, I_N)$ is white noise and $\Omega_{S_t}^{1.2}$ can be obtained through a Cholesky decomposition of the matrix Ω_{S_t}. We assumed the threshold variable Z_t to be covariance stationary and continuous and estimated the parameters of the model $\{\mu_1 \mu_2, A_{12}, \Omega_1^{\frac{1}{2}}, \Omega_2^{\frac{1}{2}}, Z^*, d\}$ according to a two-step procedure. In the first step, for a given Z^* and a d, the model is reduced to two separate VARs, depending on the values of the threshold variable. The two VARs can then be estimated individually by Generalized Least Square (GLS). Among other estimates, we obtained two sum of squares residuals (SSR), i.e. $SSR_1(Z^*, d)$ and $SSR_2(Z^*, d)$, one for each equation. We defined the total sum of squares of the residuals of the model in Equation (13) as follows:

$$SSR(Z^*, d) = SSR_1(Z^*, d) + SSR_2(Z^*, d)$$

In the second step, the conditional least squares of $Z^*$and d are:

$$(\hat{Z}^*, \hat{d}) = argmin\, SSR\, (Z^*, d)$$

Finally, the estimates of the parameters $\hat{\mu}_K$, $\hat{A}_{1K}$, and $\widehat{\Omega}_K$ are a function of $\hat{Z}^*$ and $\hat{d}$. Also, the estimates of the parameters were computed easily through Conditional Least Squares.

4.2 Markov Switching Vector Autoregressive (MS-VAR) Model

In Markov switching models, the switching variable S_t shown in Equation (11) is latent and follows a discrete, first-order, time-homogeneous, k-state, and ergodic Markov chain process. The Expectation-Maximization (EM) algorithm was used to estimate Markov Switching models (Dempster et al., 1977; Hamilton 1990). For the first estimation of the unknown parameters of the model, Maximum Likelihood Estimation (MLE) was used (Krolzig, 1997); then, the conditional on the parameter was estimated, making inferences on the state variable S_t. The procedure was iterated until the point estimates of the parameters converged (Guidolin, 2012). More specifically, this model can be rewritten in its state-space form:

$$Measurement: \quad y_t = Y_t \Psi(\xi_t \otimes l_N) + \Sigma^*(\xi_t \otimes I_N)\varepsilon_t \tag{14}$$

$$Transition: \quad \xi_{t+1} = \acute{P}\xi_t + u_{t+1} \tag{15}$$

where Y_t is an $N \times (N_p + 1)$ vector with $[1 \quad y'_{t-1} \ldots \; y'_{t-p}] \otimes l_N$ structure. Ψ is an $(N_p + 1) \times NK$ matrix, including the parameters of the VAR, and Σ^* is an $N \times NK$ matrix, including all the K Cholesky factors $\{\Sigma_1, \Sigma_2, \ldots, \Sigma_K\}$ for which $\Sigma^*(\xi_t \otimes I_N)(\xi_t \acute{\otimes} I_N)(\acute{\Sigma^*}) = \Omega_{S_t}$. By considering the innovations in the two equations, $\varepsilon_t \sim NID(0, I_N)$, while u_{t+1}, is a zero-mean discrete martingale difference sequence vector, neither correlated with ε_{t+1}nor with ξ_{t-j} , ε_{t-j} and $y_{t-j}\forall_j \geq 0$. The EM algorithm works by the measurement and the transition equations.

In this study, in order to investigate the causal relationship between the exchange market pressure and inflation, a nonlinear MS-VAR model was investigated by considering the dynamics of the relationships between the variables in different macroeconomic situations:

$$\begin{aligned}
\mathrm{EMP_t} &= \vartheta_1(s_t) + \textstyle\sum_{i=1}^{m} \alpha_i (s_t)\mathrm{EMP}_{t-i} + \sum_{i=1}^{m} \beta_i (s_t)\mathrm{INF}_{t-i} \\
&\quad + \textstyle\sum_{i=1}^{m} \gamma_i (s_t)\mathrm{LM2}_{t-i} + \epsilon_{1t} \\
\mathrm{INF_t} &= \vartheta_2(s_t) + \textstyle\sum_{i=1}^{m} \delta_i (s_t)\mathrm{EMP}_{t-i} + \sum_{i=1}^{m} \theta_i (s_t)\mathrm{INF}_{t-i} \\
&\quad + \textstyle\sum_{i=1}^{m} \vartheta_i (s_t)\mathrm{LM2}_{t-i} + \epsilon_{2t} \\
\mathrm{LM2_t} &= \vartheta_3(s_t) + \textstyle\sum_{i=1}^{m} \mu_i (s_t)\mathrm{EMP}_{t-i} + \sum_{i=1}^{m} \omega_i (s_t)\mathrm{INF}_{t-i} \\
&\quad + \textstyle\sum_{i=1}^{m} \tau_i (s_t)\mathrm{LM2}_{t-i} + \epsilon_{2t}
\end{aligned} \tag{16}$$

MS-VAR models had no threshold variable but had state variables. In the above equations, EMP_t is the exchange market pressure, INF_t is inflation, and $LM2_t$ is growth money.

5. Research Findings

In this section, first, the extracted variables of the unofficial exchange rate, foreign reserves, money (m2), and consumer price index by Economic Time

Series Database of the Central Bank of the Islamic Republic of Iran are presented. Secondly, the EMP index is calculated using Edwards's (2002) and Kumah's (2007) method. Third, the stationarity of the EMP, INF, and money growth variables by ADF, PP, and KPSS tests are investigated. Forth, the LR test is used to determine the number of regimes in a TVAR model. Then, using the TVAR model, the effect of inflation and money growth on exchange market pressure is investigated. Finally, an analysis of the dynamics of the EMP and the relationship between EMP and inflation via impulse-response functions and nonlinear Granger Causality, using the MS-VAR model, is offered.

5.1 Data

In this study, the statistics provided by the Central Bank of the Islamic Republic of Iran was used to extract the quarterly data of the variables of the unofficial exchange rate, foreign reserves, money (m2), and consumer price index during 1988:4-2017:4

To estimate the exchange market pressure, Edwards's (2002) and Kumah's (2007) method was followed where the total weight of changes in both the unofficial exchange rate and the foreign reserves were considered. Accordingly, the EMP index was calculated as $\Delta e_t - \frac{M_{\Delta e \Delta e}}{M_{\Delta R \Delta R}} \Delta R_t$, in which $M_{\Delta \mathrm{e} \Delta \mathrm{e}}$ and $M_{\Delta R \Delta \mathrm{R}}$ were respectively the second moment of changes in the exchange rate and in the foreign reserve. Figure (1) shows the time series for the exchange market pressure.

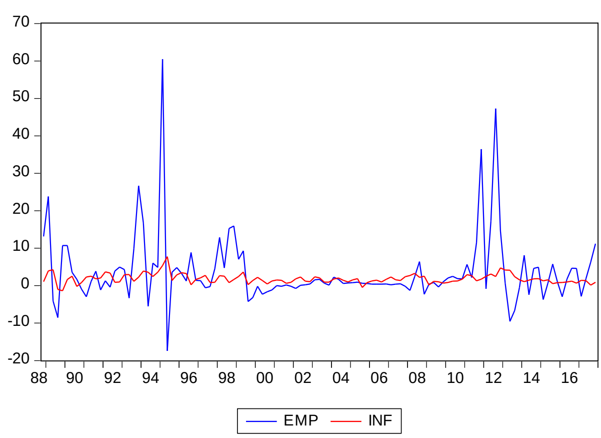


Figure 1. EMP index and INF

The results of the calculation of the EMP index in Figure (1) show that during the studied period, the EMP index had a mean value of 3.728 and a standard deviation of 9.539, with -17.417 and 60.457 for minimum and maximum values, respectively. Despite the fact that in a number of periods, the exchange rate changes were close to zero, it was possible that the EMP index had a nonlinear behavior. Thus, a nonlinear model could be used to analyze those periods.

5.2 Unit Root Test

The logarithmic difference between money and CPI variables were employed to analyze the EMP. Generalized Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test, and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test were used to measure the stationary states of the EMP index, money growth, and inflation, and the results are displayed in Table (3).

Table 3. The results of the unit root test

Variable	ADF		PP		KPSS	
	t-statistic	Test critical values (5%)	t-statistic	Test critical values (5%)	LM-stat	Asymptotic critical values
EMP	-8.451	-1.944	-8.960	-1.944	0.107	0.463
LM2	-4.293	-2.887	-5.450	-1.944	0.057	0.463
INF	-3.626	-2.887	-3.366	-1.944	0.190	0.463

***Source**: Research calculations*

Table (3) shows the results of the unit root test for the EMP index, money growth, and inflation. Considering the fact that the absolute value of statistics in Dickey-Fuller (ADF) and Phillips-Perron (PP) is bigger than the critical value in the Table (3) and is around 5%, the null hypothesis which was based on the existence of unit root and non-stationary state of the variables can be rejected and it can be stated that all variables are stationary. Also, the KPSS unit root test results show that all variables are stationary.

5.3 Threshold Vector Autoregressive (TVAR) Estimation

5.3.1 Regime characterization

Multivariate extension of the linearity test by Hansen (1999) and Lo and Zivot (2001) was used to test the null hypothesis of linearity (m = 1 regime) against the alternative, which was nonlinearity (m = 2, 3 regimes). In fact, the number of regimes was defined through an LR test. By regarding inflation as the threshold variable, the results of the threshold test presented in Table (4) show a 2-regime TVAR model.

Table 4. LR test results (inflation is the threshold variable)

Linear VAR against bi-regime threshold VAR statistic LR	251.1502 [0.00]
Linear VAR against tri-regime threshold VAR statistic LR	423.8358 [0.00]
Bi-regime threshold VAR against tri-regime threshold VAR statistic LR	172.6883 [0.4]

The values inside the brackets resemble the p-value.
***Source**: Research Calculations*

By regarding inflation as the threshold variable, the behavior of the TVAR model was investigated. If the inflation is the threshold variable and it turns out to be lower than the threshold value, it means that the observations belong to a low inflation regime. However, if the inflation is higher than the threshold, it means that the observations belong to a high inflation regime.

The results of the LR test were stated in the VAR model to define the existence of one threshold (a model with two regimes) or two thresholds (a model with three regimes). The results are displayed in Figures (2) and (3).

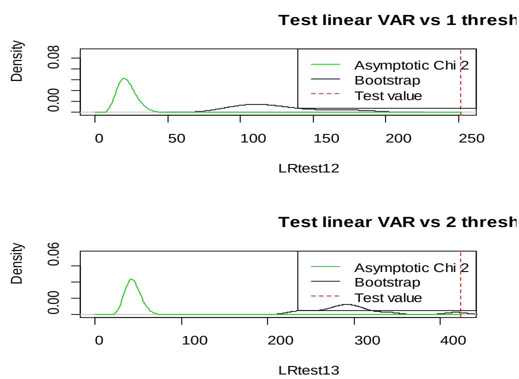


Figure 2. LR test to compare linear VAR against TVAR with one and two thresholds

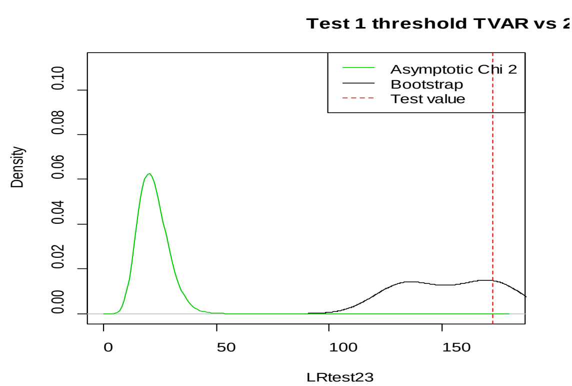


Figure 3. LR test to compare one-threshold TVAR against two-threshold TVAR

5.3.2 The results of the TVAR model

Using the optimal lag defined by the linear threshold autoregressive model as well as the results from the LR test, which defined the variable lag of the threshold as one, the threshold VAR model with two regimes was estimated and is displayed in Table (5).

Table 5. The results of the estimation of (TVAR) model

Dependent variable: EMP		
Variables	Low regime: $(INF_{t-1}) \leq 2.525$	High regime: $(INF_{t-1}) > 2.525$
LM2 (-2)	-0.0200 (0.8650)	10.9108*** (3.4874)
EMP (-3)	0.1162 (0.1133)	0.6472*** (0.2173)
INF (-3)	2.0095 (1.1219)	9.5206* (5.3481)
EMP (-4)	-0.0576 (0.1552)	-1.0249* (0.5259)
INF (-4)	-1.1355 (1.0657)	-7.2275** (3.3619)
LM2 (-4)	1.4384 (0.7269)	-15.6713*** (4.3778)
LM2 (-6)	-0.8926 (0.8216)	4.1217** (1.9306)

Notes: **, ** and *** show the significance of coefficients in the level of 1%, 5%, and 10%, respectively. Parentheses show standard deviation.*
Source: *Research Calculations*

Taking Table (5) into consideration, the variable for inflation was taken as the threshold variable with one lag (INF_{t-1}). Based on the estimations of the TVAR model, the value of the threshold variable was calculated as 2.525. Based on this, 79.1% of the observations were supposed to have taken place in a low regime and 20.9% in a high regime.

By taking the inflation as the threshold variable, the results obtained from the estimation of the TVAR model suggested that in a lower inflation regime, the lagged values of the dependent variable, inflation, and money growth had no significant effect on the EMP index.

On the other hand, in a high inflation regime, the fourth lag of the inflation (INF(-4)), money growth (LM2(-4)) variables, and the EMP index (EMP(-4)) had a negative and significant effect on the EMP. However, other lagged values of the EMP index, inflation, and money growth, as the instruments of monetary policy, had a positive and significant effect on the EMP. Therefore, although 79.1% of the observations in Iran's economy belonged to a low regime during the studied period, the relationship between the inflation variables and money growth and the EMP in Iran's economy was insignificant. However, when the inflation regime turned towards a high regime, the variables would have a significant effect on the EMP index, in a way that they either increased or decreased the EMP index.

5.4 Markov switching Vector Autoregressive (MS-VAR) Estimation

5.4.1 The results of the MSVAR model

In the previous section, the inflation variable was considered as the threshold variable, and the behavior of the EMP in different inflationary environment was examined. In this section, to investigate the dynamics of inflation and the exchange market pressure, the state-dependent behavior of inflation and EMP were analyzed using a Markov switching Vector Autoregressive(MS-VAR) model.

To analyze the EMP and inflation dynamics in the Iranian economy, an MSVAR model was estimated in two regimes and different lags. Based on the AIC information criterion, the results of the lag 4 for the exchange market pressure (EMP) and inflation (INF) equations are given in Table (6).

Table 6. The results of the estimation of the MSVAR model

variables	Dependent variable: EMP		Dependent variable: INF	
	Regime 1	Regime 2	Regime 1	Regime 2
Constant	99.8217*** (8.119)	4.17844* (2.396)	0.348717 (1.277)	1.06217*** (0.3768)
EMP_{t-1}	-0.361143*** (0.08275)	0.446884*** (0.115)	0.00424974 (0.01300)	-0.00560800 (0.01808)
EMP_{t-2}	-0.601717*** (0.1289)	-0.174709* (0.09252)	-0.0854649*** (0.02025)	0.0335986** (0.01455)
EMP_{t-3}	-0.829829*** (0.1256)	0.257908** (0.1074)	-0.0583921*** (0.01974)	-0.0199032 (0.01689)
EMP_{t-4}	0.232498** (0.09683)	-0.137195* (0.07247)	0.0437754*** (0.01522)	-0.000496217 (0.01140)
INF_{t-1}	0.396723 (1.258)	-1.2407122** (0.5276)	0.260463 (0.1978)	0.499952*** (0.08297)
INF_{t-2}	9.07694*** (1.638)	0.941458 (0.5574)	0.747773*** (0.2576)	-0.461413*** (0.08765)
INF_{t-3}	2.29528 (2.58)	-0.337131 (0.5829)	-1.92075*** (0.4052)	0.354485*** (0.09166)
INF_{t-4}	-18.0299*** (2.219)	0.748967 (0.445)	1.59093*** (0.3485)	0.0486203 (0.06998)
$LM2_{t-1}$	-2.49469* (1.225)	-0.142619 (0.4231)	0.468842** (0.1926)	-0.147457** (0.06653)
$LM2_{t-2}$	6.33502*** (1.322)	-1.28273*** (0.4047)	0.0140476 (0.2078)	0.130937** (0.06363)
$LM2_{t-3}$	-5.01925*** (1.369)	0.407461 (0.3653)	0.119052 (0.2152)	-0.0938249 (0.05744)
$LM2_{t-4}$	-19.1894*** (1.479)	-0.166653 (0.3745)	0.371206 (0.2324)	0.0181430 (0.05889)
P	P_{11} =0.803	P_{22} =0.969	Log likelihood -569.78	AIC 11.61
Linearity test	χ^2_{41} =316.76 [0]		ARCH test	F(9,51) = 0.64070 [0.7570]
Portmanteau test	χ^2_{108} =104.35 [0.5841]			

***Notes**: *, ** and *** show the significance of the coefficients in the level of 1%, 5%, and 10%, respectively.*

Parentheses show standard deviation and the brackets show the p-value.

The lm2 equation is ignored in the Table.

***Source**: Research Calculations*

In both equations, the autoregressive coefficients in all lags and in both regimes were significant. This emphasizes the stability of the estimated VAR model. However, the coefficients of the inflation in the EMP equation were significant in lags 2 and 4 in regime 1 (a regime of high EMP), and only in lag 1 in regime 2 (a regime of low EMP). At the end, Table (6) shows the diagnostic statistics of the estimated model. The hypothesis of the Linearity Test is rejected. The result of the Portmanteau Test and the ARCH test also showed that the residuals of the estimated model were not autocorrelated and are homoscedastic.

Based on the results of the MSVAR equations, the results of the Granger Causality Test are presented in Table (7). In the high-pressure regime of the foreign exchange market (regime1), inflation can be the Granger cause of the EMP, but the null hypothesis of inflation is not rejected in the lower regime of the EMP (regime 2).

Similarly, money growth can be the cause of the pressure of the foreign exchange market only in a high EMP regime.

In the inflation equation, the EMP can only be the Granger cause of inflation in low-inflationary regimes (regime 1), but in high inflationary regimes (regime 2), the EMP is not the Granger cause of inflation. The results are the same for the money growth rate (at 10% level).

The general hypothesis of the equality of coefficients in two regimes is also presented at the end of Table (7).

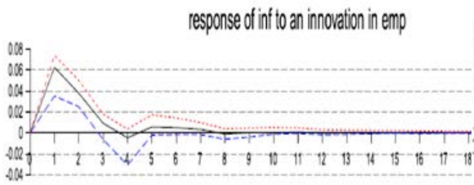
The null hypothesis of the equality of inflation coefficients in two regimes is rejected in the EMP equation; this shows that the effects of inflation on the EMP are state-dependent. Similarly, the null hypothesis of the equality of the EMP coefficients in the inflation equation in both regimes is also rejected. This shows that the EMP also had different effects on inflation in different inflationary regimes.

Table 7. Granger Causality Test

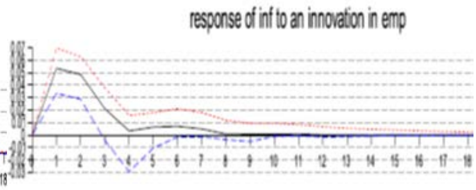
	Regime 1	Regime 2
INF is not the Granger Causality of EMP	χ^2=16.334** [0.0001]	χ^2=0.031* [0.8596]
LM2 is not the Granger Causality of EMP.	χ^2=33.603** [0]	χ^2=2.123 [0.145]
EMP is not the Granger Causality of INF.	χ^2=5.093* [0.024]	χ^2=0.112 [0.7378]
LM2 is not the Granger Causality of INF.	χ^2=3.101 [0.0782]	χ^2=0.520 [0.4707]
Equation EMP	$\sum \beta_{inf}\ in\ regime\ 1 = \sum \beta_{inf}\ in\ regime\ 2$	χ^2=14.48 [0.000]
	$\sum \beta_{lm2}\ in\ regime\ 1 = \sum \beta_{lm2}\ in\ regime\ 2$	χ^2=28.29 [0.000]
Equation INF	$\sum \beta_{emp}\ in\ regime\ 1 = \sum \beta_{emp}\ in\ regime\ 2$	χ^2=4.61 [0.0317]
	$\sum \beta_{lm2}\ in\ regime\ 1 = \sum \beta_{lm2}\ in\ regime\ 2$	χ^2=3.53 [0.0603]

***Notes**: Brackets show the p-value.*
***Source**: Research Calculations*

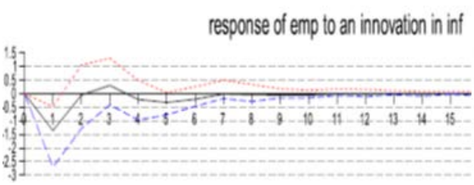
Finally, the results of the impulse-response functions in the MSVAR model for the EMP and INF equations are shown in Figure (4).



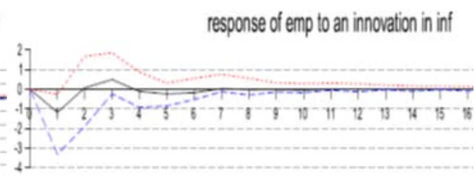
Regime 1- Response of INF to an innovation in EMP



Regime 2- Response of INF to an innovation in EMP



Regime 1- Response of EMP to an innovation in INF



Regime 2- Response of EMP to an innovation in INF

Figure 4. Impulse-response functions in the MSVAR model

The response of inflation to the shocks of EMP in regime 1 will be maximized after one period; then, the effects will start to decrease and are gradually eliminated after three periods. After the fourth period, the response of the inflation to the shocks of EMP will get close to zero and the inflation will not respond to the exchange market pressure.

The response of inflation to the shocks of EMP in regime 2 in the first period will maximize and continue to shrink until the second period. Then, the effects start to decrease and after the fourth period, they get close to zero, but this reaction in regime 2 is stable for a longer period.

There was also little difference between the responses of EMP to the inflation shocks in the two regimes. In regime 2, the response of EMP to the shocks of inflation will minimize after one period; then, the effects will increase up to the second period. After the second period, the response of EMP to the shocks of inflation will get close to zero although the results of the Causality Test indicated that in regime 2, the INF did not cause EMP.

6. Conclusion and Policy Recommendations

This study was aimed to analyze the exchange market pressure in Iran's economy. To do so, Edwards's (2002) and Kumah's (2007) methods were followed and the exchange market pressure index was calculated from the total weight of the unofficial exchange rate and the changes in the foreign reserves. The results of the Threshold Vector Autoregressive model with considering inflation as the threshold variable showed that in a low inflation regime, inflation and money growth had no significant effect on the EMP index. However, as soon as the regime of inflation turned and moved towards a high inflation regime, the inflation variable started to have a positive and significant effect on the EMP index. It means that in a high inflation regime, when the inflation grows, the EMP index increases and the domestic currency value declines. Moreover, in a high regime, money growth has a positive and significant effect on the exchange market pressure index and decreases the value of the domestic currency. Therefore, when EMP grows, implementing contractionary monetary policies could moderate the pressure. The results of the MSVAR model showed that the autoregressive coefficients in all lags were significant in both equations of EMP and INF and in both regimes. This emphasizes the stability of the estimated VAR model.

In the present study, the analysis of the causal relationships and the dynamics of the relationship between the exchange market pressure and inflation in Iran's economy showed that when the exchange market pressure crossed the threshold, specifically in the high exchange market pressure regimes, inflation would have a significant impact on the exchange market pressure, but in the regimes where the exchange market pressure was at a low level, the inflation was not the cause of the EMP. The analysis of the effects of EMP on inflation in different inflation regimes showed that EMP in low inflation regimes could also affect inflation although EMP in high inflation regimes was not the cause of inflation.

Therefore, the policymakers should note that increasing EMP, even in low inflation regimes, can lead to pressure on prices. On the other hand, if the increase in the foreign reserves causes the exchange market pressure to switch to a high regime; then, the inflationary pressures at any level of the inflation rate can exacerbate the exchange market pressure, and policymakers would be unable to control the currency market. Accordingly, if the exchange market pressure is controlled, the effects of inflation on the exchange market pressure will be discontinued, and this is a strategic and key point for policymakers.

References

Baghjari, M., Hoseininasab,E., & Najarzadeh, R. (2014). The impact of monetary policy on exchange market pressure: The Case of Iran, *Journal of Economic Research and Policies* 53-78.

Bird, G.,& Mandilaras, A. (2006). Regional Heterogeneity in the Relationship between Fiscal Imbalances and Foreign Exchange Market Pressure, *Journal of World Development* 34(7): 1171-1181.

Chan, K. S., (1993). Consistency and limiting distribution of the least squares estimator of a threshold autoregressive model, *The Annals of Statistics*, 21, 520-533.

De Macedo, J., Pereira, L.,& Reis, A. (2009). Comparing Exchange Market Pressure across Five African Countries, *Journal of Open Economy Review*, 20: 645-682.

Dempster, A. P., Laird, N. M.,& Rubin, D. B. (1977). Maximum Likelihood from Incomplete Data via the EM Algorithm, *Journal of the Royal Statistical Society*, Series B, 39, 1-38.

Edwards, S. (2002). Does the Current Account Matter?, *National Bureau of Economic Research* 21-76.

Eichengreen, B. J., Rose, A.K.,& Wyplosz, C. (1994). Speculative Attacks on Pegged Exchange Rates: an Empirical Exploration with Special Reference to the European Monetary System, *NBER Working Paper*. No. 4898.

Eichengreen, B. J., Rose, A. K.,& Wyplosz, C. (1995). Exchange Market Mayhem: The Antecedents and Aftermath of Speculative Attacks, *Economic Policy*, 10 (21): 249-312.

Enders,W. (2010). *Applied Economic Time Series*, 3end Edition.

Fiadora, V., & Biekpe, N. (2015). Monetary policy and exchange market pressure evidence from sub-Saharan Africa, *Applied Economics*, 47:3921-3937.

Franco, F., Delgado, J., Monteiro, S.,& Silva, P. (2014). Exchange Rate Pressure in Angola, *Nova Africa Center for Business and Economic Development Working Paper Series*, N0. 1502.

Gallant, A., Ronald, P.,& Tauchen,G. (1993). Nonlinear Dynamic Structures. *Econometrica*, 61 (4):871–907.

Gilal, M. A. (2011). *Exchange Market Pressure and Monetary Policy: A Case Study of Pakistan*, University of Glasgow.

Gilal, M. A.,& Byrne, J. P. (2015). Foreign Exchange Market Pressure and Capital Controls, *International Financial Markets Institutions and Money*, 37: 42-53.

Gilal, M. A.,& Chandio, R. A. (2013). Exchange Market Pressure and Intervention Index for Pakistan: Evidence from a Time-Varying Parameter Approach, *GSTF Journal on Business Review (GBR)*, 2(4).

Girton, L. D., & Roper, E. (1977). A Monetary Model of Exchange Market Pressure Applied to the Postwar Canadian Experience, *American Economic Review*, 67(4): 537-548.

Gochoco-Bautista, M., & Bautista, C. (2005). Monetary Policy & Exchange Market Pressure: The Case of the Philippines, *Journal of Macroeconomics*, 27(3): 153-168.

Guidolin, M. (2012). Modelling, estimating and forecasting financial data under regime (Markov) switching, *Working paper*, Bocconi University.

Hadian, E., Owjimehr, S. (2014). Investigating the behavior of EMP index in Iran's economy using an autoregressive pattern with smooth transition (STAR), *Quarterly Journal of Applied Economics Studies in Iran (AESI)*, (10):247-266.

Hamilton, J. D. (1990). Analysis of time series subject to changes in regime, *Journal of econometrics*, 45, 39-70.

Hansen, B. (1999). Testing for Linearity. *Journal of Economic Surveys*, 13: 551-576.

Hansen, B. E. (2000). Sample splitting and threshold estimation, *Econometrica*, 68, 575-603.

Keenan, D. M. (1985). A Tukey non-additivity-type test for time series nonlinearity, *Biometrika*, 72: 39–44.

Kemme, D. M., Lyakir, G. (2011). From Peg to Float: Exchange Market Pressure and Monetary Policy Pressure in the Czech Republic, *Review of International Economics*, 19(1): 93-108.

Khiabani, N., Ghaljei, N. (2014). Exchange Regimes and Exchange Market Pressure in a Petroleum-Exporting Economy (Iran's case), *Quarterly Journal of Applied Economics Studies in Iran (AESI)*, (3): 3-22.

Klassen, F., Jager, H. (2011). Definition-consistent measurement of exchange market pressure, *Journal of International Money and Finance*, 30: 74 - 95.

Koop, G. (1995). Parameter uncertainty and impulse response analysis, *Journal of Econometrics*, 72:135-149

Koop, G., Pesaran, M. H., Potter, S. M. (1996), Impulse response analysis in nonlinear multivariate models, *Journal of Econometrics*, 74:119-47.

Krolzig, H .M. (1997). *Markov-Switching Vector Autoregressions: Modelling, Statistical Inference, and Applications to Business Cycle Analysis (Lecture Notes in Economics and Mathematical Systems)*, Berlin, Germany: Springer Verlag, vol. 454.

Kumah, A.Y. (2007). A Markov-Switching Approach to Measuring Exchange Market Pressure, *International Journal of Finance and Economics*, 16: 114-130.

Lestano, (2010). A Structural VAR Model of Exchange Rate Market Pressure: The Case of Indonesia, *Majalah Ekonomi*, 20(1).

Lo, M. C.,& Zivot, E. (2001). Threshold Cointegration and Nonlinear Adjustment to the Law of One Price, *Macroeconomic Dynamics*, 5: 533-76.

Pandy, A. (2012). Impact of Monetary Policy on Exchange Market Pressure: The Case of Nepal, *Journal of Asian Economics*, 37:59-71.

Roper, D. E., Turnovsky, S. J. (1980). Optimal Exchange Market Intervention in a Simple Stochastic Macro Model, *Canadian Journal of Economics*, 13(2): 296-309.

Tong, H. (1983). Threshold models in non-linear time series analysis. *Lecture notes in statistics*, No. 21.

Tsay, R.S. (1986). Nonlinearity test for time series, *Biometrika*, 73:461–466.

Tsay, R. S. (1998). Testing and modeling multivariate threshold models, *Journal of American Statistical Association*, 93:1188-1202.

Turnovsky, S. J. (1985). Optimal Exchange Market Intervention: Two Alternative Classes of Rules", In: Bhandari, J.S.(ed) *Exchange Rate Management Under Uncertainty*, Cambridge: MIT Press.

Weymark, D. N. (1995). Estimating Exchange Market Pressure & the Degree of Exchange Market Intervention for Canada, *Journal of International Economics*, 39(3-4): 273-295.

Weymark, D. N. (1997a). Measuring the Degree of Exchange Market Intervention in a Small Open Economym, *Journal of International Money and Finance*, 16(1):55-79.

Weymark, D. N. (1997b). Measuring Exchange Market Pressure and Intervention in Interdependent Economy:A Two-Country Model, *Review of International Economics*, 5(1):72-82.

Weymark, D. N. (1998). A General Approach to Measuring Exchange Market Pressure, *Oxford Economic Papers*, 50(1): 106-121.

Ziaei, S. M. (2012). Evaluating the Market Exchange Rate Pressure in Inflation Condition (An Empirical Evidence of Iran), *Journal of Basic and Applied Scientific Research*, 3(11):304-309