The Impact of Exchange Rate Pass-Through via Domestic Prices on Inflation in Iran: New Evidence from a Threshold Regression Analysis[1]

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Abstract

There are various causes for inflation in macroeconomics. One of the important channels of experiencing inflation is through the international economy caused by external shocks. In this context, the impact of exchange rate volatilities on domestic prices known as Exchange Rate Pass-Through (ERPT) plays a vital role.

The present paper deals with the impact of Exchange Rate Pass-Through on inflation in Iran. To do so, using a monthly time series data for the period 1983: 1-2014: 9, a Threshold Regression has been applied to estimate the relevant model. The results indicate a growth rate of monthly nominal exchange rate of 9.1 percent acts as a threshold rate. In other words, ERPT to domestic prices above the threshold is statistically significant whereas below the threshold, is not statistically significant.

Therefore, due to the fact that one of the main functions of the central bank is to maintain a stable currency value it is very important to pay attention to the impact of Exchange Rate Pass-Through and its threshold effects in implementation monetary policies to curb inflation.

Key words: "Exchange Rate Pass-Through", "Inflation rate", "Threshold Regression", "Economy of Iran".

JEL Classification: C51; E31; E37; E61;F31.

1. Introduction

According to standard theories of international economics, employment and economic prosperity will be increased by outgoing away from commercial isolation. In this situation, citizens of a country can consume beyond the boundaries of their production facilities amongst basic links is the flow of important export which provides financial resources, technology and required capital and intermediate goods.

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In terms of open economy, the exchange rate is the most fundamental economic variables. Beside the flow of imports and exports and also inflow and outflow of capital, the exchange rate can affect other macro indicators, such as inflation rate. For this reason, the study of the effect of exchange rate on inflation was noticed by some economics, such as Kent & Dwyer (1993), Han & Suh (1995), McCarthy (1999), Taylor (2000), Choudhri & Hakura (2001), Leigh & Rossi (2002), Mwase (2006), Volkan & Korap (2007), Sek & Kapsalyamova (2008), Naz, et al. (2012).

In economic international economic theories, reviewing the relation between exchange rate and general level of domestic prices is called "Exchange Rate Pass-Through (ERPT)". Although the studies are most focused on measuring the amount of exchange rate pass-through on price levels, though reviewing the possibility of existing one or more thresholds is important. Although this would be possible that the pass-through would not be complete to the special level of exchange rate, whenever the exchange rate exceeds the critical amount of the pass-through becomes complete. In this way, the amount of exchange rate pass-throug can be depending on the high degree of exchange rate.

Some economists such as Posedel & Tica (2009) and Aleem & Lahiani (2014) presented that there exists a threshold for exchange rate around which the exchange rate pass-through would change.

2. Literature Review
2.1. Theoretical

Exchange rate is an important factor in economics connected to abroad and appears in economic policies. Exchange rate affects the price of goods and imported services in domestic market and price of domestic manufactured goods. Exchange rate fluctuations and subsequently change in prices proposes the problem of exchange rate pass-through.

Primary studies about exchange rate pass-through in the field of transferring exchange rate to import price began from early 1970 (Goldberg & Knetter, 1997), but thereafter the range of these studies extrude to surveying the effect of exchange rate on domestic manufactures price level and exports in terms of domestic money. For the first time, Dornbusch(1988) examined this issue exactly by the use of this pattern. In other words, Dornbusch's study was the founder of other studies about the transferring way of exchange rate changes to the prices. In his study, he examined the relation between exchange rate, domestic prices in terms of

the amount of market centralization, amount of imports, and substitution of imports to domestic manufactures.

Exchange rate pass-through can be defined as percentage of domestic price of imported goods per one percentage of change exchange rate between importing and exporting countries (Sek & Kapsalyamova, 2008).

Exchange rate fluctuations can be transferred to domestic prices in 3 ways: price of imported consumer goods, price of imported intermediated goods and domestic manufactured goods priced by foreign currency.

While the effect of exchange rate fluctuation in the first two ways is direct, in the third way, exchange rate fluctuation by changing cost of production can affect less directly (Sahminan, 2000).

Whenever exchange rate pass-through occurs completely and increases exchange rate to one percent simultaneously, imported domestic goods also increases to one percent, in other words, import price in terms of foreign currency and export price in terms of domestic currency stay stable. In this case, decreasing country's money value leads to worsening terms of trade of that country. Perfect exchange rate pass-through depends on Keynesian view point (short-term) (Devereux & Engel, 2002).

If exchange rate changes to one percent don't lead to one percent change in the price of imported domestic goods, it is declared that exchange rate pass-through was trivial or incomplete. Incomplete exchange rate pass-through provides the opportunity that despite of high elasticity of demand, stays nearly not sensitive to exchange rate changes.

Also, the intensity of exchange rate pass-through can be shown as a degree to which a decrease in nominal value can become a decrease in real value.

Figure 1 shows the direct and in direct effects of exchange rate pass-through.
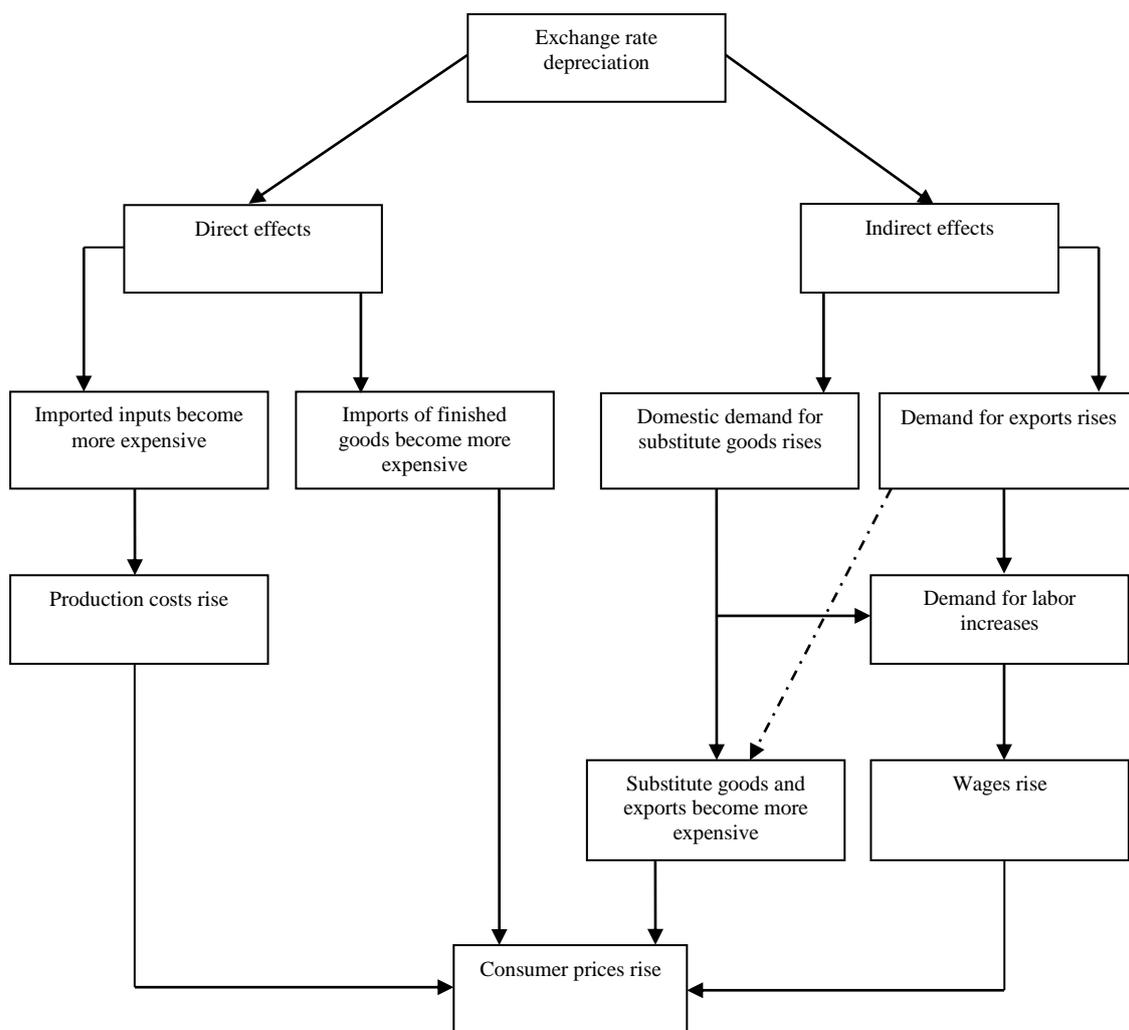
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                          ┌─────────────────┐
                          │  Exchange rate  │
                          │  depreciation   │
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Figure 1: Pass-through from an exchange rate depreciation to consumer prices

Source: Laflèche (1996)

Non-linear behaviors in exchange rate pass-through can propose trumped-up estimates of exchange rate pass-through in a situation that econometrics estimates liner. In this circumstance, we can accept that inflation condition and its rate can affect economic factors in response to exchange rate shock. In fact, domestic prices may not react to an exchange rate shock because of low and stable inflation. But whether inflation is above its threshold, they react to similar shocks (Aleem & Lahiani, 2014).

2.2. Empirical evidences

Bailliu & Fujii (2004) reviewed the relation between inflation and exchange rate pass-through degree in 11 developed countries in 1977-2001. They found Inflation Targeting policy running in many developed countries from 1990's which can lead to decreasing exchange rate pass-through degree or decreasing the transferring effect of nominal exchange rate changes based on general prices level of imported consumer goods.

Mousavi Mohseni & Sobhanipoor (2009) studied the effect of exchange rate fluctuation on imported, wholesale and consumer price in Iran during 1994-2006 by using Recursive Vector Auto Regressive (RVAR) pattern and have found out that exchange rate fluctuations have little effect on prices; in other words, exchange rate pass-through is incomplete. As well, exchange rate pass-through to imported price index is bigger than wholesale and consumer prices and passes to wholesaling in comparison with more consumer price.

Posedel & Tica (2009) have estimated the exchange rate pass-through effect in Croatia during 1992-2003 by using non-liner threshold pattern. In current study with estimating more than 13000 nonlinear regressions of exchange rate pass-through and existing threshold is proved. The results of this study indicated that the effect of nominal exchange rate change on inflation is very little or is not statistically significant in lower than threshold level, also it has strong and significant effect above the threshold level.

Takhtamanova (2010) using panel data proposed some evidence of decrease in exchange rate pass-through for 14 country members of Organization for Economic Co-operation and Development (OECD) during 1980-2007. In this study, a structural failure for 1990 is observed indicating a part of real exchange rate pass-through decrease which is explainable through low inflationary environment from 1990 onwards.

Lin & Wu (2012) in a study using Threshold Autoregressive (TAR) investigated the effect of exchange rate instability and inflationary environment on the degree of exchange rate pass- through in Taiwan during the years 1980-2008. The results of estimation show that with transition to the high instability regime, degree of exchange rate pass-through has increased and inflationary environment has also a significant and positive impact on the price index of imported goods.

Kazerooni, et al (2012) studied the effect of exchange regime variables and inflationary environment on the degree of exchange rate pass-through

in Iran during 1971-2009. Their use of Time Varying Parameter (TVP) approach showed that exchange rate regime variables and inflationary environment had significant and positive impact on the degree of exchange rate pass-through in Iran. Also, by transmitting to managed floating exchange rate regime, high inflationary environment and exchange rate pass-through have been intensified in Iran.

Cheikh (2013) using Logistic Smooth Transition Regression (LSTR) examined relationship between exchange rate pass-through and uncertainty of exchange rate pass-through in Greece, Ireland, Italy, Portugal, and Spain for the years 1993 to 2013. The results show that the instability of macroeconomic has led to increase in exchange rate pass-through in selected countries.

Aleem & Lahiani (2014) investigated the exchange rate pass-through in Mexico during the period 1994- 2009.In this study, we examined responses of domestic prices to a positive unit exchange rate shock by estimating a Threshold Vector Autoregression (TVAR) model. A monthly rate of inflation of 0.79% acts as a threshold. The results show that the exchange rate pass-through to domestic prices is statistically significant above the threshold level of the inflation rate and statistically insignificant below it.

Asgharpoor & Mahdiloo (2014) investigated the effect of inflationary environment on exchange rate pass-through degree in Iran over the years 1976-2010. For this reason, first, they used Markov–Switching Approach to extract the high and low inflationary environment. Then, by using Johansen-Joselios cointegration test they examined the effect inflationary environment along with effectiveness of business partners of final cost variables, openness degree of economy and nominal effective exchange rate on the imported price index. Empirical findings show that in Iran's economy exchange rate pass-through is incomplete and inflationary environments had asymmetric impact on exchange rate pass-through degree to import price, therefore, high inflationary environments exchange rate pass-through is more than low inflationary environments. Also, results show that business partners of final cost variable has positive and significant impact and openness degree of economy has negative and significant impact on imported price index.

Bernini & Tomasi (2015) investigated theoretically and empirically the heterogeneous response of exporters to real exchange rate fluctuations due to the quality of imported inputs and exported output. They developed a

model where the production of high-quality products requires high-quality inputs sold in monopolistically competitive foreign markets. The model predicts that exporters using imported inputs have low exchange rate pass-through, but this effect is weaker for firms shipping high-quality goods. This is due to the heterogeneous price adjustments of foreign suppliers selling inputs of different quality. They test the predictions of the model using Italian firm-level trade data for the period 2000–2006. The empirical analysis shows that the imports of intermediates have a significantly weaker effect in reducing the exchange rate pass-through into the export price of high-quality varieties. By showing that the import price of high-quality inputs is less sensitive to exchange rate variations, they provide evidence supporting the theoretical hypothesis that the pricing power of input suppliers weakens the import channel.

Hara, et al. (2015) investigated recent changes in the exchange rate pass-through in Japan. They take a two-pronged approach. First, they estimate the exchange rate pass-through into domestic prices using time-varying parameter estimation. Second, they decompose the estimated exchange rate pass-through into the responsiveness of marginal costs to the exchange rate and the responsiveness of inflation to marginal costs. The estimation results show that the rates of exchange rate pass-through into the Producer Price Index and the Consumer Price Index have been increasing since the late 2000s. The Evidence from international input-output tables suggests that the import-intensity of Japan's manufacturing sector has increased considerably over the last decade. They find that although the increasing dependence on imports in production (as well as in the retail sector) accounts for part of the rise in exchange rate pass-through, a larger part of the rise is due to greater responsiveness of inflation to marginal costs. This finding hints at a structural change in firms' pricing behavior since the late 2000s.

Savoie-Chabot & Khan (2015) believe that in an open economy such as Canada, exchange rate movements can have a material impact on consumer prices. This is particularly important in the current context, with the significant depreciation of the Canadian dollar vis-a-vis the U.S. dollar since late 2012. They provide a broad overview of the various mechanisms of exchange rate pass- through to consumer prices and discuss the implications of exchange rate pass-through (ERPT) for the conduct of monetary policy. They then describe some of the tools used at the Bank of Canada to help quantify ERPT. They conclude by taking a closer look at

the current situation in Canada, presenting a range of evidence that suggests ERPT has played an important role in recent inflation dynamics.

Donayre & Panovska (2016) estimate a Bayesian threshold vector autoregression (TVAR) to study the relationship between exchange rate pass-through and economic activity in Canada and Mexico. Both the model comparison and the analysis of impulse-response functions provide strong evidence of a nonlinear relationship and suggest that the exchange rate pass-through is dependent on the state of the economy. In particular, the pass-through coefficient is higher when the growth rate of output is large, and this difference is statistically significant across regimes for both countries. Furthermore, the results show that the degree of pass-through is complete in the case of import prices and that it falls along the distribution chain of goods.

In this study, we are empirically reviewing the effect of exchange rate pass-through on inflation in Iran and also the possibility of existing one or more thresholds by using Threshold Regression method. In Iran ,threshold regression has been used more on issues of economic growth, the theory of purchasing power parity, etc. and so far, it has not been used to examine exchange rate pass-through. In this study, we are looking forward to keeping the critical level for the exchange rate in mind and investigate the exchange rate pass-through in Iran. Thus, unlike conventional econometric methods ,we use threshold regression in this study. Also, most studies about threshold regression are conducted through univariate model; but in this study, two-variable model has been used.

3. Research methodology

In current study, all data and information is gathered by library method. Also, monthly information of free market nominal exchange rate and consumer price index available in Central Bank of the Islamic Republic of Iran for years 1983-2014, have been used.

According to economic theories, the behavior of some time series is nonlinear and it is not stable over the time. Thus, in order to study such time series it is needed to use nonlinear methods. In nonlinear patterns, response of a variable towards changes of other variables examines nonlinearity. In this case, we can use threshold regression pattern as a nonlinear pattern. Studies of Beaudry & Koop (1993), Pesaran & Potter (1997), Hansen (2001), Koop & Potter (1999), Posedel & Tica (2009) and

Aleem & Lahiani (2014) suggest widely usage of threshold patterns in empirical economy.

An important statistical issue is nonlinearity versus linearity test. Among most of economists who use linear models, nonlinearity test is a primary assumption; unless compelling evidences and documents have been existed for proving the nonlinearity.

In STATA 13 software for nonlinearity test uses Lagrange Multiplier (LM) test. Performing LM test required below steps:

Step 1: we estimate the linear part of model and obtain amount of residuals of this estimation$\{e_t\}$.

Step 2: we calculate all partial derivations $\frac{\partial f()}{\partial \alpha}$ as under null hypothesis linearity of model. Usually these partial derivatives would be a nonlinear function of regressors used in step 1. We organize an Auxiliary Regression through fitting the sample e_t on partial derivatives amounts.

Step 3: amount of $T * R^2$ has Chi-squared distribution which its freedom degree is equal to regressors used in step 2. If calculated amount $T * R^2$ be more than critical value inserted in Chi-squared distribution table, then null hypothesis of model is rejected and rival hypothesis will be accepted (Enders, 2012).

In STATA 13 software all above steps is done automatically.

In order to examine threshold effects of exchange rate pass-through on inflation in Iran, following Posedel & Tica (2009), Enders (2012) and Alaabed & Masih (2016) the following model is used:

$$\pi_t = I_t \left[\alpha_1 + \sum_{i=0}^{k} \beta_{1i} \Delta e_{t-i} \right] + (1 - I_t) \left[\alpha_2 + \sum_{i=0}^{k} \beta_{2i} \Delta e_{t-i} \right] + \varepsilon_t \qquad (1)$$

$$I_t = 1 \quad if \quad \Delta e_{t-i} \geq \tau$$

$$I_t = 0 \quad if \quad \Delta e_{t-i} < \tau$$

In which, inflation π is a function of nominal exchange rate growth. The variable I_t is a dummy variable, $I_t = 1$ if nominal exchange rate growth e_{t-i} be equal or bigger than threshold τ and $I_t = 0$ if nominal exchange rate

growth e_{t-i} be smaller than threshold τ. STATA 13 is used for estimating above model.

In experimental test the impact of exchange rate pass- through on inflation in Iran, steps of model estimation and the results of test are as follows; First, the proposed model (1) is estimated using a threshold regression. Then, LM test is used for nonlinearity test.

It is worth mentioning that in this study we used nominal exchange rate logarithm for indicating the nominal exchange rate growth and Consumer Price Index (CPI) for indicating the inflation.

3-1. Reviewing nominal exchange rate trend and inflation rate during years 1989 to 2014

Iran's economy has experienced high and double digits inflation rates from 1981s. Thus, decrease and controlling the inflation rate is policymakers and economic planners' goals. In years 1989-2014, first to fifth development plans have been designed and performed in order to reach the important goals such as economic growth and decreasing inflation rate. In table 1, there are realized amounts of inflation rate and exchange rate for years 1989-2014, categorized by development plans. As we can see in table 1, the increase in nominal exchange rate over years 2011 to 2014 relates to fifth development plan which is significant and is more than other years.

Also in table 2, adopted amounts and performance of inflation rate and exchange rate growth is prepared in five development plan.

Table 1. Inflation rate values and realized exchange rate in first to fifth economic development plans (1989-2014)

		Free market nominal exchange rate (Dollar to Rials)			Inflation rate (Percent)	
		Volume	Growth rate (Percent)	Average growth rate (Percent)	Volume	Average growth rate
First development plan	1989	1211.58	18.9	19.6	17.4	21.6
	1990	1410	16.4		9	
	1991	1419	0.6		20.7	
	1992	1498	5.6		24.4	
	1993	1810	20.8		22.9	
	1994*	2808	55.1		35.2	
Second development plan	1995	4133.35	47.2	26.3	49.4	25.6
	1996	4215.17	2.0		23.2	
	1997	4785	13.5		17.3	
	1998	6468.36	35.2		18.1	
	1999	8657.68	33.8		20.1	
Third development plan	2000	8188.13	-5.4	0.3	12.6	14.1
	2001	8008.45	-2.2		11.4	
	2002	8018.94	0.1		15.8	
	2003	8323.05	3.8		15.6	
	2004	8747	5.1		15.2	
Forth development plan	2005	9042	3.4	3.3	10.4	14.9
	2006	9226	2.0		11.9	
	2007	9357	1.4		18.4	
	2008	9677	3.4		25.4	
	2009	9979	3.1		10.8	
	2010	10601	6.2		12.4	
Fifth development plan	2011	12000	13.2	38.7	21.5	25.6
	2012	26175	118.1		30.5	
	2013	30150	15.2		34.7	
	2014	32600	8.1		15.6	

Source: Central Bank of the Islamic Republic of Iran
* These figures concern with the year 1994 for first development plan and the year 2010 for forth development plan, because performing the second development plan due to prolongation of survey and approval of bill plan with a one year lag which began from year 1995. This situation is true for fifth development plan.

Table 2. Realized and target values of economic growth rate, inflation rate and exchange rate growth in first to fifth economic development plans (1989-2015)(Percent)

	Inflation rate		Exchange rate growth
	Goal	Average performance	Average performance
First development plan (1989-1993)	14.4	18.8**	19.6
Second development plan (1995-1999)*	12.4	25.6**	26.3
Third development plan (2000-2004)	15.9	14.1	0.3
Forth development plan (2005-2009)*	9.9	14.9	3.3
Fifth development plan (2011-2015)	9.9***	25.6****	38.7****

Source: Central Bank of the Islamic Republic of Iran

* These figures concerned year 1994 for first development plan and year 2010 for forth development plan.
** For first and second development plans, these figures have been extracted from Management and Planning Organization's tables which is calculated according to base year 1988.
*** Quantities targets for fifth development plan are the same as forth development plan's target.
**** Average performance of fifth development plan is until year 2014.

As seen from the above table, there are some differences between targets and performance of inflation rate during 5 years of development plans. It seems that one of the most important factors determining this deviation is the exchange rate.

4. Findings

Estimation results of the proposed threshold regression model are shown in table 3.

**Table 3. The threshold regression model estimation results**

Variable	$q > 9.12$	$q \leq 9.12$
Intercept	-3.69 (0.33)	-8.06 (0.08)
Nominal exchange rate growth	0.85 (0.03)	1.25 (0.01)
Dependent variable: Inflation rate	R-squared: 0.86 Sum of Squared Errors: 3.02	R-squared: 0.97 Sum of Squared Errors: 9.85

source: Research's findings

As observed from above table's information, the threshold limit estimated for nominal exchange rate growth is 9.1 percent. Two regimes for one threshold limit means that nominal exchange rate growth impact on inflation has changed just one time during 31 years.
Figure 2 also shows estimated threshold limit.

Figure 2. Confidence Interval Construction for Threshold
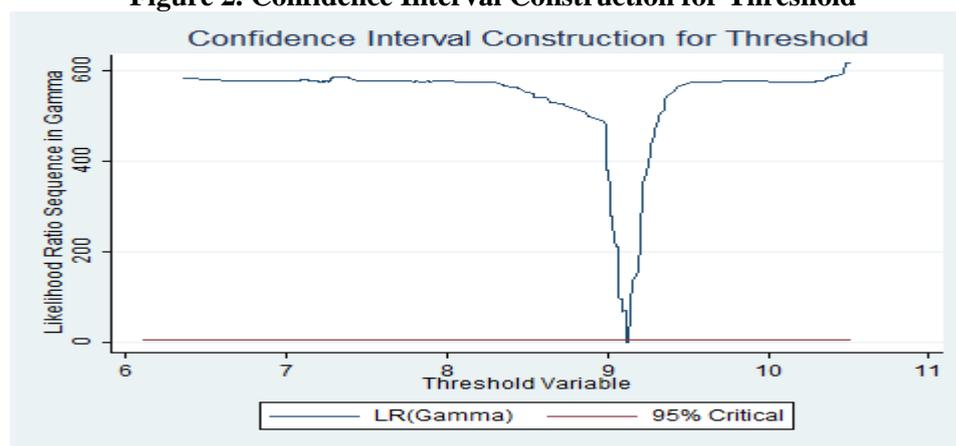
source: Research's findings
Table 4 shows results of threshold existence test.

Table 3. Test of null of no threshold against alternative of threshold allowing heteroskedastic errors (White corrected)

Number of bootstrap replications	5000
Trimming percentage	0.15
Threshold estimate	9.07
LM-test for no threshold	130.40
Bootstrap P-Value	0.0

source: Research's findings

Based on the table above, the numerical value of the LM test is 130.40 and regarding the critical value in Chi-squared distribution table which is 5.99, the null hypothesis (There is no threshold) is rejected and rival hypothesis (There is a threshold) is accepted. In other words, the null hypothesis (linearity model) is rejected and the rival hypothesis will be accepted.

Figure 3. F test for threshold reject linearity if F sequence exceeds critical value
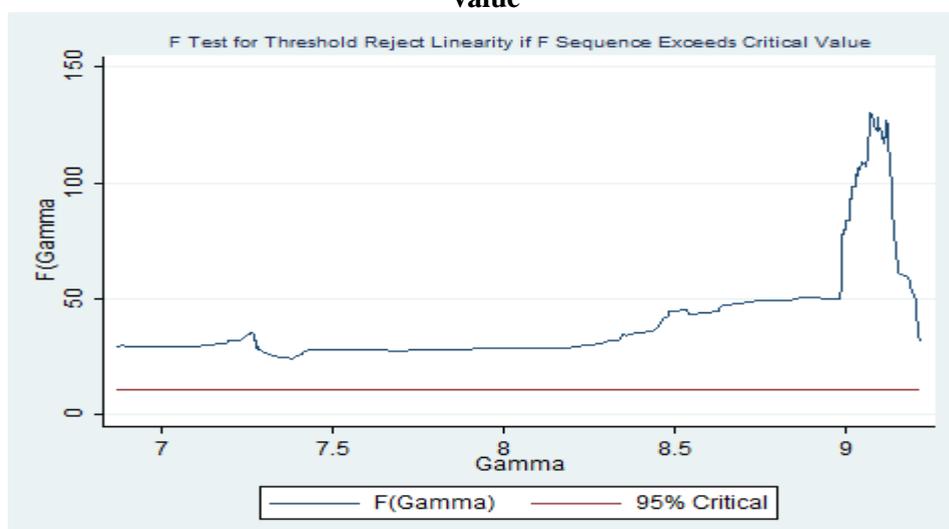
source: Research's findings

Based on the figure 3 assuming the nonexistence of threshold (the null hypothesis) is rejected.

5. Conclusions

Inflation rate beside some macroeconomic variables such as economic growth rates includes one of the important indicators in countries' economic performance assessed. Inflation affects some of the most important key economic variables such as unemployment, foreign trade, distribution of income, savings, investment and economic well-being. For this reason, investigating the factors affecting inflation is allocated to a significant part of economic and scientific literature. In an open economy in which residents of a country have interaction with the rest of the world; the exchange rate is one of the determinants of inflation.

In Iran's economy, which in late 50 years had experienced proposed war and unconventional sanctions with free trade basics, nominal exchange rate have had significant increases. In this study, exchange rate pass-through threshold impacts on inflation in Iran have been empirically investigated. Results showed that there exists one threshold limit for nominal exchange rate growth on the level of 9.1 percent. Statistically exchange rate pass-through to domestic prices above the threshold level is significant and its below the threshold is not significant. Existence of two regimes or one volume for threshold limit means that impact of nominal exchange rate growth on inflation has changed just one time over 31 years. According to results of current study empirical evidence based on existence of more than on threshold limit is not observed. Since according to results, the average of nominal exchange rate growth was more than threshold limit. This leads to increasing exchange rate pass-through.

Considering the fact that the preservation of the value of national currency is one of the more important tasks of central bank, attention to exchange rate pass-through and its threshold impacts on design and implementation of monetary and exchange policies in planning seems necessary for controlling the inflation. The results of this study will lead us to this policy guidance that regarding the issue of exchange rate pass-through in Iran and due to the damaging effects of inflation on the economy and household welfare, monetary policy makers must restrain the foreign exchange shocks. Because reducing exchange rate fluctuations can prevent raising prices of imported goods through reducing the degree of exchange rate pass-through and help to stabilize the domestic price level. In addition, controlling liquidity, increasing the production capacity and supporting domestic production are other policy recommendations of this study to economic policy makers to reduce the general level of

domestic goods prices and thereby to control the inflation rate. It is significant that the effect of low transfer of exchange rate to consumer prices contains an important point for domestic monetary policy makers. So, the effect of lower transmission of exchange rate provides more freedom for pursuing an independent monetary policy, in particular, through inflation targeting regime. Finally, due to the difference in the effect of exchange rate on inflation from both sides of the threshold, policy makers should focus more on threshold.

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