IJEFI
INTERNATIONAL JOURNAL OF ECONOMICS AND FINANCIAL ISSUES
EJ EconJournals
ISSN: 2146-4138

International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2016, 6(2), 380-385.

EJ EconJournals

The Comparative Comparison of Exchange Rate Models

Kamran Mahmodpour[1]*, Yaser Sistani Badooei[2], Hadiseh Mohseni[3], Saman Veismoradi[4]

[1]Department of Economics, University of Sistan and Baluchestan, Zahedan, Iran, [2]Department of Economics, Baft Higher Education Center, Shahid Bahonar University of Kerman, Kerman, Iran, [3]Departments of Sama, Shirvan Branch, Islamic Azad University, Shirvan, Iran, [4]University of Sistan and Baluchestan, Zahedan, Iran. *Email: Kamran_mahmodpour@pgs.usb.ac

ABSTRACT

One of the most important and effectiveness of macroeconomics variables is prediction of future exchange rate trend which heavily considered by economic scholars. Its changes affects different parts of economic, thus it is necessary to model it to provide more suitable economic advising. In order to do that, in this paper we have used seasonal autoregressive integrated moving average (SARIMA), autoregressive conditional heteroskedastistiy (ARCH) and generalized ARCH (GARCH) models to simulate the time series trends of exchange rate in Iranian non-official market. The results show that GARCH provides better and more acceptable outputs than SARIMA.

Keywords: Seasonal Autoregressive Integrated Moving Average, Autoregressive Conditional Heteroskedastistiy, Generalized Autoregressive Conditional Heteroskedastistiy, Exchange Rate
JEL Classifications: C22, C32, E31, E32

1. INTRODUCTION

Exchange rate systems evolved during many years in international area and affected economic structure of countries. These show how to determine exchange rate in economic (Ehsani et al., 2009). Exchange rate fluctuations considered after adjusted pegged exchange rate system downfall and appearing of floating exchange regime in 1973, when real and nominal exchange rates were faced to incontrollable instability. In fact as macroeconomic variable, exchange rate has played role considerable in different parts of economic such as balance of payment and international competition power to determine future policies. In econometric time series literary vector autoregressive, autoregressive integrated moving average (ARIMA), generalized autoregressive conditional heteroskedastistiy (GARCH) and exponential GARCH models applied to modeling and forecasting of economic variables (Khodavaisy and Mollabahrami, 2012). Despite of its importance between economic variables, exchange rate heavily considered in recent Iranian economy situation as sanctions and exchange rate supply barriers can leads to severe exchange rate movements in economy (Mojtahed et al., 2012). These severe movements could involve irrecoverable damage in different parts of economy. Therefore, to exchange rate modeling, accurate knowledge is necessary as it is heavily affected other economic variables.

More especially on Iranian economy, variety of situation has experienced in recent decades which exchange rate equalizing comes out as output, also international competitive situation requires necessary attention, e.g., determinant factors on exchange rate in one side and its completion degree in other side (Shajari et al., 2005). So economic modeling is a concept that does matter in both theoretical and applied aspects. Making decision on how the economic policy execution quality is growing quickly at economic literary as new, complicated and applicable models continuously presented to be more and get better analyzing of economic variables.

This paper organized as introduction in first part, empirical conducted studies review in second, theoretical framework in third and finally conclusion and policy recommendation in terminal part.

2. EXCHANGE RATE MODELING LITERARY OVERVIEW

In traditional econometric models constant variance of error term has been the main classic assumption of econometric. To remove this limited assumption Robert Engel founded the new method called as ARCH model. In this method it is assumed that random term has zero mean and serial uncorrelated but its variance formed based on own past information. Existence of small and large prediction errors in economic variables (such as exchange rate, inflation, stocks and so on) is a reason to use ARCH models as it is possible to show different behaviors during the series. In other word, has less fluctuation at some year and large in other one. In this situation it is expected variance not be constant during random trend of series and is error term function. Indeed, the GARCH advantage is the possibility to explain conditional variance trend based on its past information (Abonori and Khanalipoor, 2009).

2.1. Exchange Rate

Exchange rate defined as the price of nation's currency in terms of another currency. Real exchange rate definitely is of initial and fundamental indices to explain international competitiveness degree and explain internal situation of a country. Its fluctuations mean instability of economy. Conducted researches on developing countries show that adjusted changes of structural variables and government's irreconcilable fiscal and financial policies cause the gap of real exchange rate from its equilibrium values. Today, exchange rate variable considered as vital factor in economy because of its effectiveness on inflation as its changes effect of inflation reflected on inflation expectations. Related exchange rate policies have significant effect on macroeconomic variables and its parts (Karami and Zibaei, 2008). As exchange rate first effect on export, import and exiting and entering of capital via balance of payments and secondly in next stage by changing aggregate supply and demand, and will affect other macroeconomics as well too. This theoretical framework can be seen from old and famous Flemming theory and other macroeconomic models.

2.2. Exchange Rate at Iran

Exchange rate system has faced to much events in before and after 1979 Islamic revolution as we will describe in follow. Before 1970 decades dollar rate was stabilized in 70 Rials due to high oil revenues. Floating exchange rate system founded in 1973. And at the early of 1992 with applying exchange rate equalizing policy, exchange rate system formed to floating. Export exchange rate presented in 1974 to motive export and limit the import. This recent change canceled in 2000 and stock market transformed to main determiner of exchange rate. And all exchange rate transactions transferred to new banking market in 2002. Using of GARCH family in economic cluster, has some barriers. These parametric models have the best performance in sustainable market, i.e., while ARCH models formed to model economic series which have unequalized variance, but in the case of non-routine events such as severe changes of variable drift, their efficiency will considerably decreased (Abonori and Khanalipoor, 2009). Totally Iranian exchange rate have faced to much changes in past years and these have not been in framework of one system. More specifically government's controlling, exchange policies and import and export approaches mentioned as determinants of those changes. To determine exchange rate, there are two threshold systems. When currency price tends to increase, central bank will supply foreign currency in former price to fix it and vice versa i.e., in the case of trend decreasing, central bank will buy (demand) currency from market to fix it. Like a floating exchange rate, fixed exchange rate obtained from market equilibrium as by controlling market forces, government reach to specified level rate. But if government insists on specified rate (by command), market will apart of equilibrium price and two different prices (real market price and governmental price) will emerge that is different from fixed exchange rate system. In other side, there is floating exchange rate system which exchange rate is completely determined by market forces and there is no governmental intervention. There is no evidence of using just one system for a country (complete fixed exchange rate system and floating exchange rate system) in real world. In Iran managed floating exchange rate systems are determined as official system. While exchange rate system changing and government's intervention and controls make us believe there is no specific exchange rate system in the country. Based on statistical observations, exchange rate have slow and fast increasing trend that may be the reason of increasing the price level existence (exchange rate fluctuations mainly faced to increasing trend) (Mojtahed et al., 2012).

2.3. Research Background

Among conducted researches on exchange rate fluctuation modeling at in and outside of Iran we present some as follows:

1. Khodavaisi and Mollabahrami (2012) in their study "the modeling and forecasting of exchange rate based on random differential equations," surveyed modeling and forecasting of exchange rate time series in Iranian exchange rate market using random differential equations.
2. Dargahi and Ansari (2007) developed nervous network model to predict exchange rate based on variance turbulence index. In so doing, they considered variance and GARCH indices as turbulence exchange rate index and then used two mentioned models. They added exchange rate lags and turbulence index at second stage, so categorizing of observations based on turbulence level, applied special model for each part of observations. Their results show that high turbulence levels improved future exchange rate prediction power in compare of basis model.
3. Pluciennik (2010) applied different random differential models to prediction financial time series of some European market and then compares random differential models and time series GARCH and ARIMA models.
4. To daily UK Pound data modeling at 1990-1998 period, Craine et al. (2000), used jumping diffusion random differential equations model. They used maximum likelihood prediction method to predicting the jumping diffusion model. Results of estimated simulation model show their suggested model output provides good estimates of existence jump and fluctuations at real exchange rate time series data.
5. Askari and Krichene (2008) tried modeling the oil price dynamics using Jump-diffusion differential equations model. To estimate the model parameters, maximum likelihood method applied and concludes that oil price had been out of equilibrium as well as being sensitive to supply and demand shocks.

3. THEORETICAL FRAMEWORK

In this section we are going to present seasonal ARIMA (SARIMA) and ARIMA models. In econometric literary there are two main approaches as follow: The first method so called as traditional method is based on assumption that seasonal subject of time series is non-random and independent from other non-random matters. Conversely, in second approach seasonal matter assumed as random and correlated with non-seasonal matters. For example, the price of product in current month not only is a function of last month price but also is function of its price in similar month in past year. Therefore, to predict a variable price or any other studying variable that is necessary not only analyzing present year months but also do this for similar months of last year. Most common Seasonal ARIMA approach is multiple Box and Pierce (1970) model presenting as follow:

$$\Phi_P(B^S).\phi_P(B(1-B)^d(1-B^s)^D z_t)\theta_q=(B).\Theta_Q(B^s)\varepsilon_t \quad (1)$$

To sampling reason $\phi p\,(B)$ and $\theta q\,(B)$ we define as auto-regression and moving average factors respectively, $\Phi p\,(B^s)$ and Θ_Q (B) multi-nominal autoregressive and seasonal moving average and s is season period. In majority of time series literature paradigm (1) presented as $(P, D, Q)_s$×ARIMA (p, d, q).

An ARIMA (p, d, q) $(P, D, Q)_s$ can also include intercept which in there B is lag operator, d non-seasonal difference operator degree, D is seasonal difference operator degree, p is operator degree of non-seasonal AR, P is s operator degree of seasonal AR, q is operator degree of non-seasonal MA and finally Q is operator degree of seasonal MA as:

$\phi_p(B)=1-\phi_1 B-\phi_2 B^2-\ldots-\phi_p B^p$

$\Phi_p(B^s)=1-\Phi_1 B^s-\Phi_2 B^{2s}-\ldots-\Phi_p B^{PS}$

$\theta_q(B)=1-\theta_1 B-\theta_2 B^2-\ldots-\theta_q B^q$

$\Theta_Q(B^s)=1-\Theta_1 B^s-\Theta_2 B^{2s}-\ldots-\Theta_Q B^{Qs}$

The stationary and conversantly reversibility conditions will hold if only each root of identified equation of $\Theta_Q(B^s)=0$, $\theta q\,(B)=0$, $\Theta p\,(B^s)=0$ and $\phi_p(B)=0$ located in out of unit circle. For instance for $P=2$, $Q=1$, $s=4$, $d=0$, $D=0$, $q=1$, $p=1$ at system (1) presented as follow:

$(1-\phi_1 B)(1-\Phi_1 B^4-\Phi_2 B^{2\times4})$

$(1-B)^0(1-B^4)^0 x_t=(1-\theta_1 B)\,(1-\Theta_1 B^{4\times1})a_t$

$x_t=\Phi_1 x_{t-4}+\Phi_2 x_{t-8}+\phi_1 x_{t-1}+\phi_1\Phi_1 x_{t-5}-\phi_1\Phi_2 x_{t-9}+a_t-\Theta_1 a_{t-4}-\theta_1\Theta_1 a_{t-5}$

If unit roots exist, it is important that suitable filters formed as combination of $(1-B)^d$ $(1-B^s)^D$ and after trend stationarity of case study process, its parameters must be estimated. We have d times equal to multinomial ϕ (B) as well as D times equal to unit roots for Φ (B^s). For example for $d=1$ and $D=2$ we have:

$(1-B^s)^2=1+B^{2s}-2B^S$, $(1-B)$

Box et al. (1994) Time Series Modeling Stages: Box-Jenkings approach to execute a reliable prediction in policymaking includes below steps:

1. Model Identification: Determine the degree of lag operators Like non-seasonal time series models we can determine P, p, Q, q by using auto-correlated functions and ARMA (P, Q) $(P, Q)_s$ torque process. As a sample here we present characteristics of some simple seasonal models for one series of seasonal time series. These seasonal time series, with their features presented here, are not complete model but they cover most of common models in literature.

3.1. Seasonal Unit Root Test (4 Season of Year)

One of the main conditions to applying ARMA paradigm to modeling a random process is stationarity of under studying time series. To test stationary of seasonal time series different methods could be applied such as HEGY (1990) and Beaulieu and Miron (1993) which both described as follow. If there is possibility to have seasonal unit root, we have to use suitable method to detect it. To simplify reasons, we first analyze seasonal unit root test (4 season at each year) as well as seasonal data (monthly) in next stage.

4. UNIT ROOTS IN SEASONALLY TIME SERIES DATA (4 SEASONS IN EACH YEAR)

Suppose that we have seasonally observation (4 season per year) for series of $\{x_n\}$ to check unit root. In designing the suitable and acceptable framework, first we present multinomial $(1-B^4)$- as below:

$(1-B^4)=(1-B)(1+B)(1+B^2)$

It is evident that this multinomial has 4 unit roots.

$B=\pm$i and $B=-1$ and $B=1$

Where B=1 means unit root with frequency of zero, i.e., reproduction of an observation in next period, B=−1 means existence of unit root and reproduction of an observation after next two period (1/2 cycle per season) and $B=\pm$i means unit root and reproduction of an observation in next 4 seasons (1/4 cycle per a season). What is the meaning of unit root at frequency of zero, half-year frequency and seasonal frequency?

Consider a below fourth order multinomial with $\gamma=1$:

$(1-B)(1+B)(1+B^2)x_t=\varepsilon_t$

(a). For unit root with zero frequency:

$(1-B)x_t=0\Rightarrow x_t=x_{t-1}$

i.e., in the case of $\{B=1\ at x_t\}$ will reproduce itself frequently without any time seoerations.

(b). For half-year unit root:

$(1-B)x_t=0\Rightarrow x_t=-x_{t-1}$

With creating an one period primacy we have $x_{t+1}=-x_t$, so with replacing above x_t:

$x_{t=1}=-(-x_{t-1})$

Thus with one period primacy there is:

$x_{t=2}=x_t$

i.e., series of x_t tends to reproduce itself with two periods distance.

(c). The case of seasonally unit root (its corresponding season in last year) for both roots of we have:

$(1+iB)x_t=0 \Rightarrow x_t=-ix_{t-1} \Rightarrow x_{t-1}=-ix_{t-2}=-ix_{t-2}$

$x_t=i^2x_{t-2} \Rightarrow x_{t-2}i^2x_{t-4} \Rightarrow x_t=i^2i^2x_{t-4}=x_{t-4}$

For $-i$ root we have same result, i.e., series of x_t reproduce itself per 4 seasons. Therefore:

$(1-iB)x_t=0$ is $x_t=x_{t-4}$.

$(1-iB)x_t=0 \Rightarrow x_t=-ix_{t-1} \Rightarrow x_{t-1}=ix_{t-2}$

$x_t=i^2x_{t-2} \Rightarrow x_{t-2}i^2x_{t-4} \Rightarrow x_t=i^2i^2x_{t-4}=x_{t-4}$

In multinomial $(1-B^4)$ the implied assumption is related parameter of x_{t-e} equals to unit. It means $x_{t-q}=x_{t-q}+\varepsilon_t$. But there is no information on value of γ in empirical modeling because if at beginning we know $\gamma=1$ then unit root test was not necessary. Thus, actually it is necessary to represent the studying seasonal time series as follow:

$x_t=\gamma x_{t-4}+\varepsilon_t$

So related different multinomial fourth order can be written as follow:

$(1-\gamma B^4) = (1-\gamma^{0.25}B)^4) = (1-\gamma^{0.25}B)(1+\gamma^{0.25}B)(1-i\gamma^{0.25}B)(1+i\,\gamma^{0.25}B)$

If $\gamma=1$, those above obtained four roots resulted again. Therefore, above compound multinomial consider $\gamma=1$ as special case (Rao, 1973).

We see that using (1-B) difference at seasonal time series may annihilate existence of zero frequency (if exist), whiles still there is possibility of ½ and ¼ to have unit root in season.

For this reason in cases of existence and non-existence these unit roots of a seasonally time series could represent as $A(B)x_t=\varepsilon_t$. Where in these seasonal time series models $A(B)$ will be as below. Because existence of zero frequency does not necessarily imply existence of other types of unit roots rather it is possible to have a seasonal time series unit root in type of half-year but there are no other types (Stout, 1974).

$A(B)=(1-a_1B)(1+a_2B)(1-a_3iB)(1+{}_4iB)$

Now we want to obtain unique estimators for a_i and test if they are equal to unit. One way to operating this process is using Tailor's first order approximation of this multinomial respect to a_i around $a_i=1$ as:

$$A(B)=\sum_{i=1}^{4}\left[\frac{\partial A(B)}{\partial a_i}\right](a_i-1)+A^0(B)$$

Although mathematical details are much and tedious but it is too easy to understand them. First, we obtain partial differentiation for $a_i=1$:

$$\frac{\partial A(B)}{\partial a_i}=-(1+a_2B)(1-a_iB)(1+a_4iB)B=-(1+B+B^2+B^3)B$$

The results of unit root test for seasonally data presented in Table 1 as well as its executive command in footnote[1]. Then we continue with compare estimated statistics and critical values. So based on table values for a model with intercept and trend we test unit root:

$H0{:}\pi_1=0$; $Ha{:}\ \pi_1<0$

The statistics values shows −1.86 and critical value in 1% confidence level with T=100 is equal to −4.07. Thus, we have unit root with zero frequency. For $H_0=\pi_2=0$ also statistics is −4.64 as well as critical value in 1% confidence level with T=100 that is equal to -2.58. So there is no unit root with half-year frequency in this case. The compound two-side hypothesis $H_0{:}\pi3=\pi4=0$ the simple function $F=\frac{t_3^2+t_4^2}{2}$ value obtained as $F=\frac{5.1^2+(-5.6)^2}{2}=28.68$ the critical value for T=100 is equal to 4.70, so there is no unit root with annually frequency. The result is the same if we delete intercept and trend from auxiliary regression specification.

The unit root test help us to make better study time series as stationary during differentiating process. After stationarity of data, we can inference the order of Q and P using Shwartz-Besisian and Aqulaik.

Table 2 displays a stationary time series which considered degree of 4 for AR and MA. The ARIMA estimation results is presented in continue as well as results of its residual analyzing that prove the model qualify (Table 3).

These ARIMA model results were per season which we can make sure of its quality via test of residuals as we have shown in following. The results show that F-statistics value and value of $\chi^2=nR^2$ had been enlarged and are in critical region. Also value of probabilities which presented in front of (F) and (χ^2), is <0.05, so we don't reject the hypothesis of ARCH existence. In other side, the variance of variable cannot be constant and has been increased during the time.

1 genr x=cpi
genr (x_1=x(−1)+x(−2)+x(−3)+x(−4))
genr (x_2= − (x(−1)-x(−2)+x(−3)-x(−4))
genr (x_3= (x(−1)-x(−3))
genr (x_4=− (x(−2)-x(−4))
genr (x_5=(x-x(−4)).

Table 1: The unit root test results

Variables	Coefficient	Standard error	T-statistics	Probability
Intercept	227.992	97.3672	2.34157	0.0221
Trend	7.41102	4.95574	1.49544	0.1393
X_1	−0.0174	0.00935	−1.8619	0.0668
X_2	−0.4546	0.00935	−1.8619	0
X_3	0.05547	0.10676	5.19529	0
X_4	−0.6052	0.107	−5.6563	0

Table 2: The unit root test for stationary

Order	Ar (1)	Ar (2)	Ar (3)	Ar (4)	Ar (5)
Ma (1)	14.41	14.48	14.54	14.55	1459
Ma (2)	14.48	14.48	14.50	14.50	14.55
Ma (3)	14.51	14.47	13.39	14.54	14.58
Ma (4)	14.50	14.48	14.53	14.37	14.58
Ma (5)	14.52	14.49	14.55	14.57	14.46

Table 3: The results for ARIMA residual testing model

Variables	Coefficient	Standard error	Statistics	Probability
AR (4)	0.8237	0.15372	5.35832	0.0000
MA (4)	−0.816783	0.14098	−5.793765	0.0000

ARIMA: Autoregressive integrated moving average

Table 4: The GARCH model results

Variables	Coefficient	Standard error	Statistics	Probability
C	48.94803	145.6113	0.336156	0.7368
RESID (−1)^2	2.279337	0.656634	3.471247	0.0005
GARCH (−1)	0.396211	0.070314	5.634886	0

GARCH: Generalized autoregressive conditional heteroskedastistiy

The ARCH model is suitable framework to analyzing changeability at time series. But it has some difficulties and barriers as one of its difficulties related to determination of q. i.e., the number of lags for residuals. Of course the one way is using likelihood proportion test which discussed in continuing. On the other hand it is possible to contravene the non-negativity which leads to some difficulties of ARCH model estimation. To solve these problems the generalized ARCH model (GARCH) could be used.

The GARCH model developed in 1986. The simple form of this model is as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2$$

The above model displayed as GARCH (1, 1) that means the residuals and conditional variance import the model with one leg. It is evident that if put (8, 14) with one leg and replace σ_{t-1}^2 in the model we will have:

$$\begin{aligned}\sigma_t^2 &= \alpha_0 + \alpha_1 u_{t-1}^2 + \beta(\alpha_0 + \alpha_1 u_{t-2}^2 + \beta\sigma_{t-2}^2) \\ &= \alpha_0(1+\beta) + \alpha_1 u_{t-1}^2 + \beta\alpha_1 u_{t-2}^2 + \beta^2 \sigma_{t-2}^2\end{aligned}$$

Now if we repeat these replacing, the below result obtained:

$$\sigma_t^2 = \alpha_0(1+\beta+\beta^2+\cdots) + \alpha_1(u_{t-1}^2 + \beta u_{t-2}^2 + \beta^2 u_{t-3}^2 + \cdots)$$

$$= \alpha_0' + \alpha_1' u_{t-1}^2 + \alpha_2' u_{t-2}^2 + \alpha_3' u_{t-3}^2 + \cdots$$

$$\alpha_0' = \alpha_0 \sum_{i=0}^{\infty} \beta^i \quad , \quad \alpha_0' = \alpha_0 \beta^i$$

Therefore, the above model is equivalent of ARCH (∞). Generally, GARCH (q, p) is as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \cdots + \alpha_q u_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + \cdots + \beta_p \sigma_{t-p}^2$$

So in total form, the conditional variance of u_t described by equation above albeit the GARCH (1, 1) is sufficient at majority of time (Table 4).

5. CONCLUSION

To model Iranian non-official market currency price for 19 periods daily, seasonally and annually we used time series like ARCH, SARIMA and GARCH. Based on research analyzing on residual terms, we show that the GARCH (adjusted ARCH) model presents better and more acceptable results than SARIMA model. As it can be seen, this comparison is presumable from results of residual analyzing. In other words, equality of variance assumption of SARIMA models challenged while GARCH modeling make provides flexibility power for variance of residuals to change over time as this possibility lead to present better and accurate analyzes of model. The results show for seasonally non-official exchange rate data using GARCH model has more explanation abilities than SARIMA model.

REFERENCES

Abonori, E., Khanalipoor, A. (2009), Exchange rate fluctuations effects in Iran: An application of ARCH family. Journal of Economic Studies, 50, 101-120.

Askari, H., Krichene, N. (2008), Oil price dynamics (2002-2006). Energy Economics, 30(5), 2134-2153.

Beaulieu, J.J., Miron, J.A. (1993), Seasonal unit roots in aggregate U.S. data. Journal of Econometrics, 55(1), 305-328.

Box, G.E.P., Pierce, D. (1970), Distribution of residual autocorrelations in autoregressive-integrated moving average time series models. Journal of the American Statistical Association, 65, 1509-1526.

Box, G.E.P., Jenkins, G.M., Reinsel, G.C. (1994), Time Series Analysis: Forecasting and Control. 3rd ed. Englewood Cliffs, New Jersey: Prentice Hall.

Craine, R., Lochstoer, L.A., Syrtveit, K. (2000), Estimation of a stochastic volatility jump diffusion model. Economic Analysis Review, 15(1), 1-15.

Dargahi, H., Ansari, R. (2007), Improvement of nerves network model to exchange rate prediction alongside turbulence indices. Journal of Economic Researches, University of Tehran, 85, 177-144.

Ehsani, M., Khanalipoor, A., Abbasi, J. (2009), The effect of exchange rate instability on Iranian non-oil exports. Journal of Economic Science, 32, 13-43.

Hylleberg, S., Engle, R.F., Granger, C.W.J., Yoo, B.S. (1990), Seasonal integration and cointegration, Journal of Econometrics, 44, 215-238.

Karami, A., Zibaei, M. (2008), The exchange range fluctuability effects on agricultural products at different countries. Journal of Economic

Studies, 3, 59-71.
Khodavaisi, H., Mollabahrami, A. (2012), Modeling and prediction of exchange rate base on Random differential equations. Journal of Economic Researches, University of Tehran, 3, 129-144.
Mojtahe, A., Mohammadi, T., Khamesian, F. (2012), The long-term effects of exchange rate changes on production and its indirect effect on Iranian premium insurance production. Journal of Insurance, 2, 1-29.
Pluciennik, P. (2010), Forecasting financial processes by using diffusion models. Journal of Dynamic Economics Models, 10, 51-60.
Rao, C.R. (1973), Linear Statistical Inference and Its Applications. 2nd ed. New York: Wiley.
Shajari, H., Tayebi, K., Jalaei, S. (2005), Exchange rate and its relationship with monetary policies and economic openness degree using Fazi nerves systems. Journal of Iranian economic Researches, 26, 153-179.
Stout, W.F. (1974), Almost Sure Convergence. New York: Academic Press.