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A DYNAMICS ANALYSIS OF THE DETERMINANTS OF FOOD PRICE IN IRAN

Abdorahim Ira *

ABSTRACT

In this study, main determinants of food inflation in Iran over the period 2002-2015 are investigated and the interaction between this factors and food price impulse response will be analyzed by using Vector Error Correction (VEC) Model. Augmented Dickey-Fuller with lag length on Schwarz Info Criterion and Phillips-Perron with Newey West Bandwidth used to test the stationarity of the data. Johansen-Juselius system co-integration test applied to find the stationary linear combination of the non-stationary variables. The Long run relationship between dependent and independent variables estimated on Vector Error Correction (VEC) model. The results show that there is a relationship within the dependent variable and its independent variables. On the long run, the oil price, money supply and exchange rate are significantly positively related to the food price in Iran. Motivation of the study is to understand driving factors behind the food inflation phenomenon during the high inflation period that followed the subsidies reform plan in December 2010 and 2011 oil shock. The results presented in this paper indicate that oil price and money supply are main determinants of food inflation in Iran. The findings have important implications for understanding the volatility of food price in Iran and able to conclude the effectiveness of the monetary policy.

Keywords: *food prices, inflation, co-integration, oil price*
JEL Classification: *E31, E41, E52*

I. INTRODUCTION

Iran is a developing oil-based country with strong government control over major economic activities and some widely-known periods of high inflation. In recent years, food prices in Iran have received much attention from the consumers and policy makers. Perhaps the main concern relates to the potential consequences for consumers and Iranian living standards of the upward trend in and increasing variability of agricultural commodity prices, For instance, in the September of 2013 food inflation rise to maximum 52.1% during recent following the subsidies reform plan in December 2010 and 2011 oil shock. At a more fundamental level, however, legitimate concerns exist in relation to growing the oil price and expansionary monetary policy commodities in the medium to long term due to a conjunction of factors. The international sanctions against Iran's economy and increasing exchange rate are now expected to increase price of imported agriculture commodity and cause higher price for retail food price especially in urban area. The sharp growing of energy price and cost of transportation such as gasoline and electricity will also raise the price of agriculture product. There is therefore little yet the extent to which food markets are linked to other markets, including commodity markets, remains largely unknown in Iran as in most other countries. This paper tackles that issue by investigating the dynamics of food price formation in Iran in relation to the prices of oil, money supply and exchange rate as an impact of the imported inputs used in the food chain, namely agricultural commodities, machines and raw material. The shocks in oil prices can impact a country's economic activities in two ways. On the one hand, it can affect the level of supply, which manifests itself with some delay in influencing the production capacity of a country. On the other hand, oil shocks can exert an influence on the aggregate demand in a country, influencing economic activities in the short run (Emami and Alibpour, 2012).

Put simply, we seek to establish to what extent and how quickly changes in input prices influence food prices. Finding the macroeconomic determinants of food inflation therefore is important to the food inflation control in Iran. This paper aims to analyze the macroeconomic determinants of food inflation in of Iran using Vector Autoregressive (VAR) and Vector Error Correction Model (VECM), emphasizing the role of oil price, money supply and exchange rate in determining food price in Iran. We shall develop a co-integration analysis of food prices in Iran to make an empirical contribution to the existing literature on the determinants of food inflation in oil-base country such as Iran.

* The author is *Graduate Student at Graduate School of Economics, Tokyo International University (TIU), Tokyo, Japan* Corresponding author e-mail: *ar_ira@yahoo.co*

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II. REVIEW OF LITERATURE

Xavier et al., (2012) conducted a study by using finish monthly series of price indices from 1995 to 2010 to estimate a vector error-correction (VEC) model in a co-integration framework in order to investigate the short-term and long-term dynamics of food price formation. The results indicate that a statistically significant long-run equilibrium relationship exists between the prices of food and those of the main variable inputs consumed by the food chain, namely agricultural commodities, labor and energy.

Loening et al., (2009) by using monthly data over the past decade, estimate models of inflation in Ethiopia to identify the importance of the factors contributing to CPI inflation and three of its major components: cereal prices, food prices, and nonfood prices. The main finding is that movements in international food and goods prices, measured in domestic currency, determined the long-run evolution of domestic prices. In the short run, agricultural supply shocks affected food inflation, causing large deviations from long-run price trends. Monetary policy seems to have accommodated price shocks, but money supply growth affected short-run non-food price inflation.

Pham (2014) employs Vector Autoregressive (VAR) and Structural VAR (SVAR) models to analyze Vietnam's inflation determinants using quarterly data from 1996 to 2012. The results suggest that: (i) the inflation responses to monetary policy shocks are plausible and similar to standard monetary transmission in advanced economies; (ii) the policy interest rate plays an important role to inflation variation, which differs with what have been found in previous studies for Vietnam; and (iii) shocks to output and prices in trading partners have strong effects on inflation in Vietnam, while international oil and rice prices seem not to systematically affect Vietnam's inflation. Moreover, the State Bank of Vietnam does use monetary policy tools to ease down the inflationary pressure caused by foreign factors.

Ali et al., (2014) investigate the nature and causes of oil price pass-through into inflation in Iran in the short-and-long term. The results of this investigation showed that there exists a long-run relationship between oil price and CPI. Due to the logarithmic nature of the variables of this research, the coefficient of the oil price variable indicates the elasticity of CPI in the long run or the pass-through of oil price into CPI in the long run. This coefficient in the long-run relationship suggests that oil price accounts for 0.75 percent of the behavior of the consumer price index in the long run. After the long-run relationship between these variables was confirmed, the dynamic short-term relationship between the variables was demonstrated. The result of the dynamic model was also in line with the long-run relationship, indicating the significant and positive relationship between oil price and inflation. The short-term pass-through of the growth rate of oil price into inflation was 68%. As a matter of fact, the pass-through of oil price into consumer price index in both a short-term period and a long-run period is not complete. Moreover, the ECT coefficient shows that if a shock causes the variables to be out of the equilibrium in the short run, the effect of this shock will fade away after around 19 periods.

IRAN's INFLATION AND GOVERNMENT POLICIEC

Over the last ten years, the Iranian economy has experienced several events of critical importance, including the subsidies reform plan in 2011, the international sanctions and the oil shock in 2010; the behavior of the main macroeconomic variables has been strongly influenced by these shocks. Inflation, which experienced sudden bursts in correspondence with these episodes, has been moderately high on average (49% percent for food in 2012).

The 2010 subsidies reform shock clearly represents a breaking point in the money-inflation relationship. Food inflation increased significantly following the subsidies reform shock (from 18 percent to 52 percent), on the other side money supply increased almost 20 time between 2002 and 2014.

The trade reforms introduced in the early 2000s resulted in a gradual opening of the economy, which may have exposed it to the effects of international competition. Other factors that may have affected inflation are the impact of favorable weather conditions on agricultural prices, and stricter annual limits to the price increases for goods and services by public sector enterprises (Celasun and Goswami, 2002).

Regarding the recent peaks of Iran's inflation in 2012 and 2013, Abounoori, et al., (2014) provide some evidence of the extent to which oil price contributes to the causes of inflation. Since 2010, may, OPEC basket oil price grow up and reach to peak in March 2012, (figure 1).

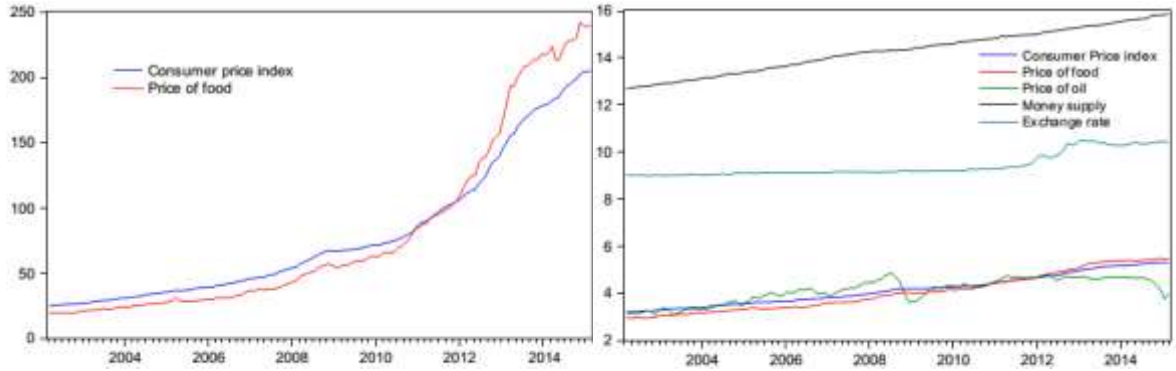

Figure 1. IRAN: CPI, Price of food, Price of oil, money supply and exchange rate (200103-201502)

THE MODEL AND DATA

Our monthly data set covers the period from March 2002 to February 2015 obtained from Statistical Center of Iran (SCI) giving a total of 156 observations. Food prices are measured by the component of the Consumer Price Index (CPI) corresponding to food subgroup. Exchange rate is measured by the monthly Rial to US Dollar exchange rates that released by Central Bank of Iran (CBI). Finally, oil prices are drawn from the database on Organization of the Petroleum Exporting Countries (OPEC) basket prices.

In order to analyze the impact of the different variables on food prices, a theoretical model has been constructed. According to Aljebrin (2006) the theoretical framework of our model is as follows: The vector of endogenous variables included in the VAR in this paper is:

$$Z = (P^f, P^e, M, ER)$$

In which P^f, P^e, M, ER are food price, oil price, money supply and exchange rate in that order. The recursive assumption implies that an oil shock will affect money supply, exchange rate, and food price level with a lag.

The public price of food to be estimated later in this paper is considered as a kind of long-run equilibria or co-integrating relations. Co-integration might be characterized by two or more integrated variables indicating a common long-run development. However, transitory fluctuations are possible. This defines a statistical equilibrium which can be interpreted as a long-run economic relation. Equation (1) shows a vector error correction model (VECM) with the order (p – 1).

$$\Delta X_t = \mu + AB^t X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \, \Delta X_{t-1} + \mu_t \qquad (1)$$

With a deterministic shift vector μ. Γi are (k × k) parameter matrices of the lagged stationary differences, B being the (k × r) matrix of k-dimensional co-integrating vectors and the corresponding (k × r) matrix of error correction coefficients. The matrix Π=AB’ represents the long-run relation between the variables in X_t.

III. METHODOLOGY

The methodology employed includes unit root tests, Johansen's co-integration test, Granger causality tests and estimation of the vector error correction model (VECM).

The Model

The aim of this paper is to analyze food price dynamics and causality, which is achieved by the application of Vector Autogression (VAR) model suggested by Sims (1980). However, one area of controversy for the VAR models is whether the variables included in a VAR should be stationary or not. Some argue that if the time series is non stationary, regression of one time series variable on one or more time variables can often give spurious results due to the effect of a common trend. Sims (1980) and others, though, recommend against differencing even if the variables have a unit root. The main argument against differencing is that “it throws away” information concerning the co-movement in the data which will, in general, lead to poor forecast. Recently, the concept of the co-integrated series has been suggested by Engle and Granger (1987) as a solution to this problem. According to the Granger Representation Theorem, if a set of variables are co-integrated, that

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is, X_t, Y_t ~ CI(1), then there must exist an "error correction" representation which describes the short-run dynamics of Y_t and X_t, in the following general form:
$\Delta Y_t = \beta_1 DX_t + \beta_2 \mu_{t-1} + \varepsilon_t$

For co-integrated series, the error correction term μ_{t-1}, which represents the speed of adjustment toward the long-run values, provides an added explanatory variable to explain changes in Y_t. Without μ_{t-1}, co-integrated systems estimated in differences are over differenced. The equation above is a single equation of ECM which can be also used in multivariate systems.

The analysis of the relationship between food prices, oil price, money and exchange rate is using the following variables vector with the first difference of ln as the natural logarithm.

$$X_t = \begin{bmatrix} \Delta lnP^f \\ \Delta lnP^e \\ \Delta lnM \\ \Delta lnER \end{bmatrix}$$

The estimation of the determinants of rural food prices in Iran is based on the following log-linear macroeconomic function:

$$\Delta lnP_t^f = \mu_t + \sum_{i=1}^{2} \alpha_{1,i} \Delta lnP_{t-i}^f + \sum_{i=1}^{2} \beta_{1,i} lnP_{t-i}^e + \sum_{i=1}^{2} \theta_{1,i} \Delta lnER_{t-i} + \sum_{i=1}^{2} \psi_{1,i} \Delta lnM_{t-i} + \sum_{i=1}^{3} \xi_{1,i} D_i + \delta_1 EC_t \quad (2)$$

$$\Delta lnP_t^e = \mu_t + \sum_{i=1}^{2} \alpha_{2,i} \Delta lnP_{t-i}^f + \sum_{i=1}^{2} \beta_{2,i} lnP_{t-i}^e + \sum_{i=1}^{2} \theta_{2,i} \Delta lnER_{t-i} + + \sum_{i=1}^{2} \psi_{2,i} \Delta lnM_{t-i} + \sum_{i=1}^{3} \xi_{2,i} D_i + \delta_2 EC_t \quad (3)$$

$$\Delta lnER_t = \mu_t + \sum_{i=1}^{2} \alpha_{3,i} \Delta lnP_{t-i}^f + \sum_{i=1}^{2} \beta_{3,i} lnP_{t-i}^e + \sum_{i=1}^{2} \theta_{3,i} \Delta lnER_{t-i} + + \sum_{i=1}^{2} \psi_{3,i} \Delta lnM_{t-i} + \sum_{i=1}^{3} \xi_{3,i} D_i + \delta_3 EC_t \quad (4)$$

$$\Delta lnM_t = \mu_t + \sum_{i=1}^{2} \alpha_{4,i} \Delta lnP_{t-i}^f + \sum_{i=1}^{2} \beta_{4,i} lnP_{t-i}^e + \sum_{i=1}^{2} \theta_{4,i} \Delta lnER_{t-i} + + \sum_{i=1}^{2} \psi_{2,i} \Delta lnM_{t-i} + \sum_{i=1}^{3} \xi_3 D_{i,i} + \delta_4 EC_t \quad (5)$$

where Δ is the first-difference operator, EC_t is the error correction term coming from the long-run cointegrating relationship, i.e. residuals, and the terms $i = 1,2$, are lag lengths. In this parsimonious VEC model, the lag lengths could be equal to zero for the variables that are not also dependent variables (seasonal dummy variables). The coefficients of EC_{t-1},δ_1,…, δ_4 capture the adjustments of ΔlnP_t^f, ΔlnP_t^e, $\Delta lnER_t$ *and* ΔlnM_t towards long-run equilibrium. The short-run causality relationships can be tested through the coefficients of each explanatory variable. For example, in order to see whether P^e Granger causes P^f in Equation (2) we can test the null hypothesis of different lag length parameters being equal zero, i.e., $H_0 = \beta_{11} = \beta_{12} = 0$.

The vector error correction model (VECM) estimation results obtained from equation (2)-(5) are given in table 5. A set of necessary standard diagnostic tests was conducted during the process of estimation to rule out any discrepancies.

In estimating equations (2)-(5), as explained in Hendry (1995), we first used four lags of the explanatory variables, i.e. estimated unrestricted ECM, and then sequentially removed the insignificant variables obtaining a final pars hat a deviation from the long-run equilibrium value in one period is corrected in the next period by parsimonious VEC specification. In such specification the variables that impose significant present-period pressure on the regress and are included into the equations without lags. In the short run, it can be observed that fluctuation-type relationships exist in general. Further, almost all adjustments take place within the same or following time periods, implying that the system settles down quickly.

IV. EMPIRICAL RESULTS

Unit Root Test

This VECM is equivalent to a vector auto-regression (VAR (p)) presentation of the levels X_t. In a VAR-model each variable can be taken as endogenous. The changes in a selected target variable in period t depend on the deviations from that specific equilibrium in the previous period and the short-run dynamics. The VECM allows

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us to estimate the long-term effects and to analyse the short-term adjustment process within one model. Actually, the variable vector X_t is assumed to be vector integrated of order ($I(1)$), i.e. ΔX_t is vector stationary. But for the purpose of this paper, it will be sufficient to test each individual variable independently for integration and stationarity by augmented Dickey-Fuller-test (ADF).

Before carrying out econometric estimation of our model it is important to investigate the time-series properties of the variables included in the model. Augmented Dickey-Fuller (ADF) 't' unit root test and Phillips-Perron (PP) test results are presented in Table 1 below and suggest that the null hypothesis of a unit root can be rejected for all the variables at first difference level ($I(1)$).

Table 1: Unit root test

Variables	Endogenous	ADF test				PP test			
		Level		1dif		level		1dif	
		stat.	P-Value	stat.	P-Value	stat.	P-Value	stat.	P-Value
LnP^f	cst	-3.4730(1)	0.9991	-3.4730(0)	0.0000	-3.472813	0.9987	-3.4731	0.0000
	cst and trend	-4.0187(1)	0.7136	-4.0187(0)	0.0000	-4.018349	0.7491	-4.0187	0.0000
LnP^e	cst	-3.4730(1)	0.2599	-3.4745(5)	0.0000	0.2557	0.2557	-3.4731	0.0000
	cst and trend	-4.0191(2)	0.2981	-4.0208(5)	0.0000	-4.018349	0.7939	-4.0187	0.0000
LnM	cst	-3.4730(1)	0.9076	-3.4730(0)	0.0000	-3.472813	0.8948	-3.4731	0.0000
	cst and trend	-4.0187(1)	0.7535	-4.0187(0)	0.0000	-4.018349	0.6361	-4.0187	0.0000
$LnER$	cst	-3.4742(5)	0.9864	-3.4742(4)	0.0000	0.9894	-3.4728	-3.4731	0.0000
	cst and trend	-4.0203(5)	0.8931	-4.0203(4)	0.0001	0.8959	-4.0183	-4.0187	0.0000

All variables are in log forms. Lag lengths, determined by AIC, are in parenthesis. An asterisk denotes % significance level. Critical values are from Davidson and MacKinnon (1996).

Co-Integration Test

An intercept can be included in co-integrating relations alternatively, as well as a deterministic time trend. The maximum lag P can be easily found by Schwarz-Bayes or Akaike information criterion. The number r of cointegrating vectors (lines in B') can be determined as the rank of the matrix Π=AB'by several tests, such as the test of maximum eigenvalue of Π (Nastansky/Strohe, 2011, p. 12-13). Under rather general conditions, the coefficient matrices A, B and Γi can be estimated by least squares (LS), generalized least squares (GLS) and maximum likelihood (ML). In the following sections of this paper, the ML method known as Johansen procedure as presented in the software EVIEWS. Criteria (Akaike, Schwarz, Hannan–Quinn, and Final Prediction Error), the lag length of two months is found to be optimal.

Table 2: The Selection of Lag Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	77.02327	NA	4.74E-06	-0.9082	-0.749049	-0.843548
1	1217.984	2191.845	0.0000	-15.7103	-15.23285*	-15.5164
2	1254.058	67.40147*	1.36e-12*	-15.97444*	-15.17868	-15.65118*
3	1266.294	22.21878	0.0000	-15.9249	-14.81086	-15.4724
4	1277.819	20.32057	0.0000	-15.8660	-14.43368	-15.2842

*Optimum lag

Because we have more than two I(1) variables, the co-integration rank must be estimated. First, the order of the co-integrating VAR needs to be selected. The Akaike criterion (ML version) suggests a VECM of order one. We include a restricted intercept but not a trend in the co-integrating relations. The maximum eigenvalue test and the trace test are applied to test the rank r.

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Table 3: Results of co-integrating test

Hypothesized	Unrestricted Co-integration Rank Test (Trace)				Unrestricted Co-integration Rank Test (Maximum Eigenvalue)			
No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
$r = 0$*	0.2021	54.2393	47.8561	0.0112	0.2021	34.0932	27.5843	0.0063
$r \leq 1$	0.0769	20.1460	29.7971	0.4130	0.0769	12.0794	21.1316	0.5398
$r \leq 2$	0.0444	8.0667	15.4947	0.4583	0.0444	6.8592	14.2646	0.5059
$r \leq 3$	0.0080	1.2074	3.8415	0.2718	0.0080	1.2074	3.8415	0.2718

*Significant at the 5% level

The maximum eigenvalue tests suggest that there is $r = 1$, i.e. one single cointegrating relation between food price, oil price, money supply and exchange rate (table 3). The trace test also suggests that there are $r = 1$ co-integrating vectors.

Granger Causality Tests

The causality concept introduce by Granger (1969) is perhaps the most widely discussed form of causality in the econometrics literatures, Granger defines a variable Y_t to be cause by another time series variables X_t if the former variables can be predicted using past values of X_t in addition to the all other relevant information needless to say, the correct estimation procedure would be to include all independent variables indicated by the relevant economic theory. Granger considers a system of the general form. In order to better understand the dynamic relationships among the four variables and refine the model. The estimated F-Statistic of the causality test are reported in Table 4.

Table 4: Results of granger causality tests.

Null Hypothesis:	F-Statistic	Prob.
$ln(P^e)$ does not Granger Cause $ln(P^f)$	3.39871	0.036
$ln(P^f)$ does not Granger Cause $ln(P^e)$	0.31799	0.7281
$ln(M)$ does not Granger Cause $ln(P^f)$	12.2276	1.00E-05
$ln(P^f)$ does not Granger Cause $ln(M)$	5.02663	0.0077
$ln(ER)$ does not Granger Cause $ln(P^f)$	3.44438	0.0345
$ln(P^f)$ does not Granger Cause $ln(ER)$	2.85196	0.0609
$ln(M)$ does not Granger Cause $ln(P^e)$	2.41017	0.0933
$ln(P^e)$ does not Granger Cause $ln(M)$	2.30833	0.103
$ln(ER)$ does not Granger Cause $ln(P^e)$	0.03445	0.9661
$ln(P^e)$ does not Granger Cause $ln(ER)$	1.7631	0.1751
$ln(ER)$ does not Granger Cause $ln(M)$	1.15792	0.3169
$ln(M)$ does not Granger Cause $ln(ER)$	1.49509	0.2276

Structural VECM Estimation Results

The results presented in Table 5 show that the EC_t coefficients of equations (2) that is significant and have negative signs implying that the series cannot drift too far apart and convergence is achieved in the long run. More specifically, each EC_t coefficient indicates t the size of that coefficient. For equations (2) the corrections are around 8 percent. In the short run, it can be observed that fluctuation-type relationships exist in general. Further, almost all adjustments take place within the same or following time periods, implying that the system settles down quickly.

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Table 5: Estimated of VEC models

	Coefficient	Prob.
EC_t	-0.081475*	0.0000
ΔlnP^f_{-1}	0.049811**	0.0526
ΔlnP^f_{-2}	-0.121257	0.1290
ΔlnP^e_{-1}	1.905905***	0.0361
ΔlnP^e_{-2}	1.888197	0.3862
ΔlnM_{-1}	4.276387*	0.0394
ΔlnM_{-2}	-4.857456	0.3384
$\Delta lnER_{-1}$	3.234446**	0.0794
$\Delta lnER_{-2}$	-4.005972	0.7222
Cst	1.977804	0.0016
D_1	-1.076774	0.0545
D_2	-0.486913	0.3364
D_3	-0.171869	0.7390

R-squared	0.408346	Durbin-Watson stat1	1.965946
F-statistic	8.052082		
Prob(F-statistic)	0.0000		

*=1%, **=5%, ***=10%

Impulse Response Analysis

The results were further verified through impulse response functions (IRFs). IRFs trace the effect of a one-time shock to one of the innovations on current and future values of endogenous variables. The generalized impulse responses provided more insight into how shocks to oil price, money supply and exchange rate affected food prices. The result of generalized impulse responses for food price is represented in Figure 2. The IRFs provided the support of causality status between these three time variables in the 4 multivariate VECM systems. In all the cases, the IRFs were very responsive to the results of VECM. Response of food price to a shock in oil price is positive and dies out a long one and half. Figure 2 shows that the response of food price to itself surplus shock is initially positive but dies out within two quarter. Finally, figure 2 shows that the initial response of food price to a shock in exchange rate and money supply is positive and significant in the first quarter, then becomes negative and dies out.

Since shocks to a particular variable can generate variations both in it and in other variables, we employ the orthogonalized methodology of Sims (1980) to determine impulse responses. In this approach it is possible to trace. In the Figure 2 we see that response of food price to itself, oil price, money supply and exchange rate.

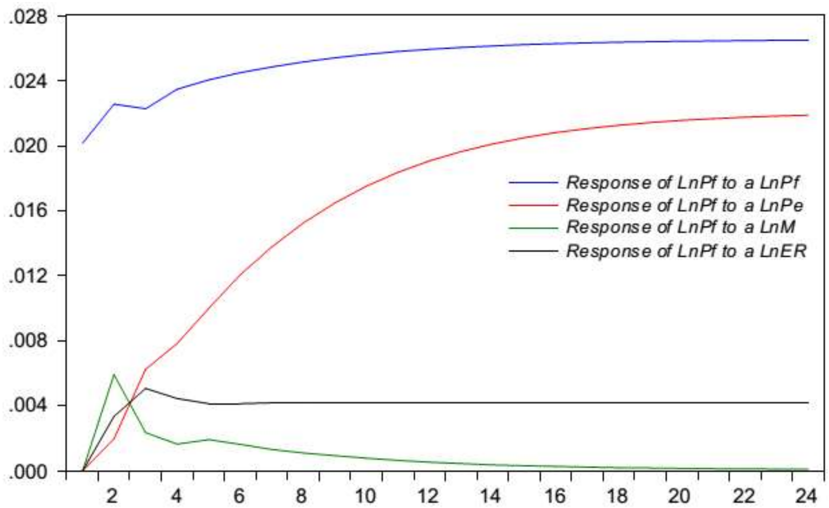

Figure 2: Impulse responses to Cholesky One S.D. Innovations

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V. CONCLUSION

The overall objective of this paper is to investigate the sources and the food inflation and examine the causality relationship between food price and its determinants. The methodology employed includes unit root tests, Johansen's co-integration test, Granger causality tests and estimation of the VECM.

The present empirical analysis starts with checking stationary of the time series variables as that is the prime requirement for co-integration and causality test-detecting causality to facilitate policy formulation. The ADF unit root test has been applied to examine the stationary of the time series data. The estimated results of unit root test are reported in Table 4. The results indicate that no time series variables appear to be stationary in variable levels, since computed test statistics could not reject the null hypothesis of non-stationary. This means that means the variables are non-stationary in their level data and suggests that stationary be checked at a higher order of differencing. In the present case it is found that when the first differences of the variables are considered, the null hypothesis of unit root is rejected at 1% significance level. Hence, the differences become stationary and consequently the related variables get characterized as integrated of order one, 1 (1). Following that the three series are integrated of order one, the co-integration relationship between them are established by using Johansen's maximum likelihood (ML) test. The results of co-integration test indicate that the time series variables (food price, oil price, liquidity, and exchange rate formation) are co-integrated (see Table 5) and hence, long run equilibrium relationship may exist among them. This gave us the hope for striving toward the stated mission of this study-testing certain hypothesized causality. The estimated results of VECM are reported in Table 5. The analysis finds the existence of causality between food price in Iran and oil price. Causality is also found between money supply exchange rate and food price. Impulse response analysis also indicates that the series are responsive to the various corresponding shocks.

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