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RESEARCH PAPER

External Debt and Exchange Rate Fluctuations in Iran: Markov Switching Approach

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Abstract
When External net assets change, a country's money supply and the central bank's debt will change. The exchange rate is much more critical in countries like Iran because a significant portion of the government's revenue comes from the External exchange of natural resources. So, the exchange rate directly influences the government's financial situation, revenues, and costs. As External debt is one of the main financing resources of the budget deficit, thus how it will be spent can positively or negatively affect the exchange rate fluctuations. This research tried to study the effect of External debt on the exchange rate by using a monetary approach to the exchange rate and used time series data for the 1981–2017 period. In addition, due to the nonlinear relationship between the variables based on the LR and BDS test, nonlinear models were used to estimate. The results show that External debt and money supply have positive and significant effects on the exchange rate. So, monetary policy can derivate the exchange rate from its long-run trend. In contrast, the difference between domestic and external production has a negative and significant effect on the exchange rate.
Keywords: Exchange Rate Fluctuations, Exchange Rate Monetary Model, External Debt, Markov-Switching Model.
JEL Classification: E31, F33, F34.

Introduction

In recent years, External debt has become an important problem not only in developing countries but also in developed ones. In many countries, the global [financial] crisis and expansionary monetary and fiscal policy have accelerated the External debt. External debt is one of the most important sources of financing for economic growth in both developing and developed countries, which could have a positive or negative impact depending on whether being under development goals and current expenditure or not, and its negative impacts are more severe in medium and long-run (Ahmadian et al., 2016). The shortage of capital and domestic resources would compel the governments to look for resources to help them in investment and economic growth. One of the most important ways of capital financing is External debt which is also one of the ways to finance the government's budget deficit. When the budget deficit is financed by External debt, it could lead to current account deficit and even External debt crisis (Mowlaei and Golkhandan, 2014). An important point regarding the External debt is that how it will be spent, in the event of mismanagement and spending these resources on current expenditure, the economic situation does not improve and the country will face with problems of refunding.

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Given the instability of budget deficit in developing countries, countries' demand to borrow from international organizations to improve economic development has increased, so that in the last 50 years, External debt has been one the main problems that developing countries have faced with. Since the second half of the 1990s, using a high amount of External debt by developing countries has led to curbing economic development in many developing countries and this has led policymakers to concentrate more on External debt.

External debt in Iran has a very long history and the country has used External resources at different times to finance its development plans, and most governments have left External debt to their next ones. External debt was one of the main resources of financing before the Revolution as well. External debt comes in a variety of forms, including borrowing from outside of governments, the private sector, buying on credit, and selling government bonds on world markets. World Bank, European and Japanese banks and companies were some of the External lenders to Iran (Yadalehzadeh Tabari and Nazari, 2015). While, External debt is one of the main factors that causes large and, in some cases, severe fluctuations of exchange rate in long-run and short-run.

The exchange rate and policymaking in this regard, has been always one of the main challenges of Iran's economy. It is worth mentioning that any change in the exchange rate gives rise to different changes in domestic and external sectors of the economy which could influence the economic performance of the country in general. Determining the exchange rate plays an important role in exports and imports, the competitiveness of domestic producers, production and employment, the general level of prices, and therefore inflation. Thus, given its extensive effects on a country's economic performance, the determination of exchange rate and exchange rate policies are important. This is particularly important under the current situation, especially with increasing sanctions and large fluctuations in the unofficial exchange rate in the open market. In countries like Iran, the exchange rate is much more important, as a great share of the government's revenue is obtained from exports of natural resources sales and the exchange rate directly influences the government's financial status, revenues, and costs (Naghdi and Bakhtiari, 2015).

Iran is a developing country that has a large amount of debt, especially External debt, and as External debt is expressed in External currencies, due to the sanctions against Iran leading to exchange rate fluctuation and decline in the value of the national currency, External debt could have significant effects on External exchange rate. Therefore, the main purpose of this research is to study the role of External debt in exchange rate fluctuation in Iran from 1985 to 2018. Among the importance of addressing this issue is that having gone through previous studies shows there are no empirical works regarding the relationship between External debt and exchange rate fluctuation in Iran. Thus, studying the role of debts on exchange rate fluctuations can to have better policies on External debt. Therefore, according to the literature review, despite different studies on the effects of External debt on economic variables and exchange rate, and the importance of monetary models of the exchange rate for determining the factors affecting the exchange rate, only a few studies have used this model. Thus, this research examines the role of External debt on the exchange rate by using monetary models of Ajayi and Choi (1993) for exchange rate.

The remainder of this paper is organized as follows. Section 2 presents the theoretical framework. In section 3, provides a brief review of literature. Section 4 deals with the methodology of the research. Section 5 provides the results of the model and discussion, and finally Section 6 concludes the paper and gives policy recommendations.

Theoretical Framework

Many economists believe that capital is an important factor in the growth and meanwhile,

emphasize that the source of capital is not that important. In this regard, many developing countries owe a large amount of External debt and there is a concern of growth slowdown due to the high level of borrowing. But in general, there is no consensus among economists on the ultimate impact of External debt on growth (Ahmadian et al., 2016). External debt can influence the economies of developing countries through capital accumulation, infrastructure development, and human resource development.

The important thing about External debt is how it is spent, which means that if it is spent on current expenditure, then it will lead to a debt crisis for the country. Four factors can be recognized to be influential in determining External debt including capital and resources surplus of the lender country, the External debt absorption capacity of borrowing countries, the shortage of human and natural resources of the borrowing country, and Solvency (Tehranchian et al., 2011).

There are two schools of thought regarding this issue in economic literature, Classical and Keynesian. From the classical point of view, based on the Ricardian Equivalence Theorem, financing public expenditures through taxation or borrowing is the same. But the main point about the abovementioned theory is refunding debt through taxation in the future. Thus, the effect of External debt on growth is neutral (Barro, 1990). While Keynesians believe that due to new investments in the country, External debt has neither a short-run nor a long-run effect on the economy. In this regard, Neo-Keynesians assert that using debt is necessary for the economy. Alongside this school of thought, Alesina and Tabellini (1989) suggest the idea of debt accumulation strategies. Meanwhile, Leeper (1991) and Woodford (1995) believe that general level of prices is the only factor that can predict the amount of External debt, and also aggregate balanced budget (Kouladoum, 2018).

The exchange rate plays an important role in international trade because it can be used to compare the difference in goods and services prices in different countries. Due to the transformation of the exchange rate system to the floating exchange rate system in many countries, various studies have worked on the determination of the exchange rate rather than its fluctuations. There are different structural models associated with exchange rate models including the asset market (stock) approach to exchange rate determination. In this model, it is assumed that the asset market is efficient which means that expectations are rational, thus prices reflex the information of variables. But in this theory, there is no consensus about assets associated with exchange rate determination. In the monetary model of determining exchange rate with flexible prices, it is assumed that the theory of purchasing power parity and the condition of uncovered interest rate parity is established, therefore it is expressed as a long-run model. Dorenbush (1976) model of sticky prices also assumes that prices are sticky in short-run and the theory of purchasing power parity is established in long-run. One of the other approaches based on asset market theory is portfolio balance approach that assumes Current account imbalances can create long-run equilibrium.

Monetary Model of Exchange Rate

In recent years, there have been many studies concentrating on the relationship between exchange rate and different factors influencing it. These studies have used different data and different methods. The exchange rate is one of the most important macroeconomic variables in emerging countries and those in transition. There is a broad literature on determinants of exchange rate fluctuations. It is difficult to predict the exchange rate movement, but there seem to be significant models in how a country's currency is valued against other currencies. One of these models is the monetary model of the exchange rate and also the main model of exchange rate modeling. In the monetary approach, it is assumed that the exchange rate is the relative price of significant sources of money supply in the domestic and external economies.

In addition, other variables such as production, interest rates, and inflation might affect the exchange rate to the extent that it firstly affects money demand.

Ajayi (1991) has introduced a structural model to analyze the effect of External debt on the exchange rate which is a combination of monetary and asset models. A major difference between these two models is that the monetary model assumes perfect capital substitutability, while the asset model (portfolio equilibrium diversity) does not. As there is no debt problem when there is perfect substitutability between domestic and foreign capital, the asset model is essential for debt modeling. The monetary model is appropriate because it stimulates the long-run equilibrium exchange rate, assuming perfect capital substitutability, and purchasing power parity. Following Frankel (1983), these two models have been combined in form of an equation to determine the exchange rate.

Standard monetary model of Frankel (1976) and Johnson (1973) and two conditions for money market equilibrium can be stated as follows,

$$m = p + c_1 y - c_2 r \tag{1}$$

$$m^* = p^* + c_1 y^* - c_2 r^* \tag{2}$$

where, m, y and r indicate logarithm of general level of prices, logarithm of real income and nominal interest rate, respectively.[1] Star shows External variables. c_1 and c_2 coefficients are assumed to have the same value for both home and External country. We use purchasing power parity to formulate exchange rate model.

$$e = p - p^* \tag{3}$$

where e is exchange rate logarithm and is defined as the value of domestic money in units of External money. By combining Equations 1 to 3 the standard monetary model of exchange rate is obtained.

$$\bar{e} = (\mathrm{m} - m^*) - c_1(\mathrm{y} - y^*) + c_2(\mathrm{r} - r^*) \tag{4}$$

As the model is based on the assumption of the flexibility of all prices, Equation 4 shows the long-run equilibrium exchange rate. However, prices might be sticky in the short-run due to institutional reasons. Dornbusch (1976, 1980) argues that the excessive rise in the exchange rate is due to this price stickiness and the different pace of price adjustment of goods versus money markets. For instance, an unexpectedly domestic easy monetary policy reduces the long-run value of the domestic currency through inflation, but due to sticky prices, decreasing domestic interest rate lead to net capital outflow, therefore it reduces the value of the domestic currency in the short-run. The dynamic path of adjustment to a long-run equilibrium requires an expected assumption. In other words, the abovementioned equation offers the relationship between exchange rate and principles associated with traditional methods of the monetary approach to determine the exchange rate by an equilibrium model of Lucas (1982) and also some new models of "open economy" (Syllignakis and Kouretas, 2011).

One implicit assumption about the monetary model is the perfect asset substitutability so that equilibrium in the money market is sufficient to determine the exchange rate. [1] In contrast, the asset approach to exchange rate recognized that domestic and foreign assets are imperfect substitutes, and changes of expected returns and the risks associated with different

1. In monetary models, interest rate can be defined as nominal or real. Here, we use nominal interest rate because real interest rate is negative due to the government control and incomplete indexing of nominal interest rates despite of high inflation rates in some less developed countries that we have reviewed.

securities lead to portfolio diversification, redistribution of wealth, and ultimately change in the exchange rate. Imperfect substitutability is an important feature of less developed countries, which have limitations on domestic and external financing.

The asset model of Bronson and Henderson (1985), and Kouri (1976) can be expressed as follows.

$$\frac{B}{eF} = h(r - r^*, \hat{e}, z) \quad (5)$$

where B and F are the supply of domestic and external bond (in units of domestic and external currency, respectively) in market. $\hat{e}$ Is the expected rate of changes of exchange rates level, and z is a variance – covariance parameter. Equation 5 can be rewritten as follows,

$$e = k + C_3(r - r^*) + C_4\hat{e} + C_5(b - f) \quad (6)$$

where k,C_3, C_4, and C_5 are constant, f= log (F), and b= log(B). As in stable long-run equilibrium, $\hat{e} = 0$, e is determined by the asset model. However, exchange rate depends on $\hat{e}$ in short-run. Based on Dornbusch (1976), a partial adjustment process is assumed for expected exchange rate: exchange rate decreases in proportion to the difference between the long-run equilibrium exchange rate,$\bar{e}$, and the actual current rate, e. Given the importance of oil price for the economy of developing countries, it can be assumed that partial adjustment process is subject to exogenous and stochastic shocks of oil prices. So, the exchange rate change is expected to be as follows,

$$\hat{e} = C_6(\bar{e} - e) + gL \quad (7)$$

where C_6 is the partial adjustment coefficient, L indicates the oil price shock, and g is a constant value.

In order to obtain the reduced form equation, we rewrite Equation 7.

$$e = \bar{e} - \left(\frac{1}{C_6}\right)(\hat{e} - gL) \quad (8)$$

Then we replace Equation 4 with Equation 8.

$$e = (m - m^*) - C_1(y - y^*) + C_2(r - r^*) - \left(\frac{1}{C_6}\right)(\hat{e} - gL) \quad (9)$$

By solving $\hat{e}$ in Equation 6 and putting the result in Equation 9 the combined model is as follows,

$$e = a_0 + a_1(m - m^*) + a_2(y - y^*) + a_3(r - r^*) + a_4D + a_5L \quad (10)$$

where:

$$a_0 = \frac{k}{C_4C_6+1}, \qquad a_1 = \frac{C_4C_6}{C_4C_6+1}, \qquad a_2 = \frac{C_1C_4C_6}{C_4C_6+1},$$

$$a_0 = \frac{k}{C_4C_6+1}, \qquad a_1 = \frac{C_4C_6}{C_4C_6+1}, \qquad a_2 = \frac{C_1C_4C_6}{C_4C_6+1},$$

and $D = b - f$.

Now, consider the expected behavior of parameters of Equation 10. According to the monetary model, (r-r*) and (m-m*) have positive coefficients, while (y-y*) should have a

negative coefficient. With adjustment of money market, the value of a country's currency should decrease (or should increase) by a relatively easy monetary policy. Besides, the rise in domestic interest rates must reduce domestic demand of money and leads to decrease in the value of domestic currency. Rise in domestic real income should increase money demand and strengthen domestic currency.

According to asset model, (r-r*) should have a negative coefficient, as the capital inflow due to the higher domestic interest rates relative to External interest rates increases the value of domestic currency relative to External currency, which is in contrast to the monetary model. Therefore, the sign of coefficient of (r-r*) depends on relative importance of money in contrast with asset market of a given economy. In an inflationary environment, interest rate is likely to be affected by inflationary expectations rather than the effects of liquidity due to the changes in the ratio of money to bonds. Therefore, it is expected that high domestic interest rates have a negative effect on domestic currency. In an economy with stable monetary policy and low expected inflation, high domestic interest rates might lead to capital inflow with positive effects on domestic currency. D affects through the asset market and has different static and dynamic analysis. In static model, External debt implies capital flow that strengthens domestic currency through the balance of assets in capital account.[1] However, a dynamic analysis of asset model Durnbocsh (1976) and Kouri (1976) as an example] considers current account imbalance and its effect on net External asset. In a dynamic model, current account deficit increases External debt or deceases net External assets held by residents of the country which has a negative effect on the value of domestic exchange rate. So, the net effect of D on e is vague, due to the contradiction between the static asset equilibrium in the capital account and the dynamic effect of the current account imbalance on the net supply of asset.

The effect of oil price shock depends on whether a country is net exporter of oil or an importer one. In short-run, when oil is demanded, the prices are inflexible and there is no constraint on production capacity, so, any increase in global prices of oil should allow for current account surplus or accumulation of international reserves for oil exporting countries and consequently increasing the value of their currencies. Oil importing countries must experience the opposite effect.

Literature Review

There is not much literature on the relationship between External debt and the real exchange rate, especially for developing countries. Most researchers have emphasized the positive effect of External debt on the real exchange rate. However, some argue that External debt harms the exchange rate and others believe it does not affect. There are few studies about the effect of External debt and global oil prices on the exchange rate in developing countries. In this regard, Ajayi (1991) studied the effect of External debt and global oil price in determining the exchange rate in Nigeria from 1975 through 1986. This study was conducted based on two-stage least squares and the monetary model of the exchange rate. The results showed that the exchange rate had a significant relationship with global oil prices, while External debt did not affect the exchange rate. In their study, Ajayi and Choi (1993) examined the effects of External debt on the exchange rate for 18 developing countries, using a monetary approach to exchange rate and introducing External debt and oil prices to the model. The results showed that the variable of External debt, money supply, and interest rate had a negative but significant effect on the exchange rate in most countries, while the oil price had

1. This is in contrast to the traditional view of flows based on balance of payments: the current account deficit, which is a sign of external debt, has a negative effect on the domestic currency.

no significant effect on the exchange rate. Masuku (2012) studied the effects of External debt on the exchange rate in Kenya over the period 1971–2012. The results showed that External debt had a positive significant effect on the exchange rate. However, this study was conducted for those exchange rate systems that had transferred from fixed to floating.

Bunesco (2014) examined whether there was a long-run or mid-run relationship between External debt and the exchange rate in Romania. This study was conducted for the period of 2005–2013, and according to the results, the estimated regression model was significant, and changes in the exchange rate could predict the effects of changes in public and private External debt. However, there is consensus among scholars that predicting exchange rate movements is difficult. Although researchers suggested theories to explain regular patterns in the exchange rate behavior, in practice, these theories are not useful for predicting the future value of exchange rates at the time of unexpected events. Odera (2015) studied the effect of External debt on effective exchange rate fluctuations in Kenya under the floating exchange rate system from 1993 to 2013. He used a linear model to study the effects of inflation, interest rate, GDP growth, money supply-to-GDP ratio, and External debt-to-GDP ratio by using ordinary least squares (OLS). The findings showed that the External debt-to-GDP ratio had a negative impact on the exchange rate, while interest rate had a positive impact. However, inflation, GDP growth, and money supply had no significant effect on the exchange rate. In addition, high and unstable External debt led to severe exchange rate instability in Kenya. Draz and Ahmad (2015) focused on the effects of External debt and global oil prices on the exchange rate in Pakistan and compared with the results of countries without their own oil. To this end, they used the least-squares and Granger causality for the period of 1965–2009. The results showed that the exchange rate is significantly influenced by External debt, but this is not the case for the oil price. However, the findings are in contrast to the results of the same study for Nigeria, i.e. the effects of oil prices and External debt on the exchange rate are different for these two countries. Saheed et al. (2015) also examined the effects of these variables in Nigeria by using the ordinary least squares (OLS) model and found that the dependent variable of the exchange rate was affected by External debt. Asonuma (2016) assessed the currency crisis by using a dynamic stochastic general equilibrium model for Argentina. In this theoretical model, factors like bonds were considered endogenous relative to domestic and external currencies as well as the real exchange rate. Jean-Claud (2018) studied the impact of External debt on the exchange rate in Chad during the period of 1975–2014. Findings showed that External debt positively and significantly affected the real exchange rates at a 5% significant level. While debt serving had a negative significant effect on the exchange rate. Wiriadinata (2018) examined the relationship between External debt, exchange rate risk, and international money transfer policies by applying a dynamic general equilibrium model. Based on his results, the External dollar debt has led to changes in the exchange rate which has been affected by the shocks of US monetary policy. These debts also would lead to temporary changes in exchange rate risk. Kumar et.al (2019) examined the impact of external debt and the volatility of exchange rate in domestic consumption in Pakistan. The finding shows that interest rate, exchange rate, volatility of exchange rate, and external debt have long-term relationship with domestic consumption and income, interest rate and exchange rate have positive impact whereas exchange rate volatility and external debt have negative impact on domestic consumption in the short run as well as in long run. This study proposes that policymakers should consider external debt and exchange rate volatility in devising the monetary policy of Pakistan. Cahyadin and Ratwianingsih (2020) examines the empirical model of external debt, exchange rate, and unemployment in selected ASEAN Countries. The findings indicated that there were short-term effects on each empirical model. The GCT result showed that there was a causal between external debt, exchange rate, and unemployment, especially in Indonesia, and, the linkages between external debt, exchange

rate, and unemployment in selected ASEAN Countries were co-movement. Fujii (2020) investigate the nexus between the debt denomination portfolio, exchange rate cyclicality, and consumption volatility of low- and middle-income countries. The results demonstrate that portfolio concentration enhances exchange rate pro-cyclicality, which makes consumption more volatile when income shocks occur.

Also, there have been several studies on External borrowing in Iran, most of which have focused on the effects of External debt on macroeconomic variables but have not studied its effects on the exchange rate. The results of several studies show positive and, in some cases, negative relationships, and also linear or nonlinear relationships. Based on the results of most studies, External debt harms Iran's economic growth, and the main reason is the negative effect of public sector debt on the economic growth (Fallahi et al., 2019; Ja'fari et al., 2016; Ahangari et al., 2014; Yadalehzadeh Tabari and Nazari, 2015). Some studies also found that the External debt had not only negative but also a nonlinear effect on economic growth (Alizadeh et al., 2015).

Moreover, due to the importance of the monetary approach to the exchange rate in determining the factors affecting the exchange rate, many studies have used these models with different methods. Syllignakis and Kouretas (2011) have examined the dynamic relationship of bilateral exchange rate in 10 Eastern European countries against the Euro by using the monetary model of exchange rate. Due to the use of alternative exchange rates, they applied the Markov switching model. According to the results, they succeeded to use the Markov model for each bilateral exchange rate and related economic variable due to their nonlinear relationship, and for all relations, the non-linearity was confirmed. Also, over the periods that some countries have adopted a fixed exchange rate, monetary policy has led to deviations from long-run equilibrium. In contrast, during the periods with semi-fixed exchange rates, the exchange rate could adjust any imbalances of the market. In their study, Loria et al. (2010) examined both the short-run and long-run monetary model of the exchange rate for Mexico. They showed that there was a strong short- and long-run relationship between monetary variables and the exchange rate. Djeutem and Kasa (2013), based on the monetary model of the exchange rate, found that the exchange rate fluctuations could be explained through accurate and strong predictions. Wu (2015) examined the likelihood of using the Markov switching method for the exchange rate and to this end, he used the monetary model of the exchange rate with some modifications. The results showed that there were two stable regimes which confirmed there was a nonlinear relationship between exchange rate fluctuations and main variables.

Also, Tokuo and Hayato (2016) shows that that global demand shocks and non-fundamental oil price fluctuations have a strong impact on gross domestic product (GDP) and export growth for both countries, while pure exchange rate shocks are relatively unimportant in explaining Japan's macroeconomic variables. Indeed, Rezazadeh (2016) also was examined the effect of oil supply, global demand and oil price shocks on the exchange rate with the real exchange rate in Iran. Based on the results, oil price and global demand shocks have a significant impact on the real exchange rate and have Duch diseases effect on the Iran economy. While, the global oil supply shock did not have a significant effect on the exchange rate and, as a result, did not play an effective role in the developments in the Iranian External exchange market.

In general, based on the findings, it could be concluded that there have been different studies related to the monetary model of the exchange rate which their main goal has been studying the monetary factors affecting the exchange rate and changes in the exchange rate. The results show that there is a strong relationship between monetary variables and exchange rate in both short-run and long-run and also both linear and nonlinear relationship between these variables has been confirmed. In addition, there are different External studies about the

effects of External debt on the exchange rate, using simple methods of econometrics and in some cases, dynamic general equilibrium model. The models that have been used were simple regression models and in some studies like Ajayi (1991) monetary models of the exchange rate have been applied. According to the findings as mentioned, there were three different analyses, and in most studies, the positive relationship between External debt and the exchange rate has been confirmed (Wiriadinata, 2018; Jean-Claud, 2018; Masuku, 2012; Cavallo et al., 2005; Bunescu, 2014). But some studies have found a negative relationship (Devereux and Lane, 2003; Ajayi and Choi, 1993). There were also a few studies that suggested there was no relationship between exchange rate and External debt (Ajayi, 1991).

Based on the results of different studies it could be concluded that most studies have used simple regression models to examine the effects of External debt on the exchange rate. While the results of studies related to the monetary model of exchange rate show the importance of monetary variables and monetary models in determining the exchange rate. Therefore, due to the importance of the monetary model of the exchange rate, this study is based on Ajayi and Choi's (1993) model and by adding External debt to the model, examines the effect of this variable on exchange rate. As Iran is an exporting oil country and oil revenues have a big share in GDP, the oil price is also added according to the abovementioned study. In addition, most studies have used a simple linear regression model, but this study, due to the use of the Markov method for monetary models of the exchange rate in Wu (2015) and Syllignakis and Kouretas (2011) and the importance of exchange rate regimes, have used Markov switching model.

Data and Methodology

This paper uses the following model based on Syllignakis and Kouretas (2011), and Ajayi and Choi (1993) to study the effects of External debt on exchange rate.

$$s_t = \alpha_0 + \alpha_1(m_t - m_t^*) + \alpha_2(y_t - y_t^*) + \alpha_3(i_t - i_t^*) + \alpha_4 shoil_t + \alpha_5 exd_t + \varepsilon_t \qquad (11)$$

M, y, and i are money supply, GDP, and nominal interest rate, also S, *shoil*, and *exd* indicate market exchange rate, oil price shocks and External debt, respectively. As mentioned in the literature review, this model has applied a monetary model as the main tool of exchange rate modeling. The superscript * indicates the values of the abovementioned variables for External. In this study, the money supply, GDP, and nominal interest rate of the United States have been used.

In this regard, the Markov switching model used to estimate the first model. For this aim, maximum information available time series data have been used including GDP of Iran and the United States (in US dollars), Nominal interest rates of the two countries (interest rates on loans in percent), money supply of two countries (money supply as a percentage of GDP and in US dollars) and External debt of Iran (in current price and in US dollars) from the world bank. In addition, market exchange rate variable of Iran (based on the definition of the price of one dollar unit in Rials) and Iranian light oil price (in US dollars) has been used from central bank of Iran. The Hodrick Prescott method (1998) was used to calculate oil price shocks. The first difference in interest rate, money supply, and the GDP of Iran and the US have been calculated before the estimation and were added to the model as a variable. Also, for all variables except the oil price shock variable, the logarithmic form was used. This study is over the period of 1981–2017 with annual frequency and for the country of Iran.

The following diagrams show the trends of the main variables of the model, including External debt and the exchange rate used in Iran. The trend of External debts from 1980 to 1990 Iran's External debt has shown a relatively unchanged trend. However, the volume of

External borrowing has risen significantly with the end of the war and the beginning of the construction period, and due to the country's urgent need for financial resources to rebuild the damage caused by the war since 1990. But, External debt declined until 2001, due to the country's inability to repay overdue installments on time (Yadalehzadeh Tabari and Nazari, 2015), which eventually led to the currency crisis and severe inflation in 1995 and 1996. The volume of External debt has risen again since about 2001 and was at a high level almost until 2006. But again, debt levels began to decline under tightening international sanctions and lack of access to global funding around 2010.

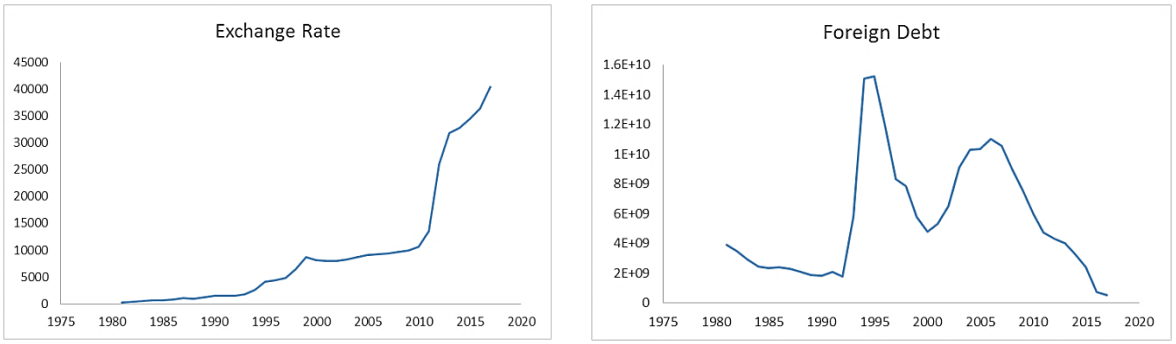

Figure 1. The Trend of Market Exchange Rate and External Debt in Iran
Source: World Bank.

Furthermore, the mechanism for determining External exchange policies and the country's External exchange system has undergone extensive changes over the past decades. The general trend of the exchange rate has been increasing since 1980, despite some slight fluctuations before 2000. In fact, the fundamental grounds for the increase in the exchange rate have gradually emerged in recent years, and therefore the developments in the External exchange market are not incompatible with the fundamental variables of the External exchange market in Iran. However, the main root of the market developments that occur every few years is the policy of the government and the central bank regarding Exchange Rates as Nominal Anchors (Deputy of Economic Research, 2016). However, regarding the exchange rate jump after 2010, it can be related to the increasing the exchange rate by 11 percent for eliminating the gap between the free market and official rate in 2011 (Vartabian Kashani, 2013), But the result was not successful, which led to an upward trend in the exchange rate. Also, after the approval of the new EU sanctions in 2011 regarding the embargo on oil purchases from Iran, the country was on the verge of a new currency crisis and faced a second currency shock in 2012. So, the exchange rate increased during this period due to the increase in demand for speculation and the creation of a psychological atmosphere in the free market. In addition, the high growth rate of liquidity in the years under review and, more importantly, the quality of its distribution has been another important factor in the continuation of currency fluctuations which continues.

Estimating econometrics models requires studying the type of relationship between the dependent variable and the set of explanatory variables. Depending on the type of relationship and the distribution of dependent and explanatory variables, linear or nonlinear models can be used to quantify or explain the behavior of variables. In Syllignakis and Kouretas (1993), the nonlinear relationship between the abovementioned variables was confirmed. However, in order to be more reliable, the likelihood ratio test (LR) and BDS test were used before choosing the estimator. The results of these tests presented in Section 5 confirm the presence of a nonlinear relationship between the variables of the model. Also, the results of these tests confirmed the rejection of the null hypothesis and the existence of a nonlinear model.

In nonlinear models, the dependent variable does not follow a linear process and a

particular state over time and experiences different states. Based on econometrics principles, in such cases, dummy variables can reflect any change in state. But sometimes the exact time of changing a particular state or the exact time of its impact is not known, thus dummy variables cannot explain state changes. To solve this problem, due to the rapid change of a variable's state, using nonlinear techniques is appropriate for estimation.

During the last two decades, nonlinear times series models have developed rapidly. However, these models have limitations, for example, they are complicated and inflexible. As they have been designed for a particular nonlinear model, they cannot be used for other cases. Markov switching model of Hamilton (1989) is an example of a nonlinear model (Kuan, 2002). It can be said that Markov switching models are known as the most common and useful nonlinear models in economics. In these models, the defined equation forms to explain the variables behavior would change by different states in which the variable is situated and is formulated as follows:

$$y_t = \alpha_0 + \alpha_1 s_t + \beta y_{t-1} + \varepsilon_t \quad (12)$$

s indicates different states for the variable. By giving different values to s, regression model takes different forms. In Markov switching approach, any change in state of variables between different states and regimes could be controlled by defining the following equation:

$$P[a < y_t \leq b | y_1, y_2, \dots, y_{t-1}] = P[a < y_t \leq b | y_{t-1}] \quad (13)$$

The above equation indicates that probability of distribution of the variable's state at any time, t, depends only on the state at time t-1. In this method, the number of optimal regimes and final model are determined by using Akaike statistic and likelihood ratio (LR).

Findings and Discussion

It is necessary to test the stationary of variables and the residual terms, before estimation, and to avoid regression fallacy. To this end, the Augmented Dickey-Fuller (ADF) test has been used. The findings of this test are summarized in Table 1 and show that all variables of the model have become stable in the first difference, except for the inflation rate, so the regression fallacy is probable. To avoid this cointegration test has been used. There are several methods to examine and test cointegration. Here, the presence of a long-run relationship between variables is evaluated by testing the durability of residuals of long-run estimation and ADF test. As the residuals of the estimation were at the level of stationary, it is not possible to reject the cointegration in the model. Moreover, almost all variables have the same degree of cointegration.

Table 1. The Results of Augmented Dickey Fuller Test (ADF)

Variable	ADF Statistic Test	The Probability of Statistic Test's Significance	The Result of Durability
Logarithm of exchange rate (market)	-4.31	0.00	I(1)
Logarithm of External debt	-3.37	0.01	I(1)
Money supply logarithm	-4.92	0.00	I(1)
Logarithm of interest rate	-4.10	0.00	I(1)
Logarithm of GDP	-5.97	0.00	I(1)
Shock of oil price	-6.12	0.00	I(0)
Residuals of long-run estimation	-5.91	0.00	I(0)

Source: Research finding.

Then, to ensure the presence of a nonlinear relationship between the variables, the likelihood ratio (LR) test was used. It should be noted that there are different types of Markov switching models, depending on which part of the model depends on the change in state. For instance, MSI[1] model is a Markov model in which the intercept depends on the states. When the variance depends on the state, then the model is MSH[2]. MSM[3] is also the Markov switching model in average. These are only three different types of Markov models. According to the abovementioned explanations, the model was estimated for different available and possible states, and the final model was selected according to the values of likelihood logarithm and Akaike statistics. Due to the priority of likelihood ratio test in using Markov models, first, the results of likelihood ratio and BDS tests are presented and then the final model selection will be explained. BDS test needs to estimation of final model at first, then, residuals is calculated and the test is applied to the residuals time series. The results are illustrated in Table 2.

Table 2. The Results of Likelihood Ratio Test (LR) and BDS Test

LR test	**The Value of Statistic Test**		**Significant Probability**	**Test Result**
	110.81		**0.00**	**Nonlinear relationship**
BDS test	**Dimensions**	**BDS statistics**	**Significant Probability**	**Test Result**
	2	0.04	0.00	Nonlinear relationship
	3	0.05	0.00	Nonlinear relationship
	4	0.04	0.00	Nonlinear relationship

Source: Research finding.

Table 2 confirm the nonlinear relationship between dependent and the explanatory variables BDS test, also, confirm the nonlinearity of the model. To determine the type of Markov models and the optimal number of regimes, the likelihood ratio and Akaike statistic is being used. According to results of these two tests, MSIH (3)-AR (3) is selected as the final model. A summary of the most important results of the model's estimation is shown in Table 3.

Table 3. The Results of Estimating the MSIH (3)-AR (3) Model

Variable	**Coefficient**	**Significant**
LMIU	0.245	0.09
LYIU	-0.913	0.00
LIIU	0.602	0.00
Shoil	0.005	0.00
LEXD	-0.07	0.03
Intercept (Regime 1)	-7.827	0.00
Intercept (Regime 2)	-8.49	0.00
Intercept (Regime 3)	-6.11	0.00
The value of likelihood logarithm statistic	39.57	
The value of Akaike statistic	-0.94	

Source: Research finding.
Note: The variables of money supply, GDP, and interest rate with first difference for both countries are LMIU, LYIU, LIIU, respectively.

1 . Markov Switching Intercept Term
2 . Markov Switching Heteroscedasticity
3 . Markov Switching Mean

As all variables have the logarithmic form, the long-run process has been considered for all variables. The results show that the long-run process of dependent variable affected by explanatory variables have experienced three different states. However, the results are credible by taking account of considerations of the model, equations used, variables, and the sample examined in the model. By considering all of these, estimated coefficients are interpreted.

The significant probability of estimated coefficient of the External debt logarithm shows a significant effect on the exchange rate. One percent increase in External debt logarithm would decrease exchange rate by about 0.07 percent. As exchange rate is defined as the price of one unit of dollar, thus it could be said that External debt can appreciate the value of domestic currency. Logarithmic coefficients indicate the elasticity of the dependent variable to the explanatory variable or variables. So, given the estimated coefficient, it can be said that exchange rate is less sensitive to External debt. Exchange rate has less elasticity to the first difference of money supply. An increase in the first difference of money supply, increases the exchange rate logarithm. As the US economy, as a developed country, enjoys stability, the variables of GDP, interest rate, and money supply are considered at optimal and stable level. Thus, any increase in the first difference of money supply can be interpreted as an increase in domestic money supply. From this point of view and given the monetary theory of inflation, it is clear that any increase in domestic money supply is accompanied by a depreciation of domestic currency. The elasticity of exchange rate to the first difference of interest rate is also positive and significant. As exchange rate to the first difference of interest rate is more elastic than money supply, the effect is more significant. Since these two variables represent the monetary sector of the economy, it can be said that monetary policy can cause the exchange rate to deviate from its long-run trend. The first difference of GDP of two countries has also negative but significant effect on exchange rate logarithm. Also, the effect of increasing GDP on the exchange rate can be studied from two perspectives. If this increase implies a boom in trade, the demand for money and its value will increase, thus the exchange rate decreases. However, if the increase in GDP represents an increase in the country's oil revenues, the value of the domestic currency will decrease due to the country's structure.

Oil price shocks has a positive and significant effect on the long-term trend of the exchange rate (Tokuo and Hayato, 2016; Rezazadeh, 2016). So, the impact of positive shocks is increasing exchange rate and decreasing country's currency. Although the coefficient is small, but, considering three points in this regard is necessary. First, the estimated coefficients are sensitive to the type of model, statistical sample, and data. Therefore, always, the degree of error in the realization of accurate results is considered. Nevertheless, the coefficient was positive as expected. Second, only light oil prices were considered, and, finally, in the model, the effect of oil price shock on the long-term exchange rate trend was investigated. Naturally, a much larger impact is expected in the short term.

In Markov switching model, the probability of switching between different states is examined by transition probability matrix which is evaluated in the following. The transfer probability matrix is presented in Table (4) after examining the status of the three regimes in Figure 2.

Table 4 shows that three regimes have a high probability of stationary. Meanwhile, the third regime has higher possibility of stationary than others with 0.99 probability. There is no possibility of change between 0 and 1 regimes during years t and t+1. The probability of transfer between regime's 0 and 2 is 6 percent, and from regime 2 to 0 is 0.1 percent.

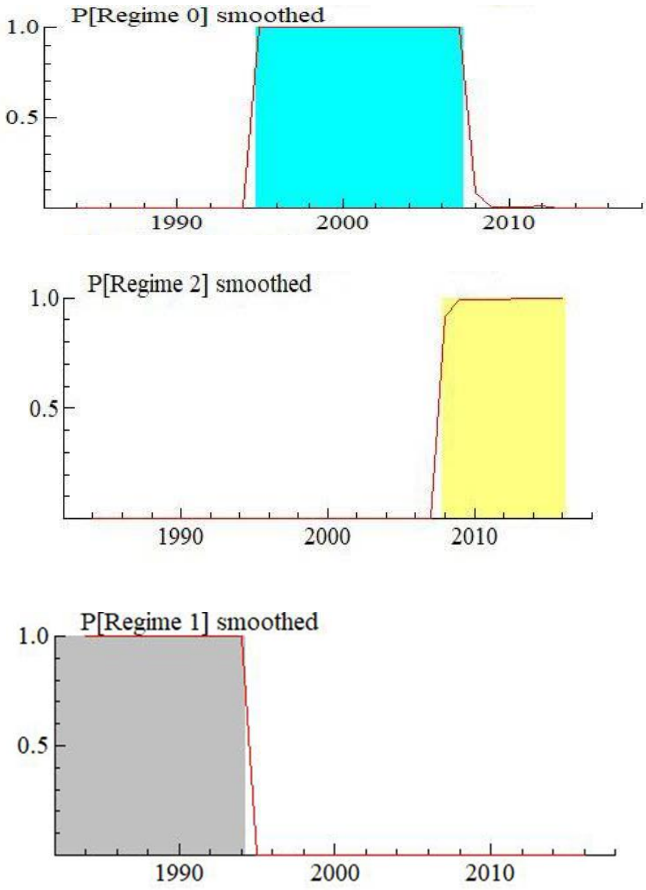

Figure 2. The Status of the Three Regimes
Source: Research finding.

Table 4. Transition Probability Matrix

	Regime 0	**Regime 2**	**Regime 2**
Regime 0	0.94	0	0.06
Regime 1	0.08	0.909	0.008
Regime 2	0.001	0	0.999

Source: Research finding.

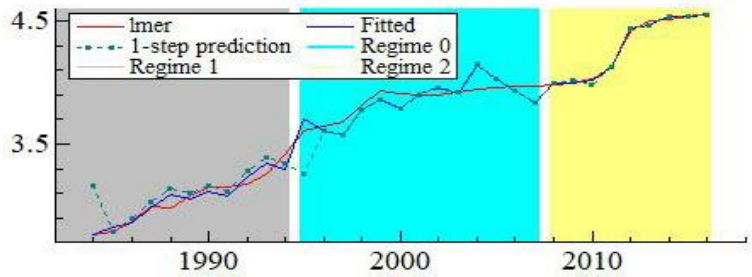

Figure 3. The Trends of Real and Estimated Market Exchange Rate Logarithm
Source: Research Finding.

Based on the trends of real and estimated market exchange rate logarithm in figure 3, the model results provide an almost acceptable estimate of the actual trend of variable given the standard deviation. The rate of changing exchange rate was different in various regimes in spite of increasing trend in the period under review. During the first regime and early years the upward trend was almost uniform. Then, the trend have changed to increasing, and,

finally, it has been growing with increasing rate since about 2010. The main reason for this increasing related to the new western sanctions on Iran in 2010, when for the first time, not only the United States, but also, the European Union imposed sanctions on Iran. In addition, the first sanctions of financial institutions of Iran, the Central Bank, insurance companies as well as financial exchanges and transfer of External exchange earnings had the fastest consequences on the country's currency system and External exchange market (Vartabian Kashani, 2013). The persistence of these problems, along with its consequences on the economy, due to the continuation and further depreciation of the national currency by 2017.

Conclusion

This research has tried to study the relationship between External debt and the exchange rate. To this end, times series data for the period of 1981–2017 has been used. In addition, given the nonlinear relationship between variables, a nonlinear model has been applied for estimation. The required statistics and data were obtained from the World Bank and the Central Bank of the Islamic Republic of Iran, according to the most availability. ADF test was used for stationary and long-term relationship between variables and Hodrick-Prescott method for the oil price shock.

The results showed that the External debt had a positive significant impact on the exchange rate. The effect of External debt on the country's economy can be studied from two general perspectives. This debt can be considered as External capital inflow or represent a balance of trade deficit. Capital inflow can be accompanied by an increase in the value of a domestic currency. If the balance of trade deficit is due to the imports of technology and capital goods, then the domestic economic prosperity increases money demand, and consequently the value of domestic currency. In contrast, if the deficit is offset by rising government expenditure and, consequently, an increase in liquidity and inflation, the value of the domestic currency will decline. Domestic currency depreciation can also be put on the agenda of policymakers as a way to boost exports and reduce the balance of trade deficit. All the analysis is under a situation where it is impossible to ignore how to use resources from External debt. The results are consistent with the theoretical foundations and results of studies by Masoko (2012), Bunesco (2014), Saheed et al. (2015), Jean-Claud (2018), and Wiriadinata (2018).

The first difference in the money supply of Iran and the US has a positive significant effect on the exchange rate. Given the country's economic structure and based on the monetary theory of inflation, any increase in the money supply can lead to domestic currency depreciation. The first difference in the nominal interest rate of the two countries also has a positive significant effect on the exchange rate logarithm. In studies, the effect of the interest rate on the exchange rate has been analyzed from two different views. The model of *asset market*, suggests that increasing the difference between the nominal interest rates of the two countries means increasing the domestic interest rates and leading to capital inflow, which increase the value of domestic money. In the monetary model, the opposite case is true. The findings of this study are inconsistent with monetary models. Money supply and nominal interest rate difference are the representatives of the monetary sector of the economy. Therefore, the monetary policy can cause the exchange rate to deviate from its long-term trend.

In contrast, the first difference between domestic and External GDP has a negative significant impact on the exchange rate logarithm. According to the theoretical background, the increase in production was expected to increase the value of the domestic currency by increasing the money demand. But it is necessary to mention that, in this study, the variable of gross domestic production (GDP) was used. In Iran, the GDP depends on oil and its revenues. Any increase in oil revenues decreases the value of the domestic currency through a fiscal

policy which is in contrast with the effect of increasing production on money demand. Finally, the oil price shock has a positive significant effect on the exchange.

In the end, due to the negative impact of External debt on the exchange rate, adopting policies that lead to capital inflow and importing efficient External technology into the country can be an effective step towards reducing these negative consequences. The results of this study also confirmed the significant impact of monetary policy on the exchange rate. According to the dominance of fiscal policy over monetary policy, it is recommended that adopting aligned monetary and fiscal policies, be considered by policymakers, in order to effectively and efficiently strengthen domestic currency.

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