OBSERVARE
Universidade Autónoma de Lisboa

e-ISSN: 1647-7251
Vol. 12, Nº. 1 (May-October 2021)

JANUS.NET
e-journal of International Relations

EXCHANGE RATE PASS-THROUGH TO PRICE INDICES IN IRAN

MOHSEN MOHAMMADI KHYAREH
m.mohamadi@ut.ac.ir
Assistant professor, University of Gonbad Kavous (Iran)

Abstract

One of the major challenges for monetary policy is to predict how exchange rate fluctuations affect inflation and price indices. Hence, the main objective of this study is to examine the exchange rate fluctuation in the price indices in Iran. This paper analyzes the effects of exchange rate fluctuations on price indices and other macroeconomic variables of Iran during the period of 2004-Q1 to 2018-Q4, using the framework of a recursive VAR model, drawing on Bernanke (1986) and Sims (1986).The results indicate that the transfer of exchange rate changes to price indices is imperfect, such that the exchange rate path through to consumer, producer, and import prices is from 14.68%, 15.55% and 18.22% in the first period increase to 51.78%, 53.15% and 88.14% in the 13th period. In addition, the results indicate that the exchange rate path-through decreases along the distribution chain, with the highest exchange rate passing through the import prices, producer prices and consumer prices, respectively. The result has interesting implications for Iran's ability to attain an effective inflation-targeting regime. Monetary policy makers should curb exchange rate fluctuations by adopting appropriate exchange rate policies in order to minimize the uncertainty of the consumer price index. The study contributes to the literature by assessing the effect of changes in the exchange rate (the Iranian Rial vis-à-vis the US$) on prices using an updated time series from 2004 to 2018. It addresses the limitations of the previous studies, which found no strong relationship between the exchange rate and inflation rate in the Iranian context. One of these limitations was using the CPI, as the only price index.

Keywords

Exchange rate path-through, Monetary Policy, price index, Recursive VAR, Iran

How to cite this article

Khyareh, Mohsen Mohammadi (2021). Exchange rate pass-through to price índices in Iran. Janus.net, e-journal of international relations. Vol12, Nº. 1, May-October 2021. Consulted [online] at date of last visit, https://doi.org/10.26619/1647-7251.12.1.8

Article received on October 31, 2020 and accepted for publication on March 4, 2021

EXCHANGE RATE PASS-THROUGH TO PRICE INDICES IN IRAN

MOHSEN MOHAMMADI KHYAREH

Introduction

Due to foreign exchange transactions in petroleum and petrochemical products, Iran has always had a positive trade balance. However, in the last few months of 2017 and since the beginning of 2018, the country's foreign exchange market has experienced substantial volatility, and the open market exchange rate has risen. The reasons for the exchange rate increase should be found from two types of background factors and aggravating factors. In the past few years, the most important potential factors have emerged that have made the country vulnerable to the foreign exchange system, including the rapid increase in liquidity restrictions on Iranian banks related to the transfer of funds; dependence on intermediate currencies such as the US dollar and euro, and dependence on centralized SWIFT. However, the factors leading to the sharp rise in the exchange rate are the sharp rise in the level of uncertain capital outflows in the country's economic environment, withdrawal from brokerage houses, and new restrictions on the country's foreign exchange trading routes.

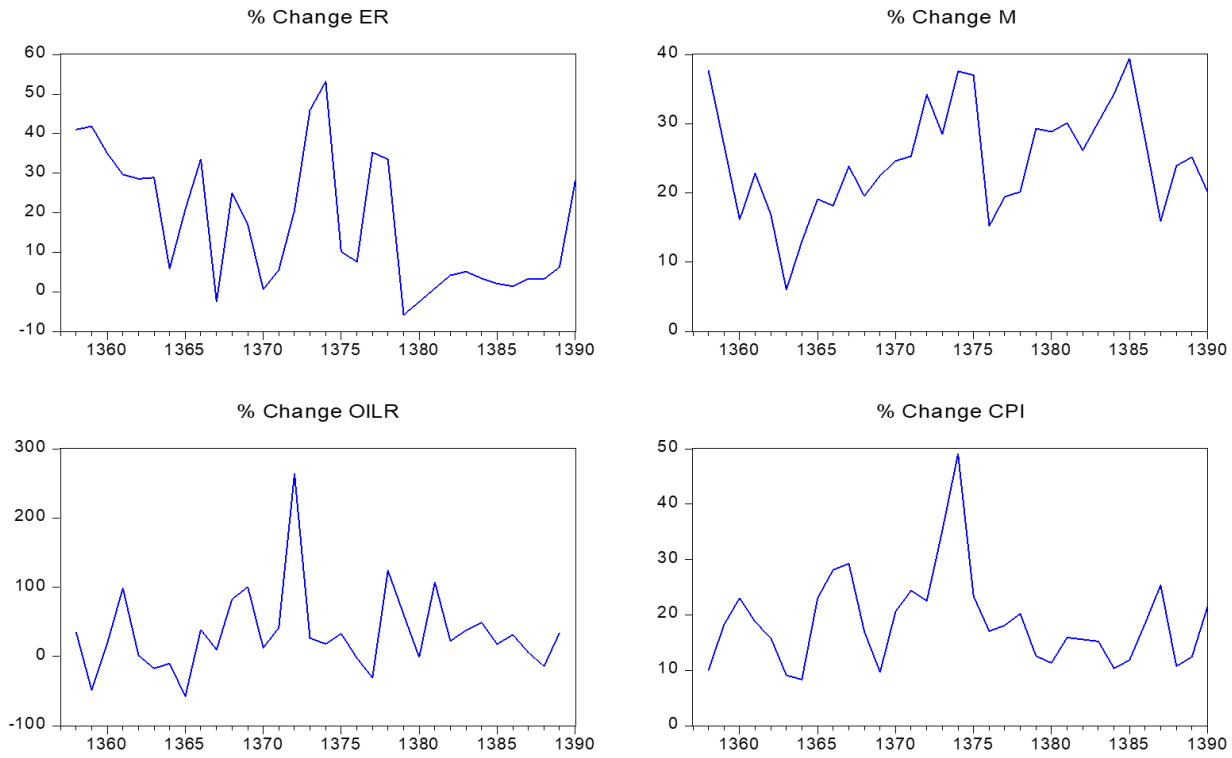
It should be noted that not all factors affecting exchange rate fluctuations are influenced by purely economic factors, and many non-economic factors, such as political developments, can affect the exchange rate expectations by influencing society's expectations. However, to consider the coincidence of political developments and exchange rate fluctuations during the period 2013-2018, we should say that the election of US president Donald Trump in November 2016 caused an increase in the fluctuation of the exchange rate in Iran, and, moreover, Trump threat to withdraw from the joint comprehensive action plan (JCPOA)[1] caused further fluctuations in the Iranian exchange rate. Thus, in order to keep inflation low and stable, it is necessary to identify the important factors involved in inflation in Iran. Meanwhile, part of the high inflation in Iran is due to foreign price shocks due to the high share of imported goods in GDP, so, the high exchange rate fluctuations have prompted our attention to study the exchange rate on price indices in Iran. As exchange rate is one determinant of inflation, changes in exchange rates are considered important in the design of monetary policy, especially when a country has a flexible exchange rate policy as well as an open trade policy. It has

[1] The Joint Comprehensive Plan of Action (JCPOA) known commonly as the Iran nuclear deal or Iran deal, is an agreement on the Iranian nuclear program reached in Vienna on 14 July 2015, between Iran and the P5+1 (the five permanent members of the United Nations Security Council—China, France, Russia, United Kingdom, United States—plus Germany) together with the European Union.

thus been an ongoing challenge for economists to examine the Exchange rate pass-through (ERPT) to domestic prices. Therefore, the main purpose of the present study is to evaluate the degree of ERPT in Iran. To this end, the dynamic response of inflation to price indices to the exchange rate shocks in Iran will be examined.

According to Figure 1, the development of the country's foreign exchange market shows the turbulence of the market and the dramatic volatility of the past few decades. At the same time that Iran implemented a unified exchange rate policy in 1993, the exchange rate rose sharply due to the imbalance of international payments, mainly due to the fall in oil prices and the issue of debt repayment due. Later, in 2002, through the financial support of the central bank's foreign exchange reserves and the central bank's financial coverage, a unified exchange rate policy was implemented, which greatly reduced the distance between the free market and the official exchange rate. Thus providing relative stability in the foreign exchange market. In addition, between 2002 and mid-2010, a managed floating system is being implemented. However, since the country's main supplier depends on the foreign exchange income from oil exports, fluctuations in world oil prices and the decision to use oil income in the annual budget have led to the fragmentation of the foreign exchange market. Since mid-2010, after the gap between the market and the official exchange rate widened, the exchange market fluctuated sharply in 2011 and 2012.

Figure 1: Trend of annual percentage change in variables



Source: Time series database, Central Bank of Iran

One of the most important reasons for the increase in the exchange rate is the growing speculative demand for currencies, the expected increase in foreign exchange rate returns and the expected increase in the expected profits of exchange rate purchases. The continued rise of market exchange rates, negative future prospects for sanctions, the country's exchange rate income and foreign exchange reserves, the expansion of lease space, and the increase in inflationary pressures caused the country to be on the verge of exchange rate crisis in late 2011 and mid-2018. On the other hand, the growth rate of liquidity and oil revenue in the past few years, and more importantly, the quality of its distribution, is another important factor in the continued exchange rate fluctuations. Speculative demand channel is a channel that affects liquidity and exchange rate volatility. It should also be noted that the accumulation of harmful liquidity over the years has promoted economic turmoil in various fields, such as the land, housing market, gold market and, recently, the foreign exchange market. In addition, factors such as high inflation in the past few years, lack of exchange rate adjustment, and high dependence on oil revenue have become factors affecting exchange rate fluctuations in recent years. However, sanctions are the most influential factor when currencies have recently begun to fluctuate. Therefore, due to the close relationship between exchange rate fluctuations, liquidity and oil revenue, this article studies the relationship between them.

In the case of Iran, the relationship between price index and ERPT has been tested using VAR and structural variance (SVAR) models. The salient feature of this study is the use of a recursive VAR model to check ERPT. This study investigated the effects of oil revenue, economic growth, money supply growth, and exchange rate fluctuations. So far, the effects of these variables have not been studied under the recursive VAR model. Another feature of the model is the ability to evaluate the sustainability of the results by evaluating the sensitivity of the results to different Cholesky rankings. Compared with other models used in previous researches, another feature of this model is that it can examine the impact of different monetary authorities' policies on different economic shocks.

In the second part of this article, we review Iran's exchange rate policy, and in the third part we review the theoretical and empirical literature. The fourth part discusses research methods and data. The fifth part discusses the experimental results, and finally the conclusions in the sixth part are discussed.

1. Overview of the Iranian Financial System

Over the past decades, the mechanism for determining foreign exchange policies and exchange rates has changed widely and has generally shifted over time to more flexible arrangements. After the adoption of the fixed exchange rate system during the years (1959-1978), the multiple exchange rate system was applied in the years following the Islamic revolution and until 1992. This system has been in place since (1994-2001) and since mid-2010 till now. After that, the managed floating system has been implemented in the country with two completely different experiences. In the first experience in 1993, due to the imbalance in the balance of payments, which was mainly due to the fall in oil prices and the repayment of overdue debts, the system failed. However, the managed floating system again implemented in 2002, and due to high profits and abundance of foreign exchange rate earnings continued until mid-2010.

The event that affected the operation of the managed float system was the imposition of sanctions against the country's financial system in October 2010. Although the history of Western hostility towards Iran and its manifestation in the form of unilateral and multilateral sanctions dates back to the early formation of the Islamic Republic of Iran; by the middle of 2010, western sanctions against Iran have taken a different course, in terms of quantity and scope. It was broader in terms of enforcement rules and mechanisms than in previous sanctions.

In the new series of western sanctions on Iran, adopted in July 2010 for the first time in addition to the United States, Europe has also imposed sanctions on Iran and has imposed sanctions on Iranian financial institutions, central banks, insurance companies, oil and gas exports, petrochemicals and products. Oil and financial transactions (such as SWIFT) and the transfer of foreign exchange earnings were also included in the sanctions.

One of the most important and immediate consequences of the imposition and imposition of sanctions was its impact on the country's exchange rate system and foreign exchange market. Evidence has been that the foreign exchange market has reacted to the sanctions in the near-term over the past six years. In the real sector of the economy, sanctions have also reduced foreign exchange earnings and reduced exchange rate supply by restricting exports of oil, gas, petroleum products and petrochemicals.

1.1. Developments and history of exchange rate arrangements in Iran

Investigating the developments of Iran's exchange rate arrangements since 1957 has shown a shift from fixed exchange rate system to more flexible exchange rate system. In general, the Iranian economy during this period, it has experienced three types of exchange rate policy adopted over six different times.

Prior to the victory of the Islamic Revolution, the country had a stable exchange rate system. However, government oversight, exchange rate rationing, and setting priorities for foreign exchange spending continued until 1973. In 1974, the price of oil on the world markets was remarkably high increased. With the increase in foreign exchange earnings from oil exports, the quota was eliminated (by maintaining a stable exchange rate system). After the victory of the Islamic Revolution, the country's exchange rate system remained a fixed exchange rate system, but with the emergence of the central bank's capital flight atmosphere to contain and control this stream implemented controls.

The beginning of imposed war caused foreign exchange earnings faced many constraints, reduced export opportunities, increased demand for imports, and lower world oil prices. At the same time, adopting a policy of import substitution, which began a decade before the victory of the revolution, increased the need for high-capacity industries whose major equipment was imported to foreign exchange earnings. On the other hand, the import of essential commodities needed by society as well as the increasing costs of development projects also required access to foreign exchange resources. Given the limited foreign exchange earnings of the country, channeling and optimally allocating these resources was crucial. After the imposed war and the initial reconstruction of the exchange rate, unification became one of the priorities of the country's economic transformation. The exchange rate unification policy was first introduced in 1993. The exchange rate policy in Iran in 1993 was followed by a sharp increase in the exchange rate due to the

imbalances in payments, mainly due to falling oil prices and the problem of overdue payments. In general, the policies implemented were not successful because of the lack of coordination and requirements in all of the country's policies for exchange rate unification.

Since the policy of exchange rate unification with the approach of achieving a more flexible exchange rate system plays an important role in improving the performance of different economic sectors, this policy was re-applied in 2002 and the types of existing rates were abolished. In 2002, the implementation of a unification exchange rate policy using the financial support from the Central Bank's foreign exchange reserves significantly reduced the free and official exchange rate gap considerably and provided relative stability in the foreign exchange market. The managed floating exchange rate system was in operation from 2002 to mid-2010. During these years, in addition to the exchange rate derived from oil and gas exports, the continued increase in non-oil exports served as a resource for managing the exchange rate market. Although there were views that the exchange rate adjustment was commensurate with the difference in domestic and foreign inflation rates, the existence of sufficient foreign exchange resources made it difficult to maintain relative stability in the foreign exchange market.

Since 2010, with the imposition of new sanctions against the country's banking system, due to a tightening of the program and the restriction of oil revenues, the exchange rate hike accelerated. The unofficial rate of the dollar at the end of 89 was about 10400 Rials, which at the end of March the following year went up to the 19000 Rial. In fact, the unofficial dollar rate in the 2011 saw an 80 percent growth. Following these inflammations, the central bank of Iran started raising the official rate and announced the official dollar rate at 12260 Rial. The exchange rate shock of 2011 continued in the following year, as the exchange rate fluctuations were very high and the dollar in the open market experienced a price of 40000 Rial per 1 US$. In the second half of the year 2017 a new round of volatility in the exchange rate market began that was exactly the same as in the 2011 and 2012. The increase in the price of the dollar accelerated since December 2017 and gradually increased to the limit of 48, 500 Rial per USD.

2. Literature review

Since the 1990s, researchers have focused more on empirical studies of exchange rates. Since then, most empirical research has studied the effect of ERPT on prices in particular industries, specific countries, or groups of countries depending on the general characteristics of their macroeconomics. For example, Feinberg (1989) and Knetter (1993) have empirically examined price adjustment in terms of degree of market concentration, relative shares of domestic and imported products, import penetration, and exchange rate fluctuations. Studies such as Devereux and Yetman (2010) concluded that the ERPT is significantly and positively correlated with the average inflation rate and the low inflationary environment leads to the pass-through of low exchange rates to import prices. Also, Campa and Goldberg (2005), Taylor (2000), and Frankel (2012) consider exchange rate volatility as an important factor in ERPT.

In addition, a large number of studies have examined the degree of exchange rate domestic and import prices for developing and emerging countries as an inter-country panel. Researchers such as McFarlane (2009) and Razafimahefa (2012) examined the

degree of ERPT on consumer prices and import prices for developing countries and emerging markets. These articles generally found that the degree of ERPT for developing and emerging countries was significantly greater than that of advanced countries. In addition, ERPT can have an asymmetric effect on prices, depending on the decrease or increase in the value of the exchange rate and its absolute fluctuation. In Kohlscheen's (2010) paper, using the VAR model, the degree of ERPT to consumer prices has been examined for a number of countries during their floating exchange rate regimes. The results showed that for countries with higher nominal exchange rate fluctuations and less commercial diversification, higher exchange rates pass. In another study, Ito & Sato (2008), by examining ERPT in East Asian countries, concluded that the degree of ERPT along the distribution chain decreased and the highest rate of ERPT happen respectively in import, producer and consumer prices. In this regard, Ghosh (2013) has examined the ERPT for a number of Latin American countries over the past four decades. The results showed that the degree of ERPT decreased over time.

Many studies have also been conducted on the pass-through of exchange rates in different countries over time. Justel & Sansone (2015), by examining the degree of ERPT using the VAR model for Chile, concluded that the rate of pass-through of exchange in Chile has been decreasing over time. Espada (2013) investigated the degree of ERPT in Mexico using the VAR model. The results indicate that the ERPT was not statistically significant. In the same period, Peón & Brindis (2014) found that the degree of ERPT decreased along the chain. In another paper, Rincón-Castro & Rodríguez-Niño (2016), using the bayesian approach by endogenously expressing the ERPT and the economic situation, concluded that the ERPT is greater if, (1) consumer inflation is accelerated, and its fluctuation should be large (2) real exchange rate over-valued (3) positive output gap (4) low openness of trade (5) high commodity prices (6) interbank interest rate Be low.

Masha & Park (2012) examined the degree of ERPT to consumer and producer prices in the Maldives using recurrent VAR analysis. The results show a high but incomplete degree of ERPT compared to other countries. Arslaner (2014) used an error correction model to estimate the ERPT in Turkey for the period 1986–2013. The results indicate a significant degree of ERPT to consumer inflation. Savoie-Chabot & Khan (2015) also examined the degree of ERPT to consumer prices. They found that ERPT played an important role in recent inflation dynamics in Canada. Tunc, C., & Kilinc (2018) also examined the ERPT in Turkey using a structured VAR approach. Their results indicate that achieving the price stability target permanently in Turkey becomes a major challenge in a volatile global financial market, due to a high ERPT.

Much of the literature on ERPT has shown that exchange rate fluctuations are only partially transmitted to domestic prices, whose effect is also lost through the production chain. Exchange rates pass through domestic prices through several channels. From direct effects through energy and other commodity prices to indirect effects through import prices, wage formation and profit margins (Bacchetta & Van Wincoop, 2003; Burstein & Gopinath, 2014; Ito & Sato, 2008; McCarthy, 2007). Even in the case of internationally tradable goods, different forms of market segmentation and nominal adhesions may explain the incomplete ERPT. In relation to the lower sensitivity of domestic prices to exchange rate fluctuations, a number of structural factors include the degree of competition between exporting and importing firms (Amiti *et al*., 2016), the frequency of price adjustments (Devereux & Yetman, 2003; Corsetti *et al*., 2008;

Gopinath *et al*., 2010), Trade Composition (Goldberg & Campa, 2010), Global Value Chain Involvement (Georgiadis *et al*., 2017), Foreign Exchange Trade Share (Casas *et al*., 2016; Gopinath, 2015) and the use of exchange rate risk coverage tools (Amiti *et al*., 2014). Also, a credible monetary policy framework that supports anchor inflation expectations can serve as an effective approach to reducing ERPT to consumer prices (Carriere-Swallow *et al*., 2016; Gagnon & Ihrig, 2004).

In addition to the country-specific structural factors and characteristics, the nature of the macroeconomic momentum that causes the exchange rate fluctuation plays a key role in determining the size and intensity of the ERPT (Comunale & Kunovac, 2017; Forbes *et al*., 2018; Shambaugh, 2008). This reflects the fact that impulses that affect the exchange rate simultaneously affect activity, profit margins, productivity, and other factors that contribute to shaping price and inflation expectations. Helmy *et al*. (2018), using monthly Egyptian data for the period 2003 to 2015, concluded that the pass-through of the exchange rate to the three price indices (import, producer and consumer) in Egypt was relatively significant and incomplete. Of course, the degree of ERPT to consumer prices was higher than producer and import prices. Ha *et al* (2019) estimated SVAR models for a set of 47 countries and concluded that different domestic and global shocks were an important factor in explaining the degree of exchange rate across countries. In addition, the specific features and conditions of each country include the policy frameworks for implementing the next influential monetary policy. Furthermore, the exchange rate was lower in countries with flexible exchange rates and credible inflation targets. Finally, empirical evidence has shown that the central bank's degree of independence influences the degree of ERPT to prices. Adekunle & Tiamiyu (2018) examined the asymmetry of ERPT to consumer prices in Nigeria during the period 2001–2015. The results showed that in the short run, consumer prices had comparable expectations and incomplete exchange rate pass.

Although there have been many foreign studies on the degree of ERPT, there are still few domestic studies. In continuation, the internal empirical studies are briefly reviewed. Mesbahi *et al*. (2017) assessed the degree of ERPT of import prices by emphasizing the role of volatility in oil revenues. Tayebi *et al*. (2015) conclude that exchange rate inflation is incomplete with different price indices, but exchange rate fluctuations cause fluctuations in import, consumer and producer price indices and part of the variability of domestic inflation over the period. The case is explained. Kazerooni *et al*. (2012) have proposed that by simultaneously implementing the monetary inflation targeting system and the floating exchange rate system, the exchange rate pass rate will be reduced. Khoshbakht & Akhbari (2007) have shown in their study that the ERPT changes on the import price index is more than the consumer price index. In their study, Shajari *et al*. (2005) concluded that the degree of ERPT in Iran is incomplete and that real exchange rate changes have a positive and significant effect on the price of imported goods.

3. Research Method

The purpose of this study is to investigate the dynamic relationship between factors affecting the exchange rate in Iran. Hence, the VAR model proposed by Sims (1980) assumes that all variables are endogenous in a macroeconomic model without any constraints on their relationships. The VAR return form contains not only the endogenous

variable interrupts, but also the uninterrupted values of other endogenous variables. Petroleum exports to oil-rich countries are important sources of foreign exchange earnings, but the outsourcing of these incomes leads to widespread uncertainty and instability in their economies, their economic policies, and their economic policies. Given the high reliance of the Iranian economy on oil revenues and the randomness of oil price shocks, the macroeconomic environment has been affected and the combination of these factors has led to uncertainty. The volatility of the economy and the bad macroeconomic environment lead to an increase in the exchange rate. As oil revenues rise, the uncertainty of the exchange rate declines, and the exchange rate slows.

The rise in oil prices and the resulting revenues can provide a boost to the exchange rate and import prices by increasing import demand. Therefore, the rise in oil prices is in the first phase of the impulse distribution chain, affecting other model variables. The variable rate of economic growth rate of production in the local literature on the exchange rate can be cited as an indicator of domestic demand pressure. Economic growth is driving demand and, given production's inability to meet demand, this will increase domestic demand and ultimately lead to increased demand for imported goods, rising exchange rates and rising prices for imported goods. The consumer price index in the impulse distribution chain is after the exchange rate because the effect of the exchange rate on the import price through imported foreign inputs affects the consumer price. Finally, the central bank response function is estimated in which the demand function relates money growth to other variables in the model, since monetary policy may reflect exchange rate fluctuations (McCarthy, 2007).

Following McCarthy (2007) in the present study, the money supply growth equation is considered as a central bank response function. In oil-exporting countries, rising oil prices and subsequently rising oil revenues lead to a massive injection of money into the economy, so the money supply is also a function of oil prices and revenues. According to what is said above, the model is based on the study (McCarthy, 2007) and has the following order for the variables.

$$X_t = \{\pi_t^{oil} \rightarrow \Delta y_t \rightarrow \Delta e_t \rightarrow \pi_t^{IPI} \rightarrow \pi_t^{PPI} \rightarrow \pi_t^{CPI} \rightarrow \Delta M1_t\}$$

Where π_t^{oil} oil price inflation, Δy_t annual GDP growth, Δe_t changes in nominal exchange, π_t^{CPI} consumer price inflation, π_t^{PPI} producer price inflation, π_t^{IPI} import price inflation, and $\Delta M1_t$ is money growth rate. Within this framework, it observes the dynamic effect of exchange rate momentum on price indices along the distribution chain. According to (McCarthy, 2007), consumer price inflation is composed of seven components at each stage. The first component is expected inflation based on information available in the t-1 period. The effects of supply and demand shocks on inflation at this stage are used as the second and third components in the t-period. The fourth component is the effect of exchange rate momentum on inflation. The next component includes the effects of import price shocks, producer prices and consumer prices on inflation in earlier stages of the chain, and the last component includes the impact of all steps in the distribution chain.

Structural impulses are obtained from VAR residues using the Cholesky variance-covariance matrix analysis. Thus, oil price inflation (π_t^{oil}) is used as a supply-side and

output growth (Δy_t) as a demand-side, in addition, the model involves money $M1_t$ as a monetary policy variable that responds to other variables through the response function. Under this assumption, the impulses in this VAR system can be represented by a recursive VAR system as follows:

$$\pi_t^{oil} = E_{t-1}[\pi_t^{oil}] + \varepsilon_t^{oil}$$
$$\Delta y_t = E_{t-1}[\Delta y_t] + \alpha_1 \varepsilon_t^{oil} + \varepsilon_t^{\Delta y}$$
$$\Delta e_t = E_{t-1}[\Delta e_t] + \beta_1 \varepsilon_t^{oil} + \beta_2 \varepsilon_t^{\Delta y} + \varepsilon_t^{\Delta e}$$
$$\pi_t^{IPI} = E_{t-1}[\pi_t^{IPI}] + \phi_1 \varepsilon_t^{oil} + \phi_2 \varepsilon_t^{\Delta y} + \phi_3 \varepsilon_t^{\Delta e} + \varepsilon_t^{IPI}$$
$$\pi_t^{PPI} = E_{t-1}[\pi_t^{PPI}] + \lambda_1 \varepsilon_t^{oil} + \lambda_2 \varepsilon_t^{\Delta y} + \lambda_3 \varepsilon_t^{\Delta e} + \lambda_4 \varepsilon_t^{IPI} + \varepsilon_t^{PPI}$$
$$\pi_t^{CPI} = E_{t-1}[\pi_t^{CPI}] + \gamma_1 \varepsilon_t^{oil} + \gamma_2 \varepsilon_t^{\Delta y} + \gamma_3 \varepsilon_t^{\Delta e} + \gamma_4 \varepsilon_t^{IPI} + \gamma_5 \varepsilon_t^{PPI} + \varepsilon_t^{CPI}$$
$$\Delta M1_t = E_{t-1}[\Delta M1_t] + \theta_1 \varepsilon_t^{oil} + \theta_2 \varepsilon_t^{\Delta y} + \theta_3 \varepsilon_t^{\Delta e} + \theta_4 \varepsilon_t^{IPI} + \theta_5 \varepsilon_t^{PPI} + \theta_6 \varepsilon_t^{CPI} + \varepsilon_t^{\Delta M1}$$

Where ε_t^{oil} the supply shocks, $\varepsilon_t^{\Delta y}$ demand shocks, $\varepsilon_t^{\Delta e}$ exchange rate shocks, ε_t^{cpi} consumer's price inflation shocks, ε_t^{PPI} producer price inflation, ε_t^{IPI} import price inflation and $\varepsilon_t^{\Delta M1}$ money supply shocks. $E_{t-1}[\ ]$ Expresses the expectations of the variables in terms of information available at the end of period t-1, which represents the time period t. Conditional expectation equations can be replaced by linear predictions in terms of 5 endogenous variable interruptions.

In the following, the functions of instant reaction of consumer price inflation to uncorrelated exchange rate shocks will be presented. In addition, impulse identification using Cholesky's analysis generates the subject, identifying impulse supply and aggregate demand. Here the assumptions are assumed to be serially uncorrelated and not correlated over a period.

4. Results and discussion

4.1. Stationary results

In order to accurately model the VAR model, static and cointegration tests have been performed for the characteristics of the studied data and the results are reported in Table (1) and Table (5). In the first step, the static data are examined using the generalized Dickey Fuller root unit test (ADF). Table (1) shows the results of the single root test for model endogenous variables.

Table 1: unit root test results

variable	ADF statistic	probability value	degree of accumulation
unit root test results at the level of variables			
OIL	-1/69762	0/4195	Non-Stationary
ER	-1/31789	0/6586	Non-Stationary
CPI	1/36534	0/9856	Non-Stationary
M1	-0/15997	0/9321	Non-Stationary
GDP	1/90123	0/9872	Non-Stationary
PPI	0/51239	0/9543	Non-Stationary
IPI	-1/29654	0/62367	Non-Stationary

Unit root test results in first difference of variables			
D(OIL)	-11/76813	0/0000	Stationary
D(ER)	-10/45789	0/0000	Stationary
D(CPI)	-11/34587	0/0000	Stationary
D(M1)	-7/14821	0/0000	Stationary
D(GDP)	-6/32167	0/0004	Stationary
D(PPI)	-7/67294	0/0000	Stationary
D(IPI)	-8/52312	0/0000	Stationary

4.2. Optimal lag selection

In order to select the appropriate lag length for estimating the VAR model, several tests such as sequential modified LR test, lag exclusion Wald test (omitting statistically meaningless lags), Hannan Qwuinn information criterion (HQ), Akaike information criterion (AIC), Schwarz information criterion (SC) and the final prediction error (FPE) were assessed. By choosing the appropriate lag in the VAR model, it will prevent the over fit by limiting the length of the small sample intervals. It also minimizes the incorrect stipulation of the model by not selecting too small interrupts. The benchmark length interval tests are shown in table 2. Sequential modified LR test, final prediction error (FPE) and Akaike information criterion (AIC) suggest using the VAR model (3). Therefore, the VAR model is estimated with three intervals in this study.

Table 2: Results of optimal lag length

Lag length	Log L	LR	FPE	AIC	SC	HQ
0	-437.54	NA	1.09 E-04	6.4	6.61*	6.78
1	-368.32	149.42	6.3 E-05	5.9	6.78	6.11*
2	-332.21	53.52	6.6 E-05	5.8	7.35	6.51
3	-273.43	35.13*	6.1E-05*	5.8*	8.18	6.63
4	-232.7	46.17	6.8 E-05	5.62	8.39	7.52

The results of the parent variable omitted test are presented in table 3 to determine whether the intervals containing significant information were omitted from the model. The results indicate that the three interruptions in the VAR system are mutually significant.

Table 3: lag exclusion Wald test results

	DOIL	DGDP	DEX	DCPI	DMPI	DM1	Joint
Lag 1	15.9 (0.01)	11.03 (0.13)	19.15 (0.00)	40.11 (0.01)	4.26 (0.64)	31.1 (1.13)	159.41 (0.01)
Lag 2	3.47 (0.72)	14.2 (0.00)	14.99 (0.01)	7.912 (0.35)	12.18 (0.08)	9.32 (0.19)	72.18 (0.00)
Lag 3	17.3 (0.05)	24.01 (0.08)	5.891 (0.45)	11.7 (0.04)	14.6 (0.01)	14.7 (0.01)	89.1 (1.13)

* The numbers in parentheses represent the P-value

In addition, the Lagrange coefficient of serial residual correlation (LM) in the VAR model was calculated with the null hypothesis of no serial correlation.

Table 4: LM Serial Correlation Test Results

Hypothesis Zero: No Serial Correlation at Order H Interval		
interrupts	LM statistic	probability value
1	42/21341	0/2212
2	35/88122	0/5849
3	46/32723	0/1103
4	39/31674	0/3122
5	44/5523	0/0547

4.3. Co-integration test

The results of the co-integration test between variables using the Johansen coefficient test are presented in table 5.

Table 5: Cointegration test results

Number of Equations	Eigen value	Critical 5%	Probability Value	Trace Statistical	Critical 5%	Probability Value
Non*	61.5	31.3	0.0000	179.02	91.6	0.0000
one vector	51.2	29.7	0.0001	120.28	68.7	0.0000
two vectors	34.8	20.6	0.0001	76.292	46.6	0.0000
three vectors	25.9	19.1	0.012	51.998	39.2	0.001
four vectors	19.631	16.56	0.022	46.3219	25.653	0.009
five vectors	16.442	14.82	0.0312	26.5916	23.674	0.013
six vectors	10.442	9.82	0.0467	15.5916	13.674	0.023

* Rejects hypothesis at 5% level

Due to the existence of seven model variables and the results of the special effects and maximum likelihood tests, maximum six coefficients are accepted. As a result, the attempt is made to estimate the VECM model by considering six coherent relationships.

4.4. Estimation of ERPT coefficients

Using the instantaneous reaction function, the cumulative pass-through coefficients are calculated by dividing the cumulative instantaneous reaction of prices after m period by the cumulative instantaneous reaction of the exchange rate to the exchange rate momentum after m period. ERPT at time t is defined as follows:

$$ERPT_t = \text{Price index}_{t,t+m} \Big/ Exchange\ rate_{t,t+m}$$

Where, P and E are respectively the change in the cumulative price and the change in the cumulative exchange rate after m period. Table 6 shows the ERPT to the consumer, producer and import price indices calculated over a 20-year time horizon. ERPT to consumer, producer, and import prices ranged from 14.68%, 15.45% and 18.22% in the

first period to 51.78%, 53.15% and 88.14% in the next 13 periods, respectively. The momentum of the exchange rate rises. It can also be seen from figure 2, that the ERPT to import and producer prices is higher than consumer prices. This result is consistent with the empirical findings of research conducted in Iran and the theoretical foundations of ERPT. Because, exchange rate shocks will have the greatest impact on the prices of finished goods and imported inputs, and then the inflation of imported inputs will affect the producer price and then the consumer price in the last place. . According to the results, it can be said that the exchange rate pass through to price indices in Iran is incomplete, which is consistent with the experimental results of exchange rate analysis in Iran such as (Bahrami *et al*., 2014; Tayebi *et al*., 2015; Heydari & Ahmadzadeh, 2015; and Ebrahimi & MadaniZadeh, 2016) are compatible. Finally, about 46.74%, 50.38% and 88.53% of the exchange rate rise eventually are reflected in consumer, producer and import prices, respectively, after 20 periods of shocks. In addition, the results show that the degree of ERPT decreases along the distribution chain and the highest rate of ERPT occur at import prices, producer prices and consumer prices, respectively. The results of the study are Ito & Sato (2008) and Peón & Brindis (2014). The results of the exchange rate transition in the results also show that the degree of ERPT has decreased over time, which is in line with the Ghosh (2013).

Table 6: ERPT Coefficients

Period	Import Price	Producer Price	Consumer Price
After 1 period	18.22	15.45	14.68
after 2 period	20.45	18.34	16.73
after 4 period	48.13	25.45	24.68
after 5 period	51.22	28.37	27.44
After 8 period	79.21	47.45	45.61
after 10 periods	82.37	52.35	50.43
After 13 rounds	88.14	53.15	51.78
after 16 periods	83.67	47.59	45.62
after 20 periods	88.53	50.38	46.74

Conclusion

When implementing anti-inflation economic policies in high-inflation countries such as Iran, it is necessary to analyze the impact of ERPT on the price index. On the other hand, exchange rate changes are very important and have a huge impact on the macroeconomic indicators of countries. Therefore, for an economy that is committed to maintaining price stability, it is very important to adjust exchange rate changes. In this way, countries can assess how the impact of exchange rate shocks affect their economies and can take preventive measures and policies based on this information. Using the cumulative transient response function derived from the recursive VAR model, the ERPT to consumer, producer, and import prices changed from 14.68%, 15.45%, and 18.22% in the first period to 51.78%, 53.15%, and 88.14 % in 13 periods after exchange rate shock. The instantaneous response function of the price index to the exchange rate shows that the exchange rate impulse has a positive and significant impact on the inflation of the price index.

The analysis of variance also confirmed the impact of the ERPT, because in view of the high share of imported goods in the consumer basket and the concentration of imports

in major manufacturing industries, the exchange rate rises led to higher prices of imported goods. And because of the increase in oil revenue, the demand for the entire economy is also increasing, so prices are also rising. The instantaneous response function of the price index to exchange rate changes shows that exchange rate shocks have a positive impact on inflation. The results of the analysis of variance confirmed the role of ERPT in explaining the form of price index fluctuations. Therefore, in view of the research results and the importance of exchange rate fluctuations in explaining inflation in the Iranian economy, the central bank's monetary policy should aim to reduce the passing level, and policies to limit exchange rate fluctuations will contribute to the goal of price stability. Similarly, in small open economies, central bank loans are particularly important for exchange rate fluctuations due to the favorable impact of exchange rates on macroeconomic variables (such as inflation). An inflation targeting system must also be established in the country's economy, because the impact of low exchange rates on domestic prices gives people greater freedom to implement independent monetary policies, especially through inflation targeting. The results also show that the transfer rate of exchange rate changes to the price index is not as complete as other studies. The transfer of the exchange rate is not complete, because the price of imported goods is not only affected by the exchange rate, but also by other factors (such as increased domestic demand).

References

Adekunle, W., & Tiamiyu, A. (2018). Exchange rate pass-through to consumer prices in Nigeria: An asymmetric approach. University Library of Munich, Germany.

Amiti, M., Itskhoki, O., & Konings, J. (2014). Importers, exporters, and exchange rate disconnect. American Economic Review, 104(7), 1942-78.

Arslaner, F., Karaman, D., Arslaner, N., & Kal, S. H. (2014). The relationship between inflation targeting and ERPT in turkey with a model averaging approach. *Central Bank of the Republic of Turkey Working Paper*, (14/6).

Bacchetta, P., & Van Wincoop, E. (2003). Why do consumer prices react less than import prices to exchange rates?. *Journal of the european economic association*, *1*(2-3), 662-670.

Bahrami, J., Mohammadi, T., & Bozorg, S., (2014). Asymmetric Exchange Rate Transfer to Domestic Price Indicators with SVAR Approach. Iranian Economic Research; 19 (60), 37-65.

Bernanke, B. S. (1986). Alternative explanations of the money-income correlation. *NBER Working Paper*, (w1842).

Burstein, A., & Gopinath, G. (2014). International prices and exchange rates. In *Handbook of international economics* (Vol. 4, pp. 391-451). Elsevier.

Campa, J. M., & Goldberg, L. S. (2005). Exchange rate pass-through into import prices. Review of Economics and Statistics, 87(4), 679-690.

Carriere-Swallow, M. Y., Gruss, B., Magud, M. N. E., & Valencia, M. F. (2016). *Monetary policy credibility and exchange rate pass-through*. International Monetary Fund.

Casas, C., Díez, F. J., Gopinath, G., & Gourinchas, P. O. (2016). *Dominant exchange rate paradigm* (No. w22943). National Bureau of Economic Research.

Comunale, M., & Kunovac, D. (2017). *ERPT in the euro area* (No. 2003). ECB Working Paper.

Corsetti, G., Dedola, L., & Leduc, S. (2008). High exchange-rate volatility and low pass-through. *Journal of Monetary Economics*, *55*(6), 1113-1128.

Devereux, M. B. & Yetman, J. (2010). Price adjustment and Exchange rate pass-through. Journal of International Money and Finance, 29(1), 181-200.

Devereux, M. B., & Yetman, J. (2003). Monetary policy and exchange rate pass-through. *University of Hong Kong, manuscript*.

Ebrahimi, S., & Madanizadeh, S. A. (2016). Changes in Exchange Rate Pass-Through in Iran. *Journal of Applied Economics Studies in Iran*, *5*(18), 147-170.

Espada, J. F. C. (2013). Estimating the Exchange rate pass-through to prices in Mexico. Monetaria, 1(2), 287-316.

Feinberg, R. (1989). The Effects of Foreign Exchange Movements on US Domestic Prices. The Review of Economics and Statistics, 71(3), 505-11.

Forbes, K., Hjortsoe, I., & Nenova, T. (2018). The shocks matter: improving our estimates of Exchange rate pass-through. Journal of International Economics, 114, 255-275.

Frankel, J., Parsley, D., & Wei, S. J. (2012). Slow pass-through around the world: a new import for developing countries? Open Economies Review, 23(2), 213-251.

Gagnon, J. E., & Ihrig, J. (2004). Monetary policy and exchange rate pass-through. *International Journal of Finance & Economics*, *9*(4), 315-338.

Georgiadis, G., Gräb, J., & Khalil, M. (2017). *Global value chain participation and exchange rate pass-through* (No. 67/2020). Bundesbank Discussion Paper.

Ghosh, A. (2013). Exchange rate pass through, macro fundamentals and regime choice in Latin America. Journal of Macroeconomics, 35, 163-171.

Goldberg, L. S., & Campa, J. M. (2010). The sensitivity of the CPI to exchange rates: Distribution margins, imported inputs, and trade exposure. *The Review of Economics and Statistics*, *92*(2), 392-407.

Gopinath, G. (2015). *The international price system* (No. w21646). National Bureau of Economic Research.

Gopinath, G., Itskhoki, O., & Rigobon, R. (2010). Exchange rate choice and Exchange rate pass-through. *American Economic Review*, *100*(1), 304-36.

Ha, J., Stocker, M., & Yilmazkuday, H. (2019). Inflation and Exchange rate pass-through. World Bank Policy Research Working Paper, (8780).

Helmy, O., Fayed, M., & Hussien, K. (2018). Exchange rate pass-through to inflation in Egypt: a structural VAR approach. Review of Economics and Political Science, 3(2), 2-19.

Heydari, H., & Ahmadzadeh, A., (2015). Exchange Rate Changes and Their Impact on Price Chains in Iran, Business Research Journal, 74, 28-2.

Ito, T., & Sato, K. (2008). Exchange rate changes and inflation in post-crisis Asian Economies: Vector Autoregression Analysis of the exchange rate pass-through. Journal of Money, Credit and Banking, 40(7), 1407-1438.

Justel, S., & Sansone, A. (2015). Exchange rate pass-through to Prices: VAR Evidence for Chile (No. 747). Central Bank of Chile.

Kazerooni, A., Salmani, B., & AFashari, M., (2012); Investigation of the Impact of Exchange rate System and Inflationary Environment on the Rate of Exchange Rate in Iran; Iranian Journal of Applied Economics Studies, Volume 1, Number 2.

Khoshbakht, A., & Akhbari, M., (2007). Investigating the Process of Influence of Exchange Rate Changes on Inflation of Consumer Price and Import Indices in Iran, Economic Research Journal, 4, 51-82.

Knetter, M. M. (1993). International comparisons of pricing-to-market behavior. The American Economic Review, 83(3), 473.

Kohlscheen, E. (2010). Emerging floaters: pass-through and (some) new commodity currencies. Journal of International Money and Finance, 29(8), 1580-1595.

Masha, I. & Park, M. C. (2012). "Exchange Rate Pass Through to Prices in Maldives" (No. 12-126). International Monetary Fund.

McCarthy, J. (2007). Pass-through of exchange rates and import prices to domestic inflation in some industrialized economies. Eastern Economic Journal, 33(4), 511-537.

McFarlane, L. (2009). Time-varying Exchange rate pass-through: An examination of four emerging market economies. Bank of Jamaica.

Mesbahi, M., Asgharpour, H., Haghighat, J., Kazerouni, A., & Fallahi, F., (2017). Exchange rate pass-through on Import Price in Iran with Emphasis on the Role of Oil Income Volatility (Nonlinear Approach), Journal of Economic Modeling, 37, 77- 100.

Peón, S. B. G., & Brindis, M. A. R. (2014). Analyzing the Exchange rate pass-through in Mexico: Evidence post inflation targeting implementation. Ensayos sobre Política Económica, 32(74), 18-35.

Razafimahefa, I. (2012). Exchange rate pass-through in Sub-Saharan African Economies and its Determinants. IMF Working Paper, 12(141).

Rincón-Castro, H., & Rodríguez-Niño, N. (2016). Nonlinear pass-through of exchange rate shocks on inflation: a bayesian smooth transition VAR approach. Borradores de Economía; No. 930.

Savoie-Chabot, L., & Khan, M. (2015). Exchange rate pass-through to Consumer Prices: Theory and Recent Evidence (No. 15-9).

Shajari, H., Tayebi, K., & Jalai, A., (2005), Exchange Rate pass-through Analysis in Iran, Journal of Knowledge and Development, No. 16.

Shambaugh, J. (2008). A new look at pass-through. *Journal of International Money and Finance*, *27*(4), 560-591.

Sims, C. A. (1980). Macroeconomics and reality. *Econometrica: journal of the Econometric Society*, 1-48.

Sims, C. A. (1986). Are forecasting models usable for policy analysis?. *Quarterly Review*, *10*(Win), 2-16.

Tayebi, K., Nasrollahi, K., Yazdani, M., & Malek Hosseini, H., (2015). Analysis of the Effect of Exchange Rate pass-through on Inflation in Iran. Iranian Journal of Economic Research, 63, 1–36.

Taylor, J. B. (2000). Low inflation, pass-through, and the pricing power of firms. European economic review, 44(7), 1389-1408.

Tunc, C., & Kilinc, M. (2018). Exchange Rate Pass-Through in a Small Open Economy: A Structural Var Approach, *Bulletin of Economic Research*, *70*(4), 410-422.