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RESEARCH PAPER

Regional and Global Drivers of Iran's Inflation: Evidence from a GVAR Model Featuring a Dominant Unit

Mehdi Hajamini[a,*] , Seyyed Mohammad Seyyed Hosseini[b]

a. Department of Economics, Yazd University, Yazd, Iran
b. Department of Economics, Ferdowsi University of Mashhad, Mashhad, Iran

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Abstract
Increasing international interdependence leads to a higher degree of inflation vulnerability to foreign and global shocks. In this regard, inflation management is one of the most important challenges various countries are facing in the global economy. The present paper aimed to examine the regional and global origins of inflation in Iran. A GVAR model featuring a dominant unit was estimated for 34 countries during 1988Q4-2016Q4. The findings indicated that Iran's inflation is directly and positively affected by oil and food price shocks in both the short and long-run. Furthermore, there are relatively strong spillover effects, and hence inflationary pressures are exacerbated due to the higher inflation rates of Iran's trading partners. Almost 21 percent of Iran's inflation changes are explained by foreign shocks. About 8 percent are attributed to the inflation of Iran's trading partners that one-third of this contribution is related to China and India, and one-fourth to Latin America and Turkey. The findings reveal that Iran's economy has a high degree of vulnerability to regional and global shocks.
Keywords: Iran's Inflation, Spillover Effect, Global VAR, Dominant Unit, Variance Decomposition.
JEL Classification: C32, E31, F41.

Introduction

An increasing trend of countries towards the interdependence of real and financial sectors is regarded as one of the inevitable characteristics for the world economy leading to a rise in the degree of vulnerability among the countries in the face of foreign and global shocks. Accordingly, as global commodity price shocks are seriously increasing, the inflation management in global context is considered as an important challenge for policy-makers.

In addition, an increasing level of demand among populated countries, along with supply scarcity due to climate changes and restrictions on agricultural development, will raise the prices of oil, food, and energy. Oil and energy are at the beginning of the production chain, and food allocates a considerable amount of share in the consumption basket. Hence, demand- or supply-driven inflationary spillover of countries like China and India is directly transmitted to their trade partners by increasing the prices of both global commodities and imported commodities, which can trigger inflationary pressures all around the world.

During recent years, a large number of studies have investigated inflationary vulnerability and economic resilience in the face of global and foreign inflation. However, the management of inflationary pressures on Iran's economy has attracted more attention. Iran's economy depends on crude oil export revenues, and is also regarded as a net food-importing country. In addition, China and India have been the most important trade partners of Iran during recent

*. Corresponding author email: hajamini.mehdi@yazd.ac.ir

years. Thus, the present paper tries to examine the role of regional and global origins of inflationary pressures in Iran’s economy.

Controlling inflation has always been one of the main macroeconomic goals for policy-makers in Iran. Iran’s economy has experienced a two-digit chronic inflation rate (almost 20 percent on average) from the oil shock of 1973. In this regard, the inflation rate reached 29 percent in 1978, and it fluctuated between 8 to 29 percent during the eight-year long war with Iraq. After the war, the government reduced its control on the markets (structural adjustment policies) and oil revenues also improved. However, the balance of payments crisis appeared in 1993 because of uncontrolled accumulated short-term foreign debts and the decline in oil revenues. Iran’s central bank decided to unify exchange rates, but the national money lost its value quickly, and finally, the inflation reached almost 50 percent in 1995 (Esfahani and Pesaran, 2009).

After 1995, anti-inflation policies, unifying exchange rate policy, improving the balance of payment, reducing international prices, and increasing imports contributed to the downward trend in inflation, and hence Iran’s economy experienced an inflation rate of about 10 to 16 percent from 2000 to 2006. However, these conditions did not continue. Liquidity has increased dramatically due to a loose monetary policy after 2005, and in addition, oil prices suddenly decreased during the 2008 financial crisis; hence the Iran inflation rate rose again and it reached about 25 percent in 2008 (Falahi and Hajamini, 2017).

The liberalization of energy prices and international sanctions triggered a new period of abnormally increasing exchange rates and subsequently the inflation rate starting from 2010. As a result, oil exports and government revenues declined dramatically, while expenditure did not. Hence, the government faced a huge budget deficit and by financing this deficit it led to an increase in the money supply. Furthermore, it is often stated that the appreciation in the exchange rate in Iran caused an increase in the cost of production, which in turn, reduces the aggregate supply. Consequently, the inflation rate increased to almost 35 percent in 2013 (Gil-Alana et al., 2019).

From 2013 on, the new government followed the anti-inflation policies, exchange rate stabilization, relative controlling money supply, and controlling inflationary expectation. These policies and also the relative dominance of the recession resulted in a downward inflation trend and the Iranian economy experienced an average inflation rate of 11 percent from 2014 to 2018. Nevertheless, the recent exchange crisis and return of the sanctions have brought a new period of inflationary pressures which have not as yet subsided.

This paper has a significant contribution as will be shown. The Iranian economy is considered in the Global Vector Autoregressive (GVAR) model and then the direct and indirect effects of global and foreign shocks on Iran’s inflation are separately investigated. Albeit Mohaddes and Pesaran (2016) have estimated a GVAR model involving Iran’s economy, but the present paper evaluated indirect effects (spillover) of oil and food shocks. In this sense, the results obtained are not covered in previous studies (see Section 2 for details). Moreover, this paper uses a new specification and also a new time period (1988Q4-2016Q4).

The remainder of the paper is structured as follows. Section 2 reviews previous studies on the subject. Section 3 describes method and data collection procedure. Section 4 presents and analyzes the empirical finding. Finally, Section 5 provides conclusions and policy implications.

Literature Review

The effect of oil and food prices on economic growth has attracted a lot of attention since the oil price shocks during the 1970s. For example, Hamilton (1983; 1996; 2003) indicated that the United States recession in 1970 was related to the oil price shock[1].

However, the effect of oil and food prices on inflation has been emphasized in recent years. In all probability, it can be claimed that the reports of World Economic Forum (WEF) on global risk played an important role in focusing on the inflationary pressure of global shocks. The annual reports from 2005 to 2019 have always warned about global price shocks and unmanageable inflationary (or anti-inflationary) shocks in the future.

McCarthy (2000; 2007) examined the oil price effect on inflation in the United States, Germany, United Kingdom, Belgium, Japan, Sweden, Switzerland, France, and the Netherlands using vector autoregressive (VAR) model. The results indicated that the oil price shocks led to an increase in the domestic price in these countries. Duma (2008) estimated the effect of oil prices on the Sri Lanka inflation by structural VAR model. Based on the results, 25 percent of inflation changes occurred due to the shocks in oil prices and import prices.

Chen (2009) assessed oil price pass-through using vector error correction model (VECM) in 19 developed countries. The results confirmed oil price pass-through in all of 19 countries. The pass-through was estimated at 0.17 in the long run and 0.005 in the short run. Jongwanich and Park (2009) investigated the effect of oil and food shocks on inflation in Asian developing countries. They employed a SVAR model and found that a major part of the inflation during the 1990s and 2000s is related to an excess in aggregate demands and inflationary expectations.

Shioji and Uchino (2010) examined the pass-through of oil shocks in Japan by VAR model. They concluded that the degree of pass-through decreased until 2000 and then increased. Esfahani et al. (2012) analyzed the effect of oil export shocks on Iran economy using VECX model and confirmed the positive effect of oil shocks on domestic prices. They argued that a high degree of vulnerability was mainly related to the relatively underdeveloped nature of financial markets in Iran.

Galesi and Lombardi (2013) assessed the global price shocks among 33 countries using the GVAR model. Based on the results, a considerable share of headline inflation is attributed to foreign sources, as most of the countries are vulnerable in the face of the oil and food price shocks.

Di Mauro and Pesaran (2013) evaluated the sensitivity of inflation towards foreign inflation shocks among industrialized countries and China using the GVAR model. The results indicated that foreign inflation significantly influenced domestic inflation in the UK, Sweden, Switzerland and Norway. In the US and the other Euro zone countries, the sensitivity of inflation to foreign inflation shocks is relatively low. Moreover, Japan and China inflations are not affected by foreign inflation shocks.

Osorio and Unsal (2013) focused on the inflationary pressures of food price shocks. They estimated SVAR and GVAR models for 33 countries. The findings indicated that food price shocks could explain 33 percent of inflation fluctuations in Asia. Therefore, these countries are highly vulnerable to foreign shocks. In addition, the role of foreign inflation in generating inflation was amplified due to the spillover of China economic growth.

Mohanty and John (2015) analyzed the role of foreign factors on inflation in India using a SVAR model. They concluded that more than 20 percent of the inflation fluctuations could be explained by global factors such as oil prices and the exchange rate.

Babajani Baboli et al. (2018) evaluated the effect of shocks in the exchange rate, oil price, and production on Iran’s macro-variable such as price level. They estimated a VAR model for the period 1991-2016. The results showed that the strong dependence of the exchange rate on oil prices lead to inflationary pressure that increases over time. In addition, the sanctions in 2012 did not reduce oil prices, but they were able to influence the exchange rate and

1. Although, Barsky and Kilian (2001; 2004) challenges this idea that increase in oil price caused stagflation in 1970s.

subsequently inflation.

Hemmati et al. (2018) investigated the external determinants of inflation dynamics in Iran. A single equation and a VEC model are estimated by quarterly data from 1999 to 2014. They found that money supply, exchange rate, import price index, and intensification of sanctions are factors which contribute in raising the general price level in the long run. In addition, they concluded that Iran's inflation is driven mostly by the exchange rate (with one season lag) and effective tariff rate (with two seasons lag).

Boroumand et al. (2019) investigated the dynamic effects of three external shocks (global oil price shock, euro-dollar exchange rate shock and global inflation shock) and the appropriate monetary policy. They employed a DSGE model based on the characteristics of Iran's economy, and concluded that core inflation rule is the best monetary rule for stabilizing both macroeconomics and inflation.

Nusair (2019) investigated the symmetric and asymmetric effects of oil prices on inflation using the autoregressive distributed lag (ARDL) and Pooled Mean Group (PMG) methods in the Gulf Cooperation Council countries. The empirical findings implied that an increase in oil prices affect inflation in all the cases, while a decrease in oil prices are either insignificant or have a negative effect on inflation. In addition, the effect of an oil price shock is larger in the long run than the effect in the short run.

Methodology

GVAR Model Featuring a Dominant Unit

A vector error correction model can be used in national scale with a limited number of variables. For this reason, Global Vector Autoregressive (GVAR) approach was presented by Pesaran et al. (2004), Di Mauro et al. (2007), and Di Mauro and Pesaran (2013) in which the curse of dimensionality is overcome by treating the foreign variables as weakly exogenous, and estimating the country-specific vector error-correcting models separately.

The ability for capturing the interactions and interdependencies in the context of the global economy is regarded as the biggest advantage of GVAR models. In this regard, the macroeconomic status of each country is modeled as a part of Global Multi-Country model. Then, the effects of foreign and global shocks on national economies are carefully analyzed.

Suppose that the global economy includes $N+1$ countries. According to Pesaran et al. (2009) and Di Mauro and Pesaran (2013), VAR model for country i is written as below:

$$\Phi_i(L,p_i)X_{it} = a_i^0 + a_i^1 t + f_t + \Lambda_i(L,s_i)d_t + u_{it}, \qquad (1)$$

where $\Phi_i(L) = I - \sum_{m=1}^{p_i}\varphi_m L^m$ and $\Lambda_i(L) = \sum_{m=1}^{s_i}\lambda_m L^m$. X_{it} represents the vector of variables for country i. The parameters p_i and s_i indicate lag lengths for X_{it} and d_t, respectively. f_t is an unobservable common factor. It is assumed that error term (u_{it}) is not serially correlated but it can be regarded as a weak and cross-sectionally dependent process. The vector d_t indicates global common observable effects, which usually includes global variables such as food and oil prices. Based on Chudik and Smith (2013), the global variables are modeled as a dominant unit as follows:

$$\Gamma_i(L,p_d)d_t = a_d^0 + a_d^1 t + \Theta_i(L,q_d)\tilde{X}_t + u_{dt}, \qquad (2)$$

where $\Gamma_i(L) = I - \sum_{m=1}^{p_d}\Gamma_m L^m$ and $\Theta_i(L) = I - \sum_{m=1}^{q_d}\Theta_m L^m$. $\tilde{X}$ is considered as the vector of feedback variables which is calculated based on weighted average of $N+1$ countries variables.

The main problem is related to the way the unobservable common factor (f_t) is modeled. For each country, the variables of other countries can be regarded as an appropriate measure for global unobservable effect. However, the number of foreign variables is very large and clearly infeasible to estimate model in practice. Since the unobservable foreign shocks affect domestic variables through trade and financial linkages, Pesaran et al. (2004) suggest the use of the weighted average of variables among the partner countries, which is defined as $f_t = X_{it}^* = \sum_{j=0}^{N} w_{ij}(t)\, X_{jt}$ where $\sum_{j=0}^{N} w_{ij}(t) = 1$ and $w_{ii}(t) = 0$.

Chudik et al. (2011) proved that the following condition should be satisfied:

$$lim_{N\to\infty} \sum_{j=0}^{N} [w_{ij}(t)]^2 = 0. \quad (3)$$

Thus the weighted average of foreign shocks for each country i converges in probability to zero as an increase occurs in the number of countries. In other words, $plim \sum_{j=0}^{N} w_{ij}\, u_{jt}$ equals to zero. This implies that the foreign variables are weakly exogenous, and there is a weak and cross-sectionally dependence between error terms. Hence, cross-country interdependence is captured in the GVAR model leading to an increase in efficiency.

According to Pesaran et al. (2009) and Di Mauro and Pesaran (2013), all variables have a unit root and VECX* model for each country i is defined as:

$$\Delta X_{i,t+1} = c_i - \alpha_i[\beta_{xi}{}' X_{it} + \beta_{x^*i}{}' X_{it}^* - \beta_i{}'\, \gamma_i t] + \Phi_i(L, p_i)\Delta X_{it} + \Psi_i(L, q_i)\Delta X_{i,t+1}^* + \Lambda_i(L, s_i) d_{t+1} + \varepsilon_{i,t+1}. \quad (4)$$

where α_i and $\beta_i = (\beta_{xi}{}', \beta_{x^*i}{}')'$ are error-correction coefficient and co-integrations relations for the i^{th} country, respectively. In addition, if the global variables are non-stationary and co-integrated, the dominant unit can be defined as an error correction model:

$$\Delta d_{t+1} = c_d - \alpha_d[\beta_d{}' d_t + \beta_{\tilde{x}}{}' \tilde{X}_t - (\beta_d{}', \beta_{\tilde{x}}{}')\, \gamma_d t] + \Gamma_i(L, p_d)\Delta d_t + \Theta_i(L, q_i)\Delta \tilde{X}_{t+1} + \varepsilon_{d,t+1}. \quad (5)$$

If the global variables are non-stationary but not co-integrated, the equation (2) is estimated in first differences.

Based on the Dovern and Roye (2013) and Di Mauro and Pesaran (2013), the link matrices W_0, which defined by the country-specific trade weights w_{ij}, is used for constructing $Z_{it} = W_i X_t$. The vector $\mathrm{X_t}$ collects all the endogenous variables of the system. Consequently, the conditional VECX* models are stacked to yield the GVAR model as follows:

$$H_0 X_t = a_0 + a_1 t + \Upsilon(L, m) X_{t-m} + \Omega(L, m) d_t + u_t, \quad (6)$$

where $H_0 = (W_0{}' A_0{}', \dots, W_N{}' A_N{}')$, $m = max\{p_i, q_i, s_i | i = 0,1, \dots, N\}$, $\Upsilon(L, m) X_{t-m} = \sum_{i=1}^{m} H_i X_{t-m}$, and $\Omega(L, m) X_{t-m} = \sum_{i=0}^{m} \Omega_i d_{t-m}$. The reduced-form GVAR is obtained by pre-multiplying throughout by H_0^{-1}:

$$X_t = \tilde{a}_0 + \tilde{a}_1 t + \widetilde{\Upsilon}(L, m) X_{t-m} + \widetilde{\Omega}(L, m) d_t + \tilde{u}_t, \quad (7)$$

where $\tilde{a}_0 = H_0^{-1} a_0$, $\tilde{a}_1 = H_0^{-1} a_1$, $\widetilde{\Upsilon}(L, m) X_{t-m} = \sum_{i=1}^{m} H_0^{-1} H_i X_{t-m}$, and $\tilde{\Omega}(L, m) d_{t-m} = \sum_{i=0}^{m} H_0^{-1} \Omega_i d_{t-m}$. Accordingly, by defining $Y_t = (X_t{}', d_t{}')'$, GVAR model featuring a dominant unit is written as follows:

$$Y_t = \tilde{a}_0 + \tilde{a}_1 t + \tilde{\Xi}(L, m) Y_{t-m} + \tilde{u}_t. \quad (8)$$

Now, the GVAR model is simultaneously solved for $N + 1$ countries so that all domestic variables are considered as endogenous.

Data

The present paper aimed to evaluate the regional and global origins of inflation in Iran. In this regard, the available data for 34 countries during 1988Q4 to 2016Q4 were used (Table1). The data included inflation rate, exchange rate and gross domestic production for each country, global food and oil prices, and import shares of each country with respect to the other countries.

Table 1. Countries in the GVAR Model

North America	South America	Europe		Asia and Australia			Africa
US	**Argentina**	**Austria**	**Netherlands**	**Australia**	**South Korea**	**Thailand**	**South Africa**
Canada	Brazil	Belgium	Norway	China	Malaysia	Turkey	
Mexico	Chile	Finland	Spain	India	New Zealand		
	Peru	France	Sweden	Indonesia	Philippines		
		Germany	Switzerland	Iran	Singapore		
		Italy	UK	Japan	Saudi Arabia		

Source: Research finding.

It is worth noting that the selected countries had more than 80 percent of the world GDP during 1988-2016. On average, 80 percent of the imports in each country were provided by the 33 other countries (Figure 1). More than 80 percent of Iran's imports were done through the countries involved in the GVAR model (except United Arab Emirates). India's economy has the lowest share as only 63 percent of the imports were provided by 33 other countries. The highest share is related to Mexico's economy, among which 93 percent of the imports were covered by the exports of the 33 countries. Therefore, the regional and global transmission channels of inflationary shocks among the countries are properly included in the GVAR model.

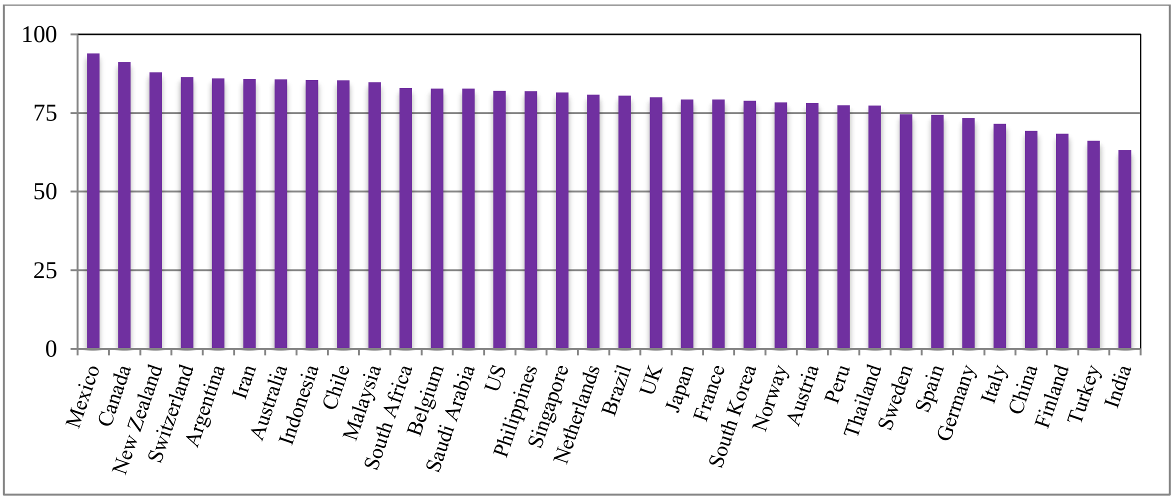

Figure 1. Trade Shares across 34 Countries of the Model
Source: Research finding.

Empirical Findings

Statistical Accuracy of the GVAR Model

Table 2 indicates the cross-sectional correlations calculated for 34 countries and descriptive statistics. Median cross-section correlations of the inflation rates, output gaps and exchange rates estimated almost 0.3 percent. Therefore, the cross-section correlations of the domestic variables are more than 0.3 for half of the countries. This result is also confirmed for the first differences related to the endogenous variables. In contrast, the average cross-country residual correlations are almost zero. According to Di Mauro and Pesaran (2013), the results show that the GVAR model correctly captures the common observable and unobservable effects (d_t and f_t).

Table 2. Summary Statistics for Average Pairwise Cross-section Correlations

	Domestic variables				First differences of variables				VECMX* residuals				Adjusted R-squared			
Statistic	Min	Mean	Med	Max	Min	Mean	Med	Max	Min	Mean	Med	Max	Min	Mean	Med	Max
Inflation	0.04	0.30	0.31	0.47	-0.04	0.11	0.11	0.26	-0.04	0.03	0.02	0.08	0.12	0.47	0.47	0.96
Exchange	0.03	0.31	0.34	0.46	-0.01	0.20	0.23	0.34	-0.02	0.13	0.13	0.23	0.02	0.20	0.18	0.49
GDP gap	-0.02	0.28	0.33	0.45	-0.07	0.26	0.31	0.44	-0.05	0.20	0.23	0.35	0.00	0.40	0.45	0.86

Source: Research finding.

Table 2 represents the adjusted R-square statistics. Adjusted R-square statistics of inflation are more than 70 percent for Argentina, France, Peru and United States, and also between 50 and 70 percent for Australia, Austria, Belgium, Brazil, Canada, Germany, Indonesia, Iran, Italy, South Korea, Malaysia, Mexico, Netherlands, Norway, Philippines, Spain, South Korea, Sweden, and Thailand. As a result, the GVAR model can describe the inflation changes very well. However, as expected, the adjusted R-square statistics for exchange rates and output gaps are usually low because these variables are related to the many economic and political factors which are not considered in the GVAR models.

Di Mauro and Pesaran (2013) demonstrated that most of the countries have actually a small economy with respect to the rest of the world. Therefore, foreign inflation rate and global oil and food prices should be considered as weakly exogenous in all country-specific models. As shown in Table 3, weakly exogenous hypothesis was tested by Johansen (1992) and Harbor et al. (1998). This hypothesis was only rejected in six cases out of 102 tests, which can be ignored. Therefore, the weakly exogenous variables of all foreign and global variables are accepted.

Table 3. Weakly Exogenous Test for Foreign and Global Variables

Country	ΔP^*	ΔP^{oil}	ΔP^{food}	Country	ΔP^*	ΔP^{oil}	ΔP^{food}	Country	ΔP^*	ΔP^{oil}	ΔP^{food}
Argentina	4.04**	3.24	3.07	Indonesia	0.08	1.26	3.47	Saudi Arabia	0.44	1.68	0.00
Australia	1.48	1.63	0.58	Iran	1.69	0.01	0.63	South Africa	0.00	0.10	0.26
Austria	0.09	0.45	0.05	Italy	4.40**	0.62	0.55	South Korea	1.13	6.09	0.93
Belgium	2.40	1.02	0.92	Japan	0.07	0.05	0.21	Singapore	0.00	3.24**	2.22
Brazil	0.61	1.59	0.00	Malaysia	2.05	0.30	0.06	Spain	0.03	0.26	0.14
Canada	6.23**	1.40	0.46	Mexico	1.82	0.19	2.51	Sweden	0.62	0.88	0.04
China	28.75**	1.06	0.78	Netherlands	0.12	2.25	0.64	Switzerland	2.50	6.04**	0.63
Chile	0.24	0.29	0.09	Norway	3.35	3.60	1.16	Thailand	1.32	1.67	2.20
Finland	0.58	0.00	0.00	New Zealand	1.02	0.00	0.01	Turkey	0.17	1.03	1.57
France	0.19	0.74	0.41	Peru	0.66	0.98	4.10	UK	1.10	0.02	1.29
Germany	0.34	1.06	0.26	Philippines	0.87	0.98	0.37	US	5.13**	3.57	1.34
India	0.24	0.00	0.48								

Note: ** represents the significance level of 5 percent.
Source: Research finding.

Finally, persistence profiles introduced by Lee and Pesaran (1993) were used to examine the global stability of the GVAR model. As displayed in Table 4, the means of the system-wide shock effect on the dynamics of the co-integrating relationships converge to zero within less than a year in most of the countries. However, the time horizon of convergence is longer for Argentina, Brazil, China, and Peru.

Table 4. Persistence Profiles of Long-run Relations to a System-wide Shock

	Periods								Periods						
Country	**0**	**1**	**2**	**3**	**4**	**8**	**12**	**Country**	**0**	**1**	**2**	**3**	**4**	**8**	**12**
L.B.	1.0	0.08	0.05	0.09	0.04	0.00	0.00	L.B.	1.0	0.03	0.02	0.01	0.00	0.00	0.00
Argentina	1.0	0.13	0.08	0.13	0.07	0.01	0.00	Malaysia	1.0	0.06	0.04	0.03	0.01	0.00	0.00
U.B.	1.0	0.33	0.29	0.29	0.19	0.02	0.00	U.B.	1.0	0.16	0.08	0.07	0.03	0.01	0.00
L.B.	1.0	0.03	0.01	0.00	0.00	0.00	0.00	L.B.	1.0	0.05	0.07	0.01	0.01	0.00	0.00
Australia	1.0	0.06	0.02	0.01	0.00	0.00	0.00	Mexico	1.0	0.11	0.12	0.02	0.01	0.00	0.00
U.B.	1.0	0.19	0.08	0.03	0.01	0.00	0.00	U.B.	1.0	0.34	0.36	0.09	0.05	0.01	0.00
L.B.	1.0	0.02	0.01	0.00	0.00	0.00	0.00	L.B.	1.0	0.04	0.01	0.01	0.00	0.00	0.00
Austria	1.0	0.02	0.04	0.00	0.01	0.00	0.00	Netherlands	1.0	0.08	0.03	0.02	0.00	0.00	0.00
U.B.	1.0	0.11	0.11	0.02	0.03	0.00	0.00	U.B.	1.0	0.21	0.10	0.05	0.02	0.00	0.00
L.B.	1.0	0.04	0.01	0.00	0.00	0.00	0.00	L.B.	1.0	0.01	0.00	0.00	0.00	0.00	0.00
Belgium	1.0	0.07	0.01	0.01	0.00	0.00	0.00	Norway	1.0	0.01	0.00	0.00	0.00	0.00	0.00
U.B.	1.0	0.16	0.05	0.03	0.01	0.00	0.00	U.B.	1.0	0.09	0.02	0.02	0.00	0.00	0.00
L.B.	1.0	0.02	0.02	0.02	0.01	0.00	0.00	L.B.	1.0	0.05	0.02	0.01	0.00	0.00	0.00
Brazil	1.0	0.04	0.02	0.04	0.00	0.00	0.00	New Zealand	1.0	0.09	0.03	0.01	0.00	0.00	0.00
U.B.	1.0	0.20	0.14	0.15	0.05	0.01	0.00	U.B.	1.0	0.19	0.08	0.04	0.02	0.00	0.00
L.B.	1.0	0.08	0.02	0.01	0.00	0.00	0.00	L.B.	1.0	0.26	0.06	0.18	0.10	0.01	0.00
Canada	1.0	0.12	0.03	0.02	0.00	0.00	0.00	Peru	1.0	0.37	0.12	0.34	0.15	0.02	0.00
U.B.	1.0	0.25	0.10	0.06	0.02	0.00	0.00	U.B.	1.0	0.63	0.39	0.60	0.29	0.07	0.03
L.B.	1.0	0.03	0.01	0.02	0.00	0.00	0.00	L.B.	1.0	0.03	0.01	0.01	0.00	0.00	0.00
China	1.0	0.06	0.03	0.04	0.01	0.00	0.00	Saudi Arabia	1.0	0.06	0.02	0.01	0.00	0.00	0.00
U.B.	1.0	0.25	0.18	0.17	0.05	0.01	0.00	U.B.	1.0	0.13	0.07	0.04	0.01	0.00	0.00
L.B.	1.0	0.05	0.02	0.01	0.00	0.00	0.00	L.B.	1.0	0.04	0.01	0.00	0.00	0.00	0.00
Chile	1.0	0.08	0.02	0.02	0.00	0.00	0.00	South Africa	1.0	0.09	0.04	0.02	0.01	0.00	0.00
U.B.	1.0	0.23	0.11	0.08	0.02	0.00	0.00	U.B.	1.0	0.21	0.10	0.06	0.04	0.00	0.00
L.B.	1.0	0.02	0.01	0.00	0.00	0.00	0.00	L.B.	1.0	0.18	0.04	0.04	0.01	0.00	0.00
Finland	1.0	0.04	0.01	0.01	0.00	0.00	0.00	South Korea	1.0	0.28	0.08	0.08	0.02	0.00	0.00
U.B.	1.0	0.08	0.04	0.02	0.01	0.00	0.00	U.B.	1.0	0.56	0.26	0.23	0.13	0.03	0.00
L.B.	1.0	0.13	0.12	0.03	0.03	0.00	0.00	L.B.	1.0	0.01	0.00	0.00	0.00	0.00	0.00
France	1.0	0.22	0.16	0.03	0.03	0.00	0.00	Singapore	1.0	0.01	0.00	0.00	0.00	0.00	0.00
U.B.	1.0	0.52	0.47	0.14	0.12	0.01	0.01	U.B.	1.0	0.09	0.01	0.01	0.00	0.00	0.00
L.B.	1.0	0.02	0.01	0.01	0.00	0.00	0.00	L.B.	1.0	0.02	0.01	0.00	0.00	0.00	0.00
Germany	1.0	0.05	0.02	0.04	0.01	0.00	0.00	Spain	1.0	0.05	0.01	0.00	0.00	0.00	0.00
U.B.	1.0	0.17	0.08	0.09	0.05	0.00	0.00	U.B.	1.0	0.21	0.08	0.04	0.01	0.00	0.00

Table 4. Persistence Profiles of Long-run Relations to a System-wide Shock

	Periods								Periods						
L.B.	1.0	0.05	0.03	0.02	0.00	0.00	0.00	L.B.	1.0	0.16	0.10	0.03	0.04	0.00	0.00
India	1.0	0.10	0.07	0.04	0.01	0.00	0.00	Sweden	1.0	0.24	0.14	0.03	0.05	0.00	0.00
U.B.	1.0	0.25	0.21	0.10	0.03	0.01	0.00	U.B.	1.0	0.57	0.40	0.16	0.14	0.03	0.01
L.B.	1.0	0.07	0.09	0.11	0.01	0.00	0.00	L.B.	1.0	0.05	0.01	0.00	0.00	0.00	0.00
Indonesia	1.0	0.16	0.23	0.33	0.03	0.00	0.00	Switzerland	1.0	0.09	0.03	0.01	0.00	0.00	0.00
U.B.	1.0	0.32	0.53	0.66	0.18	0.03	0.01	U.B.	1.0	0.25	0.10	0.04	0.02	0.00	0.00
L.B.	1.0	0.01	0.00	0.00	0.00	0.00	0.00	L.B.	1.0	0.09	0.01	0.00	0.00	0.00	0.00
Iran	1.0	0.02	0.00	0.00	0.00	0.00	0.00	Thailand	1.0	0.18	0.02	0.01	0.00	0.00	0.00
U.B.	1.0	0.07	0.01	0.01	0.00	0.00	0.00	U.B.	1.0	0.38	0.10	0.06	0.02	0.00	0.00
L.B.	1.0	0.16	0.08	0.02	0.01	0.00	0.00	L.B.	1.0	0.45	0.22	0.03	0.02	0.00	0.00
Italy	1.0	0.26	0.18	0.04	0.03	0.00	0.00	Turkey	1.0	1.18	0.43	0.09	0.06	0.00	0.00
U.B.	1.0	0.47	0.34	0.10	0.09	0.01	0.00	U.B.	1.0	2.58	1.04	0.24	0.23	0.01	0.00
L.B.	1.0	0.01	0.01	0.00	0.00	0.00	0.00	L.B.	1.0	0.05	0.01	0.01	0.00	0.00	0.00
Japan	1.0	0.02	0.01	0.01	0.00	0.00	0.00	UK	1.0	0.11	0.03	0.01	0.00	0.00	0.00
U.B.	1.0	0.08	0.05	0.03	0.01	0.00	0.00	U.B.	1.0	0.26	0.11	0.05	0.01	0.00	0.00
L.B.	1.0	0.03	0.03	0.02	0.00	0.00	0.00	L.B.	1.0	0.03	0.02	0.01	0.00	0.00	0.00
Philippines	1.0	0.05	0.07	0.05	0.01	0.00	0.00	US	1.0	0.03	0.03	0.02	0.00	0.00	0.00
U.B.	1.0	0.18	0.20	0.18	0.05	0.01	0.00	U.B.	1.0	0.13	0.13	0.06	0.02	0.01	0.00

Note: L.B. and U.B. are lower and upper bounds of 95 percent confidence intervals, respectively. They are calculated based on a bootstrap using 1000 replications.
Source: Research finding.

Direct and Spillover Effects of Oil Shocks

One advantage of the GVAR model is that it captures the spillover effects of global shocks as well as direct effects. The oil price shocks changes global food prices and subsequently the level of general prices in countries. Therefore, when a global oil shock occurs, Iran's inflation is also affected by the changes in global food prices and inflation of its trading partners. This secondary effect is called the spillover or indirect effect (Figure 2).

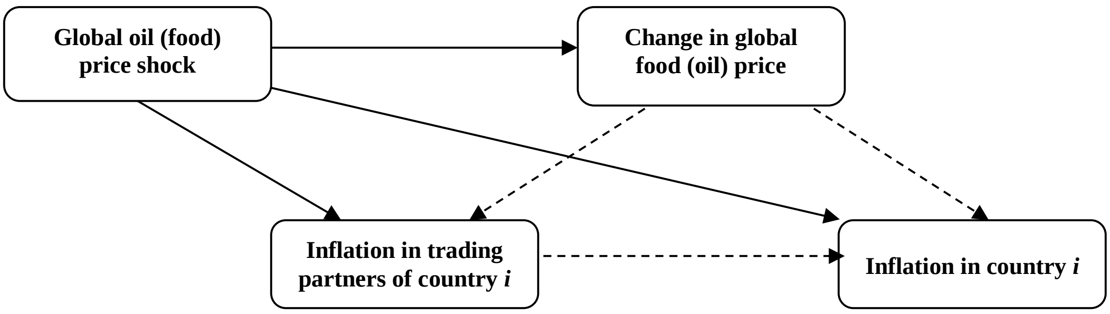

Figure 2. Direct and Indirect Effects of Global Oil Price Shocks
Note: continuous line shows direct effect and dotted line shows indirect effects.
Source: Research finding.

Figure 3 illustrates the direct and indirect effects of a global oil shock on Iran's inflation. According to the direct effect, the inflation rate initially decreased. Iran is an oil exporting country suffering from Dutch disease and the government is heavily dependent on oil revenues. Higher levels of oil revenues result in increasing government intervention in the foreign exchange market, facilitating the import of consumer goods, and increasing indirect subsidies; and since Iran is an oil-exporting country, the positive shocks in crude oil prices allow the government to follow price repression and subsequently the inflation rate decreases in the short run.

This initial decrease in inflation can also be analyzed by the terms-of-trade effect (Galesi and Lombardi, 2013). As oil prices rise, international trade and aggregate demand of the oil-importing countries fall leading to an increase among oil-exporting countries. Thus, real income distribution changes in favor of oil-exporting countries and it is expected that a decrease will occur in the inflation among these countries. In contrast, when the oil price drops in global markets, a redistribution of real income takes place from oil-exporting countries to oil-importing countries. In other words, oil-exporting countries experience higher inflation rates.

However, repression of price and foreign exchange rate is not possible in the long run. The decrease in inflation caused by an oil revenue jump will be temporary; inflation starts to increase and eventually it is fixed at a level above the initial value in the long run. The long-run effect of oil price shock on Iran's inflation is estimated at almost 0.01 percent (for 1 percent increase in oil price). As expected, oil is one of the causes of inflation in the Iran's economy.

On the other hand, as can be seen in Figure 3, there is a relatively strong spillover effect that exacerbates the direct effect of the oil price shock. A positive oil price shock leads to an increase in the inflation rate in Iran through the increasing food prices and also the increasing inflation of its trading partners. Then the positive oil price shocks increase inflation directly and indirectly in both the short and long run. However, the short-run effect of oil price shock is smaller than the long-run effect, which can be explained by a psychological effect. Oil price shocks lead to an increase in uncertainty and accordingly oil consumers postpone the purchasing of crude oil and oil-based products. Therefore, terms-of-trade effect temporarily appears for oil-exporting countries.

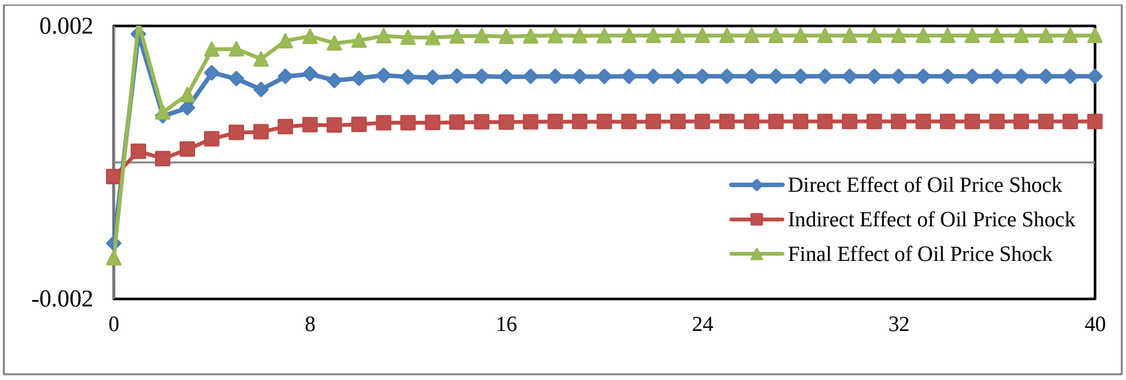

Figure 3. Direct and Indirect Effects of Oil Shock on Iran's Inflation
Source: Research finding.

Direct and Indirect Effects of Food Shocks

As illustrated in Figure 4, a food price shock leads to an increase in Iran's inflation simultaneously. Then the inflation rate begins to decline for one year, but it rises again until finally stabilizing above the initial level. Based on the results, the long-run effect of food global prices on inflation rate is 0.02 percent (for 1 percent increase in oil price).

The short-run effect of food shocks is negative and/or less than the long-run positive effect. These results can be interpreted based on two main reasons. First, food has a considerable share in the consumer price basket, especially in lower income-classes. Therefore, a food price shock leads to an increase in headline inflation which rises sharply in medium-to-long term through inflation expectation and wage-price spiral. Second, food shocks create a greater level of uncertainty and agricultural demand (positive shock) or supply (negative shock) is postponed in the short run. In the long run, food-importing countries must provide essential food and food-exporting countries are interested in supplying the food due to the high cost of storing the agricultural commodities. Therefore, the effect of food shock on inflation rate has a reaction lag.

In addition, as displayed in Figure 4, there is a strong spillover effect for food price shocks. The food price shocks lead to higher inflation of Iran trading partners. Therefore, not only is Iran's inflation directly affected by food price shock but it is also influenced due to the changes in the inflation of its trading partners. The inflation of trading partners is transmitted to Iran's economy and accordingly the initial increase in inflation is intensified. Then, as expected, Iran's inflation rate is positively influenced by food price shocks since Iran is a food-importing country.

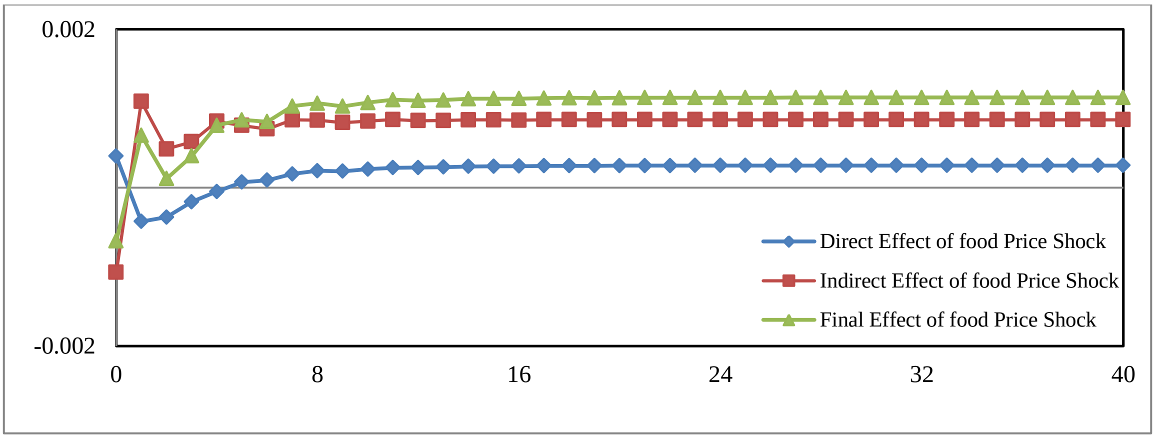

Figure 4. Direct and Indirect Effects of Food Shock on Iran's Inflation
Source: Research finding.

Furthermore, the results indicate that the effect of the food price shock on Iran's inflation is significantly more than that of the oil shock. The effect of oil and food prices are 0.01 and 0.02 percent, respectively; so a simultaneous shock of one percent in oil and food prices has a positive effect of 0.03 percent on inflation in Iran. These findings are expected since price and income elasticities of food demand and also price elasticity of agricultural commodities supply are small. In addition, the food basket of consumers is rarely altered in the short run while oil can be simply replaced by other energy sources. Then, as food prices change in global markets, less change take place in the quantities of supply and demand and the market is cleared through price changes.

Variance Decomposition of Iran's Inflation

The generalized forecast error-variance decomposition is estimated for inflation in Iran. Figures 5 to 7 identify the relative importance of each variable in explaining the geographical sources of Iran's inflation.

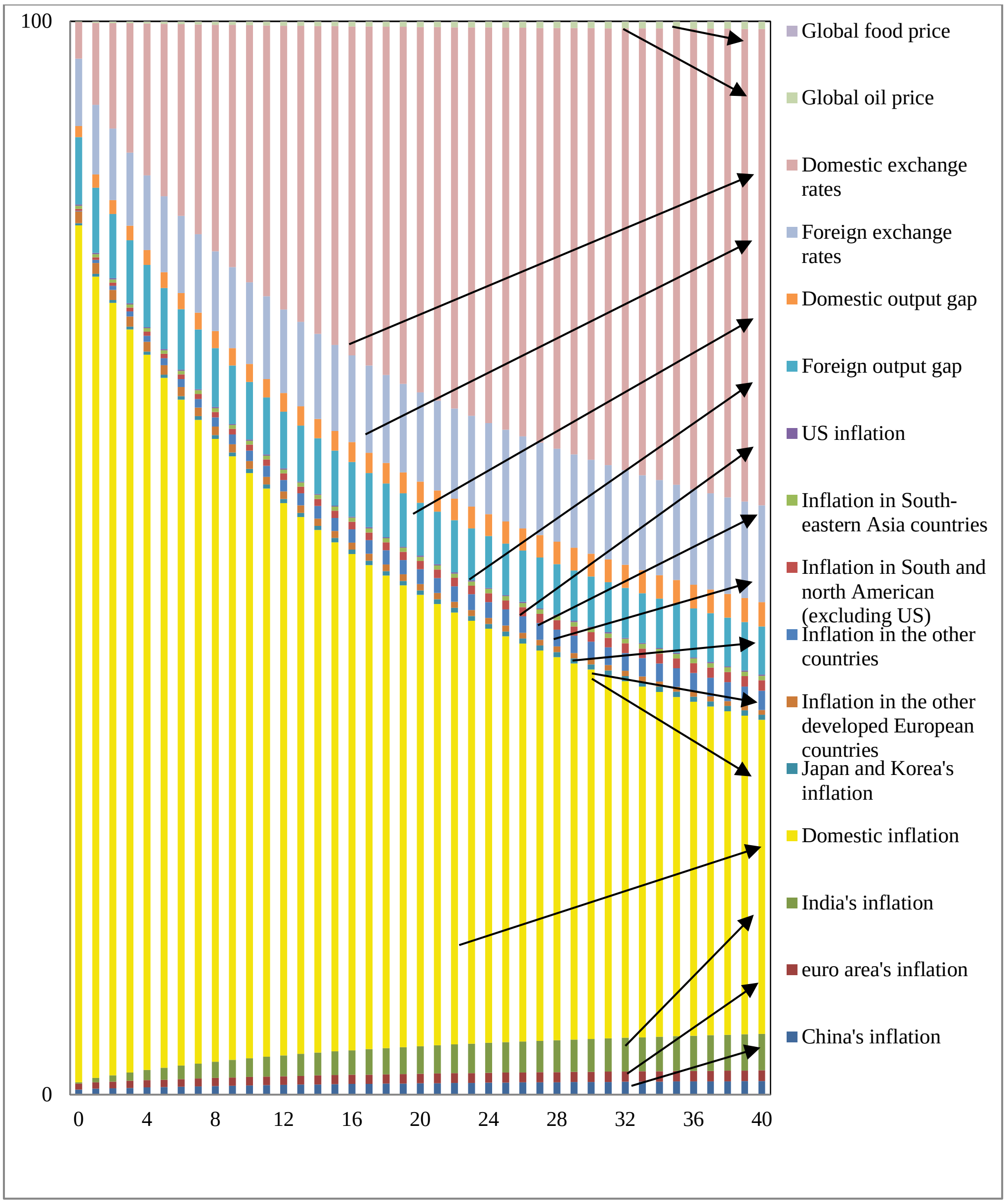

Figure 5. Generalized Forecast Error-variance Decompositions for Iran's Inflation
Source: Research finding.

More than 70 percent of inflation changes are explained by lagged domestic inflation, which decreases to less than 30 percent over time. In contrast, the foreign exchange rate explains almost 8 percent of the inflation variance during the first year; but its contribution has climbed to 20 percent in the second and third years and 40 percent in the long run. Also the share of domestic output gap is estimated about one to two percent. These evidences confirm the role of structural factors in Iran's chronic inflation.

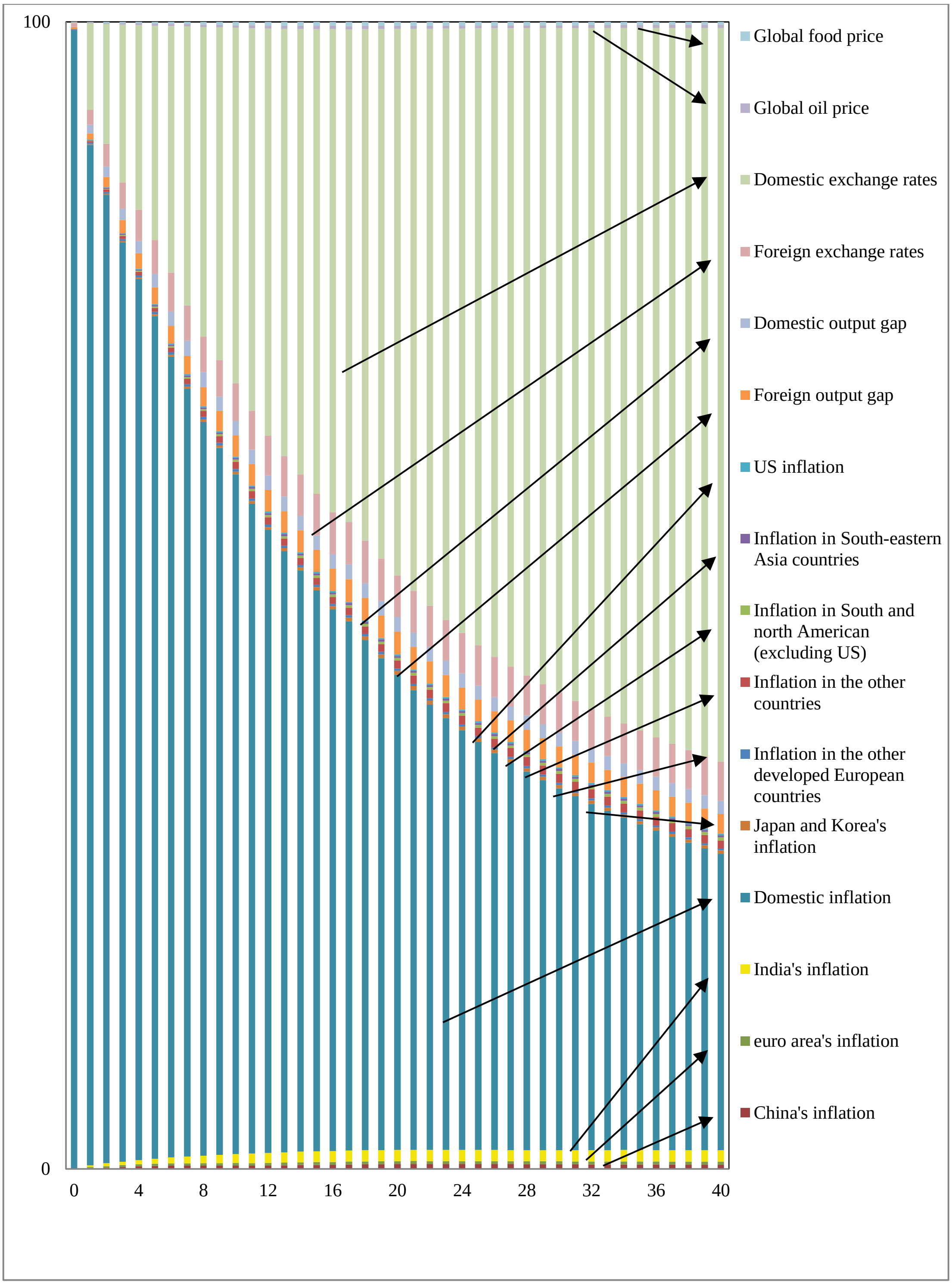

Figure 6. Generalized Forecast Error-variance Decompositions for Inflation (lower bounds)
Note: lower bounds of 95 percent confidence intervals are calculated based on a bootstrap using 1000 replications.
Source: Research finding.

The global price shocks directly explain only about 0.5 percent of the changes in Iran inflation. But as mentioned, these shocks have a relatively significant spillover effect that operates through trading partners. In this regard, the findings indicate that almost 21 percent of the variance of Iran's inflation is permanently attributed to foreign sources such as inflation shocks among trading partners (8 percent), foreign output gap (5 percent), and exchange rate of other countries (8 percent). One-third of the contribution of the 8 percent trading partner shocks comes from China and India, and also one-fourth from Latin America and Turkey. It means that more than 60 percent of foreign inflation shocks are attributed to Iran's trading partners among developing countries. In contrast, the developed countries in Europe and Southeast Asian countries impose the lowest inflation on Iran's economy.

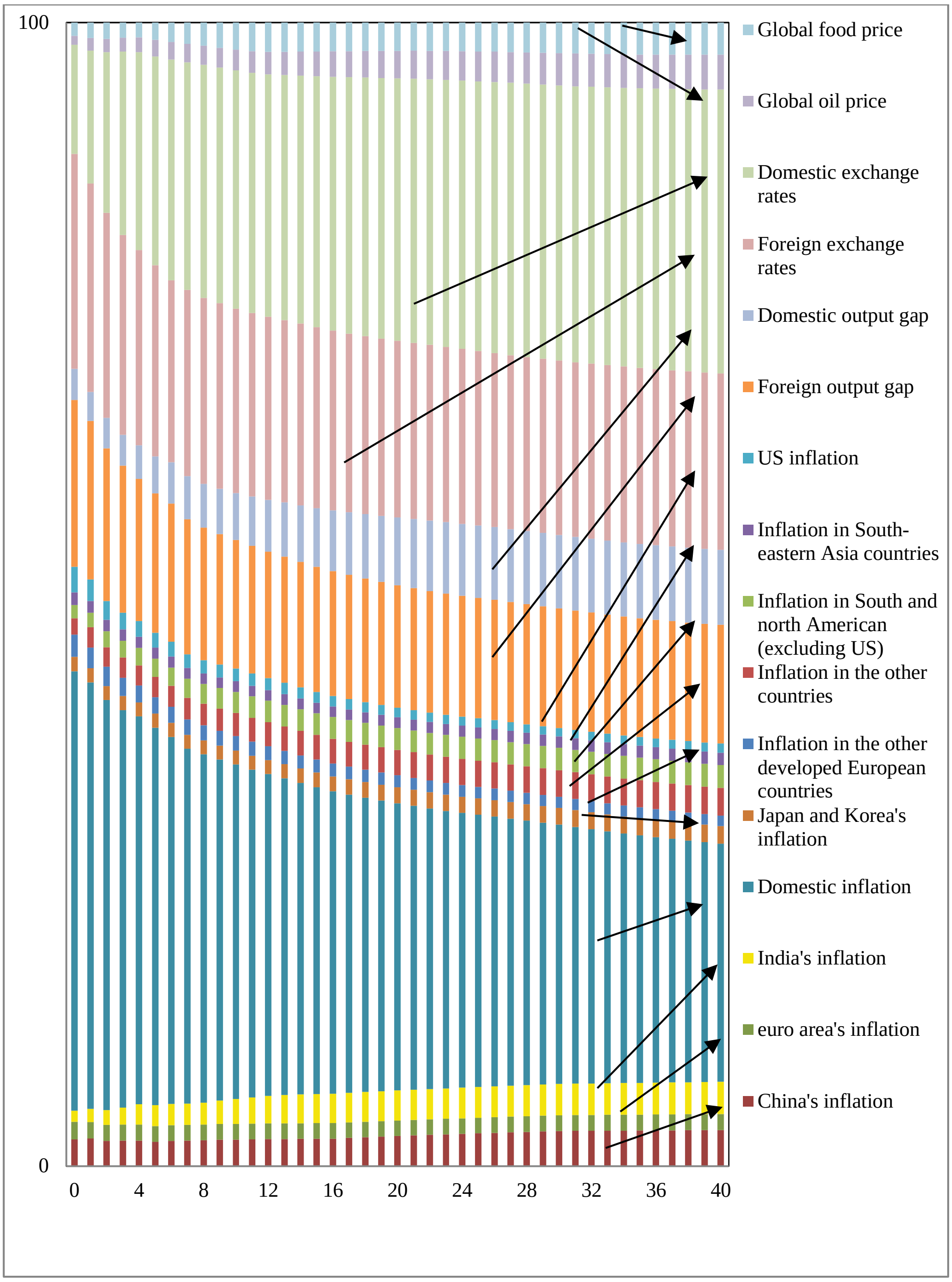

Figure 7. Generalized Forecast Error-variance Decompositions for Inflation (upper bounds)
Note: upper bounds of 95 percent confidence intervals are calculated based on a bootstrap using 1000 replications.
Source: Research finding.

Conclusion

Increasing financial and real international interdependence causes a higher degree of inflation vulnerability to foreign and global shocks. In this regard, inflation management is considered as one of the most important challenges which various countries are facing in the global economy. Accordingly, the present paper aims to evaluate geographic (domestic, regional and global) origins in Iran's inflation.

A GVAR model featuring a dominant unit is estimated for 34 countries during 1988Q4-2016Q4. These countries have more than 80 percent of the world GDP. In addition, 80 percent of the imports of each country have been provided by the other 33 countries. Therefore, the regional and global transmission channels of inflationary shocks across countries are properly included in the GVAR model. The empirical findings are as follows.

When a positive oil shock occurs, Iran's inflation rate initially decreases. Iran is an oil-exporting country, so this result can be analyzed by terms-of-trade effect. In addition, the Iranian government is heavily dependent on oil revenues, hence rising oil revenue makes it easier for the government to repress foreign exchange rates and prices. However, the repression of prices and foreign exchange rate is not possible due to the need to increase oil revenues again. Inflation starts to increase and eventually it is fixed at a level above the initial value in the long run.

Furthermore, there is a relatively strong spillover effect, which intensifies initial inflationary pressure (direct effect). Positive oil price shocks cause inflation in Iran's economy through the increasing food prices and also the increasing inflation of its trading partners. In sum, the positive oil price shocks increase inflation directly and indirectly in both the short and long run; but the short-run effect of oil price shock is smaller than the long-run effect, which can be explained by the psychological effect.

Since Iran is a food-importing country, the changes in global food prices directly and positively influence Iran's inflation in the long run. The effect of food shocks in the short run is less than the effect in the long run, which is probably related to the considerable share of food in the consumption basket and also postponing trade in global markets. Furthermore, there is a strong spillover effect. The food price shocks lead to higher inflation of Iran's trading partners, and hence Iran's inflation is exacerbated due to higher import prices.

Additionally, the effect of food shocks is greater than that of the oil shocks in both the short and long run. Thus, the degree of inflation vulnerability to food shocks is more important than the inflationary effect of oil shock. These findings are expected since price and income elasticities of food demand and also price elasticity of agricultural commodities supply are small. In addition, the food basket of consumers is rarely altered in the short run while oil can simply be replaced by other energy sources.

Based on results of variance decompositions, 85 percent of Iran inflation changes can be explained by domestic factors such as the output gap, exchange rate, and lagged inflation in the short run, which fall less than 75 percent in the long run. These evidences confirm the role of structural factors in Iran's chronic moderate inflation.

In contrast, the contribution of foreign shocks (foreign inflation, foreign output gap, and exchange rate) increase from 15 to 23 percent in the long run. More significantly, about 8 percent of the foreign shocks contribution are attributed to inflation of Iran trading partners, of which one-third of this contribution is related to China and India, and one-fourth to Latin America and Turkey. In short, more than 60 percent of foreign inflation shocks come from Iran's new trading partners.

The pattern of Iran's international trade has dramatically increased the degree of inflation vulnerability. The share of importing from China, India, and Turkey increased from 6 percent to 40 percent during the recent decade, and on the other hand, the share of the developed countries in Europe decreased from 48 percent to 26 percent. The share of trade with emerging Asian countries (except China and India) has also declined by 10 percent. The empirical findings indicate that the inflationary pressures caused by global shocks are relatively low among developed and industrialized countries. Indeed, these countries try not to transmit inflation shocks to their trading partners, for example, through decreasing profit margin. Therefore, an appropriate trading policy for Iran is to distribute international trading among developed and emerging countries, and consequently to reduce the share of countries that are vulnerable to external shocks and transmit them on their trading partners (such as Iran).

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