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Exchange Market Pressure and the Degree of Exchange Market Intervention: The Case of Iran

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Abstract

In this paper, we will review the foreign exchange market and will try to extract an exchange market pressure and an intervention index for Iran by following the Weymark (1995) approach to evaluate the Central Bank of Iran's exchange rate policy during 1368:Q1 to 1391:Q3. The estimation method employed, is the econometric technique known in the literature as the Two-Stage Least Squares (2SLS).The exchange market pressure's mean value of 0.062 provides evidence that depreciating pressure remained dominant over the entire sample period. Also, the mean value of the intervention index is 0.44, indicating that the foreign exchange reserve and exchange rate changes absorbed forty-four and fifty-six percent of the pressure, respectively. Otherwise the results of the paper show that on an average there was a downward pressure on Iran's currency and the Central Bank of Iran pursued an active intervention policy. Specifically, as the intervention index shows, the Central Bank of Iran used both exchange rate and foreign exchange reserve interventions for restoring the foreign exchange market to equilibrium levels, a policy known as the managed float exchange rate regime.

Keywords: Exchange Market Pressure; Intervention Index; Exchange Rate; Foreign Reserve; 2SLS.

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Introduction

Currency crises are complicated economic issues that have occurred throughout history in many countries. Currency crisis in countries such as Mexico, Russia, Turkey, Eastern Asia, are just some examples. Evidences show that currency crisis have occurred frequently in recent years and continue to concern policy makers (Tanner 2002).[1] Policy makers in developing countries are confronted not only with situation evolving domestically, but they must remain vigilant to exogenous events and their ramification, especially in light of globalization, rapid technological changes, and constantly evolving global economic relationships (Panday, 2012). One example of external changes that affects these countries is the nature of capital flows. Many emerging market economics have voiced their concern about the rush of capital inflow, which can fuel consumption, cause a real exchange rate appreciation, and erode competitiveness. In a similar vein, many other less developed economics receive substantial inflows from remittance, which are different from capital inflows but nevertheless can have similar implications. A pertinent issue in this regard is the ability of the monetary authority to maintain a desired exchange rate system so that promotes economic stability and fosters growth. One key issue in this regard is to analyze policy effectiveness in averting a currency collapse, or even preventing the buildup of unsustainable pressure on the currency.

The value of the Iranian Rial against the US dollar has been under severe pressure. It is important for

1 .According to Kaminsky and Reinhart (1999), the number of crises rose from about 2.6 per year during 1970-79 to about 3.1 per year from 1980 to 1995.

Iranian policymakers to know when such pressure occurs and how much its intensity is, so that they can react decisively.

Girton and Roper (1977) introduced a framework that links policy variables to a measure of pressure on the currency. The authors introduced the term "exchange market pressure" (EMP), which defines pressure on the domestic currency as the sum of percentage change in the exchange rate and percentage change in international reserves. With this definition, EMP encompasses pressure on the currency under both flexible and fixed exchange rate regimes. EMP is also a useful indicator of potential currency crises. Weymark (1997) further formalized the exchange market pressure by indicating that the EMP on a currency is its excess supply in the foreign exchange market if policy makers would be passive, that is, refrain from actions to offset that excess supply, where this positive (negative) excess supply is expressed in the relative appreciation (depreciation) required to remove it. Consequently, in a floating exchange rate regime, EMP coincides with the observed depreciation, whereas in all other regimes EMP is the depreciation- equivalent of excess supply in counterfactual of a passive policy maker.

In general the Girton–Roper (G-P) model examines important factors that effect on EMP. Based on G-P model; there is a traditional view, which indicates expansionary monetary policy causes more pressure on EMP. On the other hand, the Weymark model examines direction of EMP and extracts the intervention index which is based on the exchange market pressure. Pressure on exchange rate and central bank intervention is one of the important subjects in currency debates. Exchange market pressure index and the index of central bank intervention are important criteria for analyzing the statue of currency. In this paper, we are going to compute the index of exchange market pressure and the index of central bank intervention in Iran by using Weymark model.

The paper is organized as following: In section 2, we review past studies on exchange market pressure. In section 3, we describe Weymark model of exchange market pressure. In section 4, we analyze data and in section 5, we estimate the model and constructing exchange market pressure and intervention index. Section 6 summarizes and concludes the paper.

Literature Review

Exchange market pressure is usually reflected in changes of official holdings of foreign exchange reserves and the nominal exchange rate. Under a complete fixed exchange rate regime, the central bank has to defend the committed parity with, in principle, unlimited purchases or sales of foreign exchange in case of excess demand for or excess supply of domestic currency. Under a pure floating exchange rate regime, the central bank has no such commitment and the exchange rate is totally free to absorb any change in demand and/or supply of the home currency. However, neither completely fixed nor pure floating regimes exist worldwide. The fact that changes in the exchange rate and in foreign exchange reserves often occur together indicates that monetary authorities tend to employ intermediate exchange rate systems. Under an intermediate regime, the excess demand or supply pressure that the home currency faces is usually relieved by a combination of both official reserve changes and exchange rate changes.

The issue of how a currency's EMP can be measured under the intermediate exchange rate regime is of great importance and has attracted increasing attention from policy makers, researchers, academics and international economists.

Prior to Girton and Roper's (1977) paper, Whiteman *etal*. (1975) argued that under a managed float, the effective exchange rate and foreign exchange reserve changes reflect the extent of money market disequilibrium although no one had yet constructed a single composite index to measure it. But as mention in introduction, the EMP concept was first put forward by Girton and Roper (1977).They construct an EMP index that is the sum of international reserve changes and exchange rate changes. Other economists have conducted empirical tests on the EMP index to identify the effect of monetary policy (Kim, 1985; Burdekin and Burkett, 1990; Bahmani-Oskooee and Bernstein (1999); Tanner (2000, 2002); Maria Socorro Gochoco-Bautista, Carlos C. Bautista (2005);Stavarek, Daniel and Dohnal, Mark (2009); Anjan Panday (2012)). The simple framework of Girton and Roper (1977) was further developed in a small open economy model setting (Boyer, 1978; Roper and Turnovsky, 1980). In this framework, a policy reaction function of the central bank is defined and the EMP index construction improved [1] .Under the framework of Roper and Turnovsky (1980), although the EMP index is still a linear combination of international reserve changes and

1.See Roper and Turnovsky (1980) for the specifications of the policy reaction function.

exchange rate changes, the weights of the two components are no longer identical. Girton and Roper's (1977) model and its modified versions have been applied to Brazil's experience over 1955-1975 by Connolly and Da Silveira (1979), sterling's effective exchange rateover the period 1964 -1978 by Hacche and Townend (1981), Korea's experience by Kim (1985), Costa Rica's experience by Thornton (1995), by Burdekin and Burkett (1990) to Canada, by Mah (1998) to Korea, by Pollard (1999) to Barbados, Jamaica, and Trinidad &Tobago, by Hallwood and Marsh (2003) to the pound sterling during the inter-war period, 1925-31, and by Modeste (2005) to Guyana, Maria Socorro Gochoco-Bautista, Carlos C. Bautista (2005) for Philiphine, Daniel and Dohnal, Mark (2009) for Central Europe and Anjan Panday (2012) for Nepal.

A seminal study on the EMP index was undertaken by Weymark (1995) in which the author modifies the limitations of previous research (e.g. Girton and Roper, 1977; Roper and Turnovsky, 1980) and constructs an IS-LM-AS-type small open economy model under the price stickiness assumption. She also introduces a conversion factor parameter into the EMP index construction and estimates it. This parameter represents the relative weight of the exchange rate changes to the intervention changes (represented by international reserve changes) in the EMP index. Many empirical analyses and estimations (e.g. Kohlscheen, 2000; Zhu, 2003; Stavarek, 2007) have since been conducted following the work of Weymark (1997) to estimate the EMP index using variations of the conversion factor parameter.

Roper and Turnovsky (1980)

carried forward Girton and Roper's (1977) work. Based on the assumptions of fixed prices and perfect capital mobility, they derived the optimum trade-off that monetary authorities face between exchange rate and foreign exchange reserve changes for relieving pressure on the domestic currency. They allowed the intervention to take the form of changes in exchange rate and foreign exchange reserves with both of them not equally weighted.

Weymark (1995) and Eichengreen et al. (1996) extended the monetary model of extensive EMP empirical literature, all studies have used (a variant of) this EMP measure. The EMP index and the parameters in Weymark (1995) and Eichengreen et al. (1996), for example, are defined and estimated on the basis of structural models of exchange rate determination theory. Therefore, the EMP index is called a model dependent index and the approach to estimate the index is called a model-dependent approach.

In this paper, we focus on Weymark model. In this reason, in this part, we summarize the results of Weymark research. Wermark in her article, bilateral and multilateral estimates of exchange market pressure and the degree of exchange market intervention were calculated for Canada over the period 1975 to 1990. The estimated intervention indices indicate that the Bank of Canada engaged in exchange rate management throughout the sample period. The estimates also suggest that the bilateral Canada/US exchange rate was the primary target of these intervention activities.As an illustration of the practical application of such measures to problems of policy analysis, the estimated values of exchange market pressure and exchange market intervention were used to analyze the intervention activities of the Bank of Canada over the period 1981 to 1984.

Howitt's analysis of Bank of Canada policy was conducted without the benefit of summary statistics of exchange market pressure and exchange market intervention. As a consequence, Howitt's conclusions depend as much on his intuition about how the economy operates as on the macro-economic data available to him. What has been shown in article is that when an explicit model of a small open economy and model-consistent summary statistics of exchange market pressure and intervention are substituted for Howitt's intuition, Howitt's conclusions about the conduct of Bank of Canada policy are largely supported. The summary statistics indicate that Howitt was generally correct in his description of the timing and duration of speculative attacks against the Canadian dollar as well as Bank of Canada intervention practices. The exchange market pressure calculations also provide some interesting new information. In particular, the estimated magnitudes show that the speculative attacks against the Canadian dollar became progressively more severe over the period 1981 to 1984.

1. The Model

There are many models about exchange market pressure. In this paper, we follow the approach of Weymark (1995) for the reason of its simplicity clarity and its rigor. Weymark's simple model is based on money demand, price, interest rate, money supply and monetary authorities' response function and is given as:

$$m_t^d = p_t + b_1 y_t - b_2 i_t + v_t \qquad b_1 > 0, b_2 > 0 \qquad (1)$$

$$p_t = a_0 + a_1 p_t^* + a_2 s_t \qquad a_1, a_2 > 0 \qquad (2)$$

$$i_t = i_t^* + E_t S_{t+1} - s_t \qquad (3)$$

$$m_t^s = m^s{}_{t-1} + \Delta d_t + \Delta f_t \qquad (4)$$

$$\Delta f_t = -\bar{p}_t \Delta s_t \qquad (5)$$

Where:

m_t = Refers to money stock in period t, p_t = domestic price level in period t, y_t =real domestic income in period t, i_t = domestic interest rate level in period t, v_t =stochastic money demand disturbance in period t, s_t =Nominal exchange rate refers to the number of units of domestic currency per unit of foreign currency in period t . $\Delta d_t = [h_t D_t - h_{t-1} D_{t-1}] / M_{t-1}$ Where h_t is the money multiplier in period t, D_t domestic credit and M_{t-1} is the inherited monetary stock in t. $\Delta f_t = [h_t F_t - h_{t-1} F_{t-1}] / M_{t-1}$ where F_t is the stock of foreign exchange reserves in period t with h_t and M_{t-1} defined as above. $\bar{p}_t$ = the policy authority's time-variant response coefficient.

The asterisk denotes foreign counterparts of domestic variables. Small letters denote that all variable used are in logarithms. The notation $E_t S_{t+1}$ represents rational agents' expected value of exchange rate one period ahead based on the information currently available.

Equation (1) shows that domestic money demand ($m^d{}_t$) is positively associated with domestic income (y_t) and negatively associated with interest rate (i_t). This implies positive and negative sign for estimated real domestic income parameter ($b_1 \succ 0$) and interest rate parameter ($b_2 \prec 0$). Similarly, equation (2) shows that domestic prices (P_t) are influenced by foreign price (P_t^*) and exchange rate changes (S_t). However, the absolute version of purchasing power parity is assumed not to hold as it allows for systematic deviation given by a_0 . If $a_0 = 0$ and $a_1 = a_2 = 1$ simultaneously then equation (2) breaks down to an absolute version of purchasing power parity.

Equation (3) is uncovered interest rate parity which holds that the domestic interest rate equals the foreign interest after adjustments for the expected change in exchange rate. Equation (4) defines the money supply process. It shows that the current money supply is determined by inherited money stock (m_{t-1}^s), and by changes in the domestic component of monetary base, namely domestic credit ($\Delta d_t = \frac{\Delta F_t}{B_{t-1}}$) and foreign exchange reserves ($\Delta f_t = \frac{\Delta F_t}{B_{t-1}}$). B_t Denotesdomestic monetary base. The money multiplier is assumed to be constant and intervention is assumed unsterilized[2].

Equation (5) shows monetary authority's response function to exchange rate movements. The negative sign of monetary authority's response function indicates that Central Bank's smooth exchange rate changes by selling and purchasing foreign exchange reserves. It purchases foreign exchange reserves ($\Delta f_t \succ 0$) when there is pressure on domestic currency to appreciate (i.e. $\Delta s_t \prec 0$). On the other hand, Central

[2]. Unsterilized intervention implies that Central Bank does not offset the effects of the purchase and sale of foreign exchange reserves on monetary base.

Bank sells foreign exchange reserves when the domestic currency is under depreciating pressure. The monetary authority's response function takes values between $0 \leq \bar{p}_t \leq \infty$. Under a fixed exchange rate, $p_t = \infty$ with implications for the Central Bank's infinite intervention for maintaining fixed exchange rate parity. Under floating exchange rate $p_t = 0$ and Under the intermediate exchange rate arrangements, $0 \prec p_t \prec \infty$. In practice, the monetary authority's response function p_t is time varying. It is argued that a Central Bank does not intervene each time domestic currency is under pressure. It may be the case that monetary authorities abstain from intervening in the foreign exchange market and let the exchange rate changes absorbs the entire exchange market pressure. In such a case, the monetary authority's response function equals zero ($p_t = 0$). On the other hand, $p_t \succ 0$ when the Central Bank leans against the wind and purchases foreign exchange reserves when there is downward pressure on domestic currency. It may be the case that the monetary authority's response coefficient is negative $p_t \prec 0$. This occurs when the monetary authority leans with wind – that is, the Central Bank purchases foreign exchange reserves $(\Delta f_t \succ 0)$ when the domestic currency is already under pressure to depreciate ($\Delta s_t \succ 0$) and vice versa. Substitution of equation (2) in equation (1) yields:

$$m_t^d = a_0 + a_1 p_t^* + a_2 s_t + b_1 y_t - b_2 i_t + v_t \qquad (6)$$

Substitution of equation (3) in equation (6) yields:

$$m_t^d = a_0 + a_1 p_t^* + a_2 s_t + b_1 y_t - b_2 (i_t^* + ES_{t+1} - s_t) + v_t \quad (7)$$

$$m_t^d = a_0 + a_1 p_t^* + (a_2 + b_2) s_t + b_1 y_t - b_2 (i_t^* + ES_{t+1}) + v_t \quad (8)$$

The monetary approach assumes continuous money market equilibrium at any period:

$$\Delta m_t^s = \Delta m_t^d = \Delta m \quad (9)$$

$$\bar{p}_t \Delta s_t = a_1 \Delta p_t^* + (a_2 + b_2) \Delta s_t + b_1 \Delta y_t - b_2 \Delta i_t^* - b_2 \Delta E_t S_{t+1} + \Delta v_t \quad (10)$$

Equation (10) shows that the exchange rate change required for restoring money market equilibrium subsequent to exogenous disturbance depends upon the monetary authority's response function $\bar{p}_t$. The sources of exogenous disturbance that cause domestic money market disequilibrium are foreign price change, changes in domestic income, foreign interest rate change, domestic credit, expectation about future exchange rate change, and the random money demand shock. Re-arranging equation (10):

$$\Delta s_t = \frac{1}{-(\bar{p}_t + a_2 + b_2)} \left[a_1 \Delta p^* + b_1 \Delta y_t - b_2 \Delta i_t^* - \Delta d_t + v_t - b_2 \Delta E_t S_{t+1} \right] \quad (12)$$

$$\Delta s_t = \frac{1}{t} \left[EDM_t - b_2 \Delta E_t (s_{t+1}) \right]$$

$$\Delta d_t - \bar{p}_t \Delta s_t - (a_2 + b_2) \Delta s_t = a_1 \Delta p_t^* + b_1 \Delta y_t - b_2 \Delta i_t^* - b_2 \Delta E_t S_{t+1} + v_t \quad (11)$$

$$-(\bar{p}_t + a_2 + b_2) \Delta s_t = a_1 \Delta p_t^* + b_1 \Delta y_t - b_2 \Delta i_t^* - \Delta d_t + v_t - b_2 \Delta E_t S_{t+1}$$

Where $= -\left[\bar{p}_t + a_2 + b_2\right]$ and $EDM_t = \left[a_1\Delta p_t^* + b_1\Delta y_t - b_2\Delta i_t^* + v_t - \Delta d_t\right]$

Equation (12) shows that exchange rate changes may occur due to excessive demand for money $EDM_t = \left[a_1\Delta p_t^* + b_1\Delta y_t - b_2\Delta i_t^* + v_t - \Delta d_t\right]$ or because of agents' expectations about future exchange rate changes $b_2\Delta E_t S_{t+1} \succ 0$. The actual exchange rate changes also depend on the Central Bank's choice for the value of $\bar{p}_t$ and also on exchange rate (a_2) and interest rate (b_2).The expression EDM_t also suggest that an increase in domestic credit will not increase pressure on domestic currency if it is equally offset by an increase in the demand for domestic monetary aggregates.

Re-arranging equation (12) yields:

$$(\bar{p}_t + a_2 + b_2)\Delta s_t = -\left[a_1\Delta p_t^* + b_1\Delta y_t - b_2\Delta i_t^* - \Delta d_t + v_t - b_2\Delta E_t s_{t+1}\right]$$
$$\bar{p}_t\Delta s_t + (a_2 + b_2)\Delta s_t = -\left[a_1\Delta p_t^* + b_1\Delta y_t - b_2\Delta i_t^* - \Delta d_t + v_t - b_2\Delta E_t s_{t+1}\right]$$

Substitution of $\bar{p}\Delta s_t = -\Delta f_t$ from equation (5) in the above equation yields:

$$-\Delta f_t + (a_2 + b_2)\Delta s_t = -\left[a_1\Delta p_t^* + b_1\Delta y_t - b_2\Delta i_t^* - \Delta d_t + v_t - b_2\Delta E_t s_{t+1}\right] \quad (13)$$

Re-arranging equation (13) yields:

$$(a_2 + b_2)\Delta s_t = -\left[a_1\Delta p_t^* + b_1\Delta y_t - b_2\Delta i_t^* - \Delta d_t + v_t - b_2\Delta E_t s_{t+1} - \Delta f_t\right] \quad (14)$$

Multiplying both sides of equation (14) by $\frac{1}{a_2 + b_2}$ yields:

$$\Delta s_t = \frac{-\left[a_1 \Delta p_t^* + b_1 \Delta y_t - b_2 \Delta i_t^* + v_t - \Delta d_t - b_2 \Delta E_t s_{t+1} - \Delta f_t\right]}{a_2 + b_2} \qquad (15)$$

And the implied exchange rate elasticity with respect to foreign exchange reserves is given as:

$$¦ = -\frac{\partial \Delta s_t}{\partial \Delta f_t} = \frac{-1}{a_2 + b_2} \qquad (16)$$

It is assumed that exchange elasticity of domestic price (a_2) is greater than interest elasticity of money demand (b_2). This implies that the elasticity of exchange rate with respect to foreign exchange reserves is always negative (i.e. $¦ = \frac{-1}{a_2 + b_2} \prec 0$).

In Weymark (1995) model, dependent Exchange Market Pressure is given as:

$$EMP_t = \Delta s_t + ¦\Delta f_t \qquad (17)$$

The construction of exchange market pressure requires the estimates of ¦. This further requires the estimates of interest rate elasticity of real money demand (b_2) and exchange elasticity of domestic price (a_2). Thus the construction of Weymark's (1995) exchange market pressure index requires only two estimates, namely interest elasticity of money demand (b_2) and exchange rate elasticity of domestic price (a_2).

Under fixed and floating exchange rates, the entire pressure is absorbed by exchange rate and foreign exchange reserve changes. However, under a managed float or intermediate exchange rate arrangements, monetary authorities have to decide what fraction of pressure they are willing to relieve by foreign exchange intervention.

Hence under a managed float, exchange market pressure is relieved by exchange rate changes ($\frac{\Delta s_t}{EMP_t}$) and part of it by foreign exchange reserves ($\frac{\Delta f_t}{EMP_t}$). Therefore, the division of equation (17) yields:

$$1 = \frac{\Delta s_t}{EMP_t} + \frac{¦\Delta f_t}{EMP_t} \tag{18}$$

Weymark defines exchange market intervention as a fraction of pressure that the Central Bank relieves through the purchase and sale of foreign exchange reserve and is given as:

$$\mu_t = \frac{¦(\Delta f_t)}{EMP_t} = \frac{\Delta f_t}{\left(\frac{1}{¦}\right)\Delta s_t + \Delta f_t} \tag{19}$$

The intervention index takes values between $-\infty \prec \mu \prec \infty$. In a fixed exchange rate regime $\Delta s_t = 0$ and the entire pressure is absorbed by foreign exchange reserves ($\Delta f_t = EMP_t$). In such a case $\mu_t = 1$.

On the other hand, under a flexible exchange rate regime, the entire pressure is absorbed by exchange rate changes ($\Delta s_t = EMP_t$) and foreign exchange reserve changes are held constant ($\Delta f_t = 0$). Under an intermediate exchange rate system, the time varying coefficient takes values between zero and infinity $0 \prec \bar{p} \prec \infty$ and therefore, intervention index takes a value between zero and unity $0 \prec \mu_t \prec 1$.

2. The Data

We use quarterly data for the period 1368:Q1 to 1391:Q3measured in logarithmic scale. The data on interest rate, domestic price, market spot exchange rate, gross national product (GDP), foreign exchange reserves changes, money (m_1) .Data are taken from Central Bank of Iran (CBI). The data relate to USA (CPI and GDP) were taken from Bureau of Labor Statistics.

The exchange rate (s_t) refers to number of units of domestic currency in terms of US dollars. Consumer price indices for both Iran (p_t) and USA (p_t^*) reflect the cost of acquiring a fixed basket of goods and services by the average consumer. Money (m_t) refers to currency plus demand deposits. Foreign exchange reserves (f_t) refer to total reserves. Real income is (y_t) and refers to nominal income adjusted using Iran's consumer price index. Base year is 1376.

3. Estimation of the Model

In order to estimate the parameters of the model, we first need to estimate ¦ which requires estimates of the parameters a_2 and b_2 from equation 1 and 2:

The basic objective of constructing an exchange market pressure and intervention index is to determine the direction of pressure and evaluate the monetary authorities' response function over the sample period.

We have used our data [3] and a Two-Stage Least Square procedure for obtaining interest sensitivity of money demand (b_2) and price sensitivity of exchange rate (a_2) from the estimated real money demand (eq.1) and price equation (eq. 2). This approach is adopted to overcome the endogenity. Problem that arises due to simultaneous determination of the dependent variable and one or more of the independent variables. In such a situation, ordinary least square approach yields inconsistent estimates of behavioral parameters in the regression equations. The Two

3 . We didn't test the non-stationary of all variables simply because in the 2SLS approach, this test is not warranted (See, Jack Johanston, John DiNnardo, Econometric Methods, 4th edition, McGrawHill, p:217.)

Stage Least Square (2SLS) uses instrument variables for obtaining unbiased estimates of the endogenous variables[4]. Instrumental variable is assumed to be uncorrelated with the model's error term but correlated with the endogenous variables. It is argued that the instruments used may be strongly correlated with the endogenous variable but may be uncorrelated with the dependent variable.

Table 1 shows our estimates of the real money demand function, using a Two-Stage Least Square (2SLS) method.

Table 1. Real Money Demand Estimation

	Coefficient	Std.Error	t-Statistic	Prob
const	5.747866	1.003812	7.726041	0000
gdp	0.23431	0.084389204	2.77654	0.035
i	-1.085696	0.230243	-4.715435431	0000
M(-1)	0.287308	0.038086	7.543664339	0000

Source: Research findings

4 . We used the US, CPI, GDP, interest rate, and exchange rate as the first stage instruments.

It is evident from Table 1 that interest rate and real domestic income estimates are of negative and positive signs respectively. The positive domestic real income estimate suggests that as incomes increase, people demand more money to finance their transactions. On the other hand, a negative interest rate estimate suggests that with the rise in opportunity cost of holding money, people prefer to hold their cash balances in terms of assets that earn interest rate instead of holding them in cash balances. This behavior of individuals and firms suggests a negative sign of interest rate in real money demand equation.

Table 2. Purchasing Power Parity Equation

	Coefficient	Std.Error	t-Statistic	Prob
const	-21.4413	0.344769	-62.19033614	0000
Cpi-usa	4.77441	0.115787	41.23442183	0.035
s	0.469493	0.025871	18.14746241	0000

Source: Research findings

Positive estimates of exchange rate and foreign price are consistent with purchasing power parity. Purchasing Power Parity suggests that exchange rate and foreign price changes are positively associated with domestic prices.

3.1. Estimation of Exchange Market Pressure and Intervention Index

Following Weymark (1995), we use interest rate and exchange rate estimates obtained from two-stage least square approach for constructing exchange market pressure and intervention index for Iran. We have adopted this approach to overcome the endogenity problem that arises due to simultaneous determination of dependent and one or more of the independent variables. This requires using instrumental instead of endogenous variables in the estimation of the regression equation. The instrumental variables must be correlated with endogenous variables but uncorrelated with the model's error term. We construct exchange market pressure and intervention index to check the direction of pressure and evaluate the monetary authority's response. The intervention index estimates are then used to characterize the exchange rate regime of the Iran from 1368 to 1391.

Exchange market pressure index is given as:

$$EMP_t = \Delta s_t + ¦ \Delta f_t$$

We need the estimate of bilateral elasticity ¦ to construct a model consistent exchange market pressure and intervention index. It is obtained by adding the estimated parameter of interest sensitivity of money demand (b_2) from money demand equation and (a_2) exchange rate estimate from price equation. The parameter a_2 reflects the sensitivity of domestic prices to exchange rate changes. Similarly, b_2 is interest rate sensitivity of the demand for money. The estimates of both these variables obtained from our regression equation using two-stage least square approach following Weymark (1995) are:

$a_2 = 0.469493$ And $b_2 = 1.085696$

Based on these estimates of interest rate and exchange rate, the model consistent elasticity ¦ is:

$$\text{¦} = \frac{-1}{a_2 + b_2} = \frac{-1}{0.4694 + 1.08569} = -0.64301$$

¦ denotes exchange rate elasticity with respect to foreign exchange reserve changes and is used to convert foreign exchange reserve changes into equivalent exchange rate units. The sign of ¦ is negative, which implies that exchange rate and foreign exchange reserve changes move in the opposite direction. An increase in foreign exchange reserves is associated with the appreciation of domestic currency against the US dollar in the foreign exchange market.

Figure 1 shows quarterly estimates of exchange market pressure. It is evident from the figure that depreciation pressure has remained dominant over the entire sample period. This is further supported by exchange market pressure mean value of 0.062. This can be interpreted as if the Central Bank had abstained from intervening in the foreign exchange market, the domestic currency would have depreciated by 0.6 percent. However, a positive Exchange Market Pressure mean value does not imply that in each quarter there was downward pressure on domestic currency's value. There are twenty quarters for which we have appreciation pressure. For the remaining seventy-one quarters, we have depreciating pressure on the domestic currency.

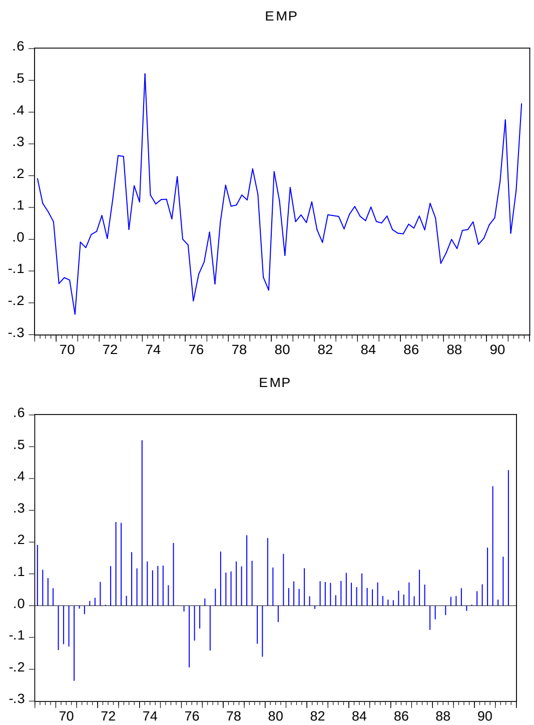

Figure1. Exchange Market Pressure (EMP)

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From figure 1, it is evident there was downward pressure on domestic currency. In this period, survey the status of exchange rate shows that in the 60s, with multi rate currency, the distance between the market exchange rate and official exchange rate were not high and the exchange market pressure is not high. Early 70's, with the implementation of the economic adjustment policies, the gap between the two rates are increased and then sharp decline in oil revenues exacerbated these differences. And then 1374, the value of EMP increased drastically and reached levels over 0.52. Afterwards in 1381, as a unified

exchange rate policy was adopted, the gap between the two rates was eliminated, and the two rates were identical and continued until 1388.During this period, the pressure in the oreign exchange market was relatively uniform staying between zero and one tenth. As of the late1389 and early 1390, the difference between the free market exchange rate and official exchange rates widened. With the intensification of economic sanctions, including sanctions of the banking sector, and decline in foreign exchange reserves, the gap between the two rates has widened tremendously. Here again, the exchange market pressure went up.

Figure 2 shows intervention index values. We define an intervention index as the fraction of pressure that the Central Bank relieves through purchase and sale of foreign exchange reserves and is given as:

$$\mu_t = \frac{\text{¦}(\Delta f_t)}{EMP_t} = \frac{\Delta f_t}{\left(\frac{1}{\text{¦}}\right)\Delta s_t + \Delta f_t}$$

Its values range between $-\infty$ till $+\infty$ .A value of $\mu_t = 0$ implies the absence of Central Bank intervention and exchange rate changes relieving the entire exchange market pressure. This is consistent with flexible exchange rate arrangements. $0 \prec \mu \prec 1$ with implications that exchange market pressure is relieved by exchange rate and foreign exchange reserve changes. Such a monetary policy characterizes the exchange rate regime as managed float. $\mu_t \prec 0$ reveals the monetary authority's leaning with the wind in that the central bank purchased foreign exchange reserves when there was already a downward pressure on domestic currency. $\mu_t \succ 1$ can be interpreted as foreign exchange reserve changes being more than that warranted by the pressure. This leads the exchange rate to move in the direction opposite to that which would have prevailed in the absence of Central Bank intervention

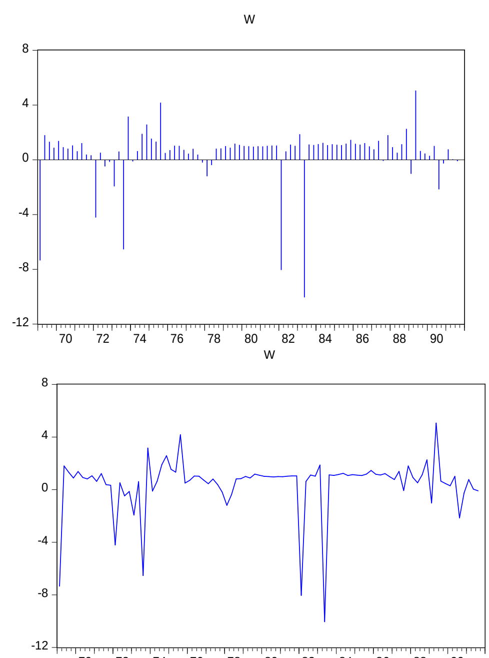

Figure 2. reveals that there are fourteen

Figure 2. Intervention (EMP)

quarters for which $\mu_t = 1$. This can be interpreted as foreign exchange reserves changes having relieved the entire pressure Index (μ_t)

in these quarters. Since the exchange rate did not change, we can term the exchange rate regime a fixed one for these quarters. Similarly for forty quarters we have $\mu_t \prec 1$ .This reveals that in these quarters both exchange rate and foreign exchange reserves changes absorbed exchange market pressure, which is consistent with a managed float. For twenty seven quarters $\mu_t \succ 1$suggesting that relative changes in foreign exchange reserves were more than those warranted by the pressure. This caused the exchange rate to move in the direction opposite to that warranted by the pressure. For the remaining seventeen quarters, we have $\mu_t \prec 0$.This implies the Central Bank's leaning with the wind policy in that the Central Bank purchased foreign exchange reserves when there was already downward pressure on domestic currency and sold reserves with a strengthening domestic currency.

The intervention index mean value is 0.44.This shows that foreign exchange reserves and exchange rate changes absorbed forty four and fifty-six percent of the pressure respectively. Since both exchange rate and foreign exchange reserve changes absorbed the pressure we can safely characterize Iran's exchange rate regime as managed float for the given sample period.

4. Conclusion

In this paper, we extracted an exchange market pressure and intervention index for Iran using the Weymark (1995) model. The objective was to check the direction of pressure and evaluate monetary authority's response. The exchange market pressure's mean value of 0.062 provides evidence that depreciating pressure remained dominant over the entire sample period.

The intervention index mean value suggests active Central Bank intervention. However, the Central Bank's response is not uniform and varies with the direction of pressure. The intervention index exceeds its unity value when the domestic currency is under pressure to appreciate and vice versa. The mean value of the intervention index is 0.44, indicating that foreign exchange reserve and exchange rate changes absorbed forty-four and fifty-six percent of the pressure respectively. Based on the intervention index's mean value, we can safely characterize Iran's exchange rate as managed float over the entire sample period.

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بررسی فشار بازار ارز و اندازه‌گیری درجه دخالت دولت در این بازار: مطالعه موردی ایران

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در این مقاله موضوع فشار بازار ارز مورد بررسی قرار گرفته شده است و تلاش خواهد شد تا شاخص فشار بازار ارز و شاخص دخالت دولت در این بازار با استفاده از رویکرد وی‌مارک جهت ارزیابی عملکرد بانک مرکزی طی دوره فصل اول ۱۳۶۸ تا فصل سوم ۱۳۹۱ محاسبه شود.

تکنیک سنجی استفاده شده جهت تخمین، روش حداقل مربعات معمولی (2SLS) می‌باشد. نتایج تخمین نشان می‌دهد که میانگین فشار بازار ارز عدد ۰/۰۶۲ است، که یعنی در دوره مورد بررسی به طور متوسط فشار جهت کاهش ارزش پول داخلی وجود داشته است. همچنین میانگین شاخص دخالت عدد ۰/٤٤ بوده است که نشان دهنده این است که به ترتیب ذخایر خارجی و تغییرات نرخ ارز، ٤٤ درصد و ٥٦ درصد فشار بازار ارز را جذب کرده است. نتایج فوق بیانگر این است که در دوره مورد بررسی، به طور متوسط فشار جهت کاهش ارزش پول داخلی وجود داشته و بانک مرکزی به طور فعالانه در بازار ارز دخالت نموده است. بویژه نتایج شاخص دخالت دولت نشان می‌دهد که بانک مرکزی از هر دو ابزار تغییرات نرخ ارز و ذخایر ارزی جهت دخالت در بازار ارز استفاده کرده که موید رژیم ارزی ایران در دوره مورد بررسی، شناور مدیریت شده است.

واژگان‌کلیدی: **فشار بازار ارز، شاخص دخالت، نرخ ارز، ذخایر ارزی و روش 2SLS.**

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۵. دکتری اقتصاد از دانشگاه تربیت مدرس.

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با تشکر ویژه از دکتر ابراهیم حسینی نسب برای همکاری مؤثر خود در این مقاله .