International Economic Studies
Vol. 44, No. 1, Spring & Summer 2014
pp. 67-74
Received: 15-10-2013 Accepted: 12-05-2014

Monetary Policy and Exchange Rate Overshooting in Iran

Hosein Sharifi-Renani*
Department of Economics, Khorasgan Branch, Islamic Azad University, Isfahan, Iran
Molood Raki
Department of Economics, Khorasgan Branch, Islamic Azad University, Isfahan, Iran
Naghmeh Honarvar
Department of Economics, Khorasgan Branch, Islamic Azad University, Isfahan, Iran

Abstract
Assumption of exchange rate overshooting has significant position in international macroeconomic discussion. This phenomenon is one of the abnormal behaviors of exchange rate that happen in short run. Dornbusch (1976) shows that because speed of equilibrium prices is slow relative to asset markets and commodity prices are sticky in the short run, However, over time, commodity prices will rise and result in a decrease in real money supply and thus, in a higher interest rate. This, in turn, will cause the currency to appreciate. The aim of this article is study of exchange rate overshooting for period 2001:3-2010:2 by Vector Error Correction approach. Results show that monetary relative shock in long run and short run also effect exchange rate that imply exchange rate overshooting in Iran.

Keywords: Monetary policy, Exchange Rate Overshooting, Vector Error Correction (VEC) Approach

JEL Classification: F31, E52

* Correspondent Author, sharifi55r@yahoo.com

1. Introduction

Exchange rate as a criterion for national currency value of a country against currency of others countries, reflects economic situation of those country in comparison to economic situation of other countries. Exchange rate in one open economic for mutual connection with another internal and external variables, accounts as key variable that internal and external economic policies, economic changes have significant effect to it. Also exchange rate is variable that can affect economic operation and economic variables. So for significant and role of exchange rate in macroeconomic, many researches and studies have been done about it. From 1970 decade that was created floating exchange rate system, a lot of researches were on the determinants factors of exchange rates and monetary models to determine exchange rate[1]. Based on results of these researches money supply, national income, interest rate, inflation and trade balance have been main determinants of exchange rate (Taghavi, 1999; Yavari and Qaderi, 2004).

One of the major issues has been regarding interest of many researchers in exchange rate field is sticky-price monetary exchange rate model by Dornbusch (1976). Base of this model are that, prices in commodity market and wages in labor market are determined with the sticky assumption and gradually change by time and reaction various movement such as change in money supply. But exchange rate determines in flexible situation; so that in response to this fluctuation, shows reaction of itself immediately. Exchange rate changes in this situation are not consistent with movement in prices and can have long run deviation of Purchasing Power Parity (PPP). So in this model, PPP theory in short run, because of prices are sticky that result of incomplete information, different contracts and different consumption patterns, not establish and will establish in long run. In this model for monetary shock such as increase in money supply, at the first, exchange rate moves to levels above the level of its long run and by time and prices adjustment in commodity markets, it is moving towards value of long-run equilibrium. Generally phenomenon of exchange rate overshooting is very severe changes in exchange rates in short run. This phenomenon can affect to real exchange rate, equation of exchange, process of enter and exit commodity and investment and portfolio. Because major reason for this phenomenon, is friction and sticky in commodity market price adjustment process, can use in business cycles discussion.

Following the exchange rate overshooting model of Dornbusch, many studies were conducted by several economists in this regard. Driskill (1981), Bhandari (1985), Akiba (1996), Kolmann (1997), Goldfajn and Gubta (2001), Papell (2004) and Nieh and Wang (2005) affirmed Dornbusch with empirical results. Bahmani-Oskooee and Kara (2000) with monthly data of Turkey, conclude that in reaction to sudden increase in Turkey money supply, the depreciation of the Turkish Lira lasted as long as 30 years. They demonstrated that exchange rate overshooting might be a long run phenomenon. Pantamit (2002) investigated the exchange rate overshooting in 5 Western Asian countries and by using the monetary model of sticky price of Dornbusch and Autoregression Distribution Lag (ARDL) approach concluded that in the these countries exchange rate overshooting happens because of the monetary shock. Duasa (2009) studied effect of shock in exchange rate on import and export price and used some variables such as money supply, import and export prices in his study. He found that monetary policy was the major factor of business cycle while exchange rate was as a channel for balancing monetary policy effect, and then transferring this effect to the economy of Malaysia. However, Willkinson et al. (2000) do not follow the model of Dornbusch's currency market process.

With regard to the importance of exchange rate and monetary policy, the objective of this paper is to study this phenomenon in Iran and relationship between exchange rate and macroeconomic variables such as money supply, national income, interest rate and inflation with the application of Vector Error Correction Model (VECM). To this aim, the theoretical discussions related to exchange rate overshooting will be considered in Section 2, and then model and methodology are presented in Section 3. Section 4 analyzes the empirical results, and finally conclusion and suggestions will be presented by Section 5.

[1] For example, can cite the researches of Frankel (1976), Dorebnush (1976), Bylsun (1978), Frankel (1979), Dorenbush and Fisher, Hooper and Morton (1982).

2. Conceptual Discussion

Monetary model of exchange rate is focused on the important role of relative money supply. This model studies behavior of exchange rate via changes in demand for and supply of money. We review monetary approaches such as models of exchange rate determined by flexible prices, developed by Frankel (1976), Moosa (1976), Bilson (1978), monetary model with sticky prices developed by Dornbusch (1976) and difference between real interest rate model by Ferankl (1979). Monetary model with flexible prices is based on money demand function, Uncovered Interest rate Parity (UIP) and assumption of inflation expectation as follows:

$$s = (m - m^*) - \varphi(y - y^*) + \lambda(p_e^0 - p_e^*) \qquad (1)$$

where m is money supply, p_e is expectation prices level, Y national real income and s is exchange rate. Based on this equation, a 1% increase in national money supply, it leads to depreciation in domestic currency and vice versa, while an increase in foreign money supply causes appreciation in national currency. If national income increases, it leads money transaction demand to increase. This means that if one assumes that supply money and interest rate are fixed, an increase in demand is via a decrease in domestic prices. A decrease in domestic prices means that national currency appreciates and the PPP holds. In monetary model based on flexible prices, we assume that entire prices in economy are completely flexible so that the exchange market equilibrium seems effective. In such circumstances, countries with high level growth of money rate are being concerned with high inflation.

Dornbusch (1976) developed a model that can explain long-run and large deviation of exchange rate. This model, which is known as the monetary model based sticky prices, shows phenomenon of exchange rate overshooting. It assumes that prices in commodity markets and income in labor market are sticky and change slowly over time in response to various fluctuations. Since exchange rate is flexible in response to a change, fluctuations in its value appear over the time. In such circumstances, changes in exchange rate are not consistent with changes in prices. Domestic interest rates for monetary shock and prices sticky decrease and then exchange rate relative to long run balance value comfort to overshooting phenomenon. Due to depreciation in domestic currency, it can be expected to increase the compensation to low domestic interest rates.

The economy after early reaction to exchange rate and interest rate relative to an increase in money supply moves to long run balance and demand for domestic commodities will increase. Since it is assumed that production is fixed, the demand surplus for domestic commodities leads to upward domestic prices level. Demand surplus for domestic products through foreigners will lead to an appreciation in national currency. At the same time, an increase in domestic price leads to an increase in domestic currency demand and then an increase in domestic interest rate so that it maintains equilibrium in the money market. According to Dornbusch model with assuming PPP in long run, UIP and return cash exchange rate towards long run balance, proportion between current exchange rate gap between long run balance and real interest rate is specified as follows:

$$s = (m - m^*) - \varphi(y - y^*) + \lambda(p_e^0 - p_e^*) - \frac{\lambda}{\theta}\left[\left(r - p_e^0\right) - \left(r^* - p_e^*\right)\right] \qquad (2)$$

where θ is relative interest rate to balance value, $p_e^{\cdot}$ stands for long run expected domestic inflation rate and p_e^* is expected foreign inflation rate.

In addition, Frankel (1979) generalized the Dornbusch model as follows:

$$s = b(m - m^*) + c(y - y^*) + d(i - i^*) + e(p_e^0 - p_e^*) \qquad (3)$$

where the only difference between this model (Equation 3) and Dornbusch model (2) is due to the use of sticky prices to explain inflation expectations.

3. Methodology

3.1. Vector Error Correction (VEC) Model

An analysis of time series is used to predict time trends of variables used in our model. In the situation that stationary requirement of time series is defected, variables are stable with difference, and there is co-integration between variables, we can use VEC model as well. This model gives reliable estimation of the model in

comparison with VAR model to evaluate short run dynamics. Based on VAR model and the assumption that all variables are I(1), Lutkepohl (2004) introduced general VEC model with *r* co-integration as follow:

$$\Gamma_0 \Delta y_t = \alpha \beta' y_{t-1} + \Gamma_1 \Delta y_{t-1} + \ldots + \Gamma_{p-1} \Delta y_{t-p+1} + B_0 x_t + \ldots + B_q x_{t-q} + CD_t + u_t \quad (4)$$

where y_t is a vector of *K* observable endogenous variables, x_t is a vector of M observable exogenous variables while D_t contains all remaining deterministic variables. Deterministic variables may be constant, linear trend; seasonal dummy variables and so on. The residual vector u_t is assumed to be a K-dimensional unobservable zero means being white noise with definite positive covariance matrix $E(u_t u_t') = \Sigma_u$. The parameter matrices α and β have dimensions (K × r) and they have the rank r. They specify the long-run part of the model with β containing the cointegrating relations and α representing the loading coefficients. If $\Gamma_0 = I$, there are no zero restrictions on the Γ_j matrices and there are no exogenous variables, that is, a reduced form model is specified without exogenous variables and where each equation has the same right-hand side variables, then the Johansen reduced rank (RR) estimation procedure and a simple two step (S2S) method can be applied (Lutkepohl and Kratzig, 2004).

Sims (1980) introduced Impulse Response Functions (*IRF*) and Forecast Error Variance Decomposition (*FEVD*) to study dynamics between variables. *IRF* can be used to analyze the dynamic interactions between the endogenous variables of a VEC process. Forecast error variance is decomposed into components accounted for by the innovations in the different variables of the system.

3.2. Model Specification

According to Frankel model (1979), and special consideration of Iran's economy, we can specify the model as follow:

$$Y_t' = [E \quad M \quad Y \quad \pi] \quad (5)$$

In this equation E is the exchange rate bases on the US dollar. *M* is difference between money supply in Iran and the United State, *Y* is the difference between real GDP of Iran and that of United State and π is difference between inflation rate of Iran and United State [1]. Based on the monetarist view, there is an expectation that money supply difference coefficient is positive. On the other hand, more growth in Iran's production in comparison with the United State production can strengthen the domestic currency. Therefore, the negative coefficients of difference production are expected. Also, it expects to the coefficients of inflation rate difference is positive, because depreciation is depend on increase in domestic inflation rate. It notes that because of not clearing in money and financial markets of country, government involvement in these markets, not availability of interest rate time series and insignificant changes of interest rate, this variable deletes in model specification. Thus we can specify model based on equation (4) as follows:

$$\begin{bmatrix} \Delta E \\ \Delta M \\ \Delta Y \\ \Delta \pi \end{bmatrix} = \begin{bmatrix} \varsigma_1 \\ \varsigma_2 \\ \varsigma_3 \\ \varsigma_4 \end{bmatrix} [c] + \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{bmatrix} EC_{t-1} + \sum_{i=1}^{p} \begin{bmatrix} a_{i,11} & a_{i,12} & a_{i,13} & a_{i,14} \\ a_{i,21} & a_{i,22} & a_{i,23} & a_{i,24} \\ a_{i,31} & a_{i,12} & a_{i,33} & a_{i,34} \\ a_{i,41} & a_{i,42} & a_{i,43} & a_{i,44} \end{bmatrix} \begin{bmatrix} \Delta E_{t-i} \\ \Delta M_{t-i} \\ \Delta Y_{t-i} \\ \Delta \pi_{t-i} \end{bmatrix} + \begin{bmatrix} \hat{u}_{1t} \\ \hat{u}_{2t} \\ \hat{u}_{3t} \\ \hat{u}_{4t} \end{bmatrix} \quad (6)$$

4. Empirical Results

This section reviews empirical results of estimating the relationship between the model variables through applying VEC approach based on monthly statistics 2001:3-2010:2 in which data belong to the United State and Iran[2]. It selects monthly data because exchange rate overshooting is a short run phenomenon.

The results of unit root test on the model variables through using Augmented Dickey Fuller (ADF) have reported in Table 1. The results show that all variables are I(1) in the 1% significant level. Hence they allow us to use VEC approach.

---

[1]. All variables are in logarithmic forms.

[2]-All data have been obtained from the Central Bank of Iran's balance sheets for different years and data for the United State was taken from the Federal Reserve website.

Table 1: Results of Augmented Dickey Fuller Unit Root test

Level variables	Statistics	Difference variables	Statistics
E	-2.49	ΔE	-5.22
M	-1.49	ΔM	-3.70
Y	-2.16	ΔY	-3.88
Π	-1.98	Δπ	-5.92

Notes: Critical levels of test statistics are based on the study of Davidson and MacKinnon (1993):
- With an intercept, a linear trend and seasonal dummy variables 10%: (-3.13), 5%: (-3.41), 1%: (-3.96)
- With an intercept and seasonal dummy variables without a linear trend 10%: (-2.57), 5%: (-2.86), 1%: (-3.43).

Source: Authors

To determine the optimal lags being significant in the VEC model, we use Akaike Information Criterion (*AIC*), Schwarz Criterion (*SC*), Hannam-Quinn Criterion (*HQC*) and Final Prediction Error (*FPE*). Based on results reported in Table 2, to compare the numbers of lags, we select 1 lag period to variables based on SC criterion in order to preserve most of observations.

Table 2: Number of Optimal Lags

AIC	11
FPE	11
SC	1
HQC	9

Source: Authors

To test the long-rum equilibrium relationship between variables in our model, we have used Lutkepohl and Kratzig (2004) and Johansen (1995) cointegration tests. The results indicate that there exists a long-run equilibrium relationship between exchange rate and macro fundamentals. These results are reported in Table 3:

Table 3: The results of coitegration test

Rank	Johansen Cointegration			Lutkepohl - Kratzig Cointegration		
	LR	p-value	5% LR critical values	LR	p-value	5% LR critical values
$r=0$	<u>118.48</u>	0.00	63.66	<u>70.12</u>	0.00	45.32
$r\leq 1$	40.74	0.08	42.77	20.05	0.39	28.52
$r\leq 2$	18.02	0.35	25.73	8.51	0.49	15.76
$r\leq 3$	6.06	0.46	12.45	0.44	0.93	6.79

Notes: The underlined numbers indicate the selection of rank *r*.
The VAR lag length is 1 for the model, which is selected based on the smallest number of SC.
Source: Authors

Additionally, we apply diagnostic tests to examine against autocorrelation, non-normality, and MARCH effects in the VAR residuals. We report the results in Table 4, which show that none of the diagnostic tests imply signs of misspecification.

Table 4: The results of the diagnostic tests

Test	Q_{16}	LM_1	LM_2	LJB_2	(2)$MARCH_{\text{LM}}$
Test statistic	370	27	53	9.35	528
p-value	(0.07)	(0.06)	(0.05)	(0.31)	(0.18)

Notes:
– Null hypothesis was rejected only when the statistic p-value is less than 0.1 or 0.05
– Q_h : Portmanteau test for detection autocorrelation
– LM_h: Breusch–Godfrey test for detection autocorrelation
– LJB_k: Jarque-Bera test for detection of non-normal
– $MARCH_{LM}$(q): ARCH-LM test for detection autoregressive conditional heteroskedasticity

Source: Authors

Table 5 represents the estimated results for the VEC model as specified previously. Such results show that at the first, we have depreciation in domestic currency in 3 lagged period, and then appreciation in 7 next lags so that this result confirms exchange rate overshooting in short time. Coefficient signs of other variables are also consistent with the monetary literature. Negative estimated coefficients of $\Delta\pi$ and ΔY show that economic growth and inflation in comparison with the United States will reinforce the domestic currency value.

Regarding long-run relationship of exchange rate overshooting, as in Part B can be seen in Table 5, money relative supply elasticity has been estimated by about 0.18, which means 1% increase in money relative supply in Iran; causes currency depreciation in domestic currency. Coefficient of relative production is negative and significant and shows that 1% increase in

domestic product causes a 0.67% decrease in exchange rate or appreciate the domestic currency, that these results are consistent with the literature. Since domestic gross production of Iran is depending on oil revenue, an increase in government revenue due to oil export has a significant effect on appreciation of domestic currency. The coefficient of relative inflation is significant and despite monetarist view is negative. However, its relative effect on the exchange rate is very small and negligible.

Table 5: Estimation results of the VEC model

Part A: Short-run coefficients

Lags	،	1	2	3	4	5	6	7	8	9	10	11
ΔE		-0.16	-0.27	-0.46	-0.31	-0.44	0.07	-0.98	-0.29	-0.20	0.17	0.30
		(-0.65)	(-1.15)	(-1.89)	(-1.27)	(-1.76)	(0.28)	(-3.59)	(-1.03)	(-0.69)	(0.65)	(1.17)
ΔM		0.01	0.02	0.01	-0.05	-0.07	-0.02	-0.08	-0.02	-0.09	-0.05	0.01
		(0.11)	(0.26)	(0.25)	(-0.84)	(-1.12)	(-0.23)	(-1.16)	(-0.29)	(-1.45)	(-0.82)	(0.07)
ΔY		-0.17	-0.14	-0.08	-0.12	-0.12	-0.10	-0.07	-0.09	-0.06	-0.06	-0.02
		(-1.38)	(-1.27)	(-0.71)	(-1.19)	(-1.36)	(-1.37)	(-0.75)	(-1.17)	(-1.17)	(-0.90)	(-0.30)
Δπ		0.00	0.00	0.00	-0.001	-0.001	0.00	0.00	0.00	-0.01	-0.01	-0.01
		(-0.24)	(-0.23)	(-0.28)	(-0.41)	(-0.67)	(-0.22)	(-0.22)	(-0.48)	(-1.30)	(-1.35)	(-1.47)
C	-0.49 (-0.99)											

P art B: Long-run coefficients

$$E = 3.57 + 0.181\,M - 0.674\,Y - 0.007\,\pi$$
$$(75.49)\quad (70.57)\quad (12.34)\quad (3.99)$$

Note: Numbers in parentheses show the t statistics.
Source: Authors

Figure 1 shows impulse response of targeting variables through applying the method of Hall (1992) in 95% significant level with the number of 500 bootstrap replications. This figure shows exchange rate overshooting well, being in line with the above results in short and long run.

Table 6 also shows the share of each variable on the innovations created in the exchange rate in form of forecast error variance decomposition. The share of shock in money supply relative to exchange rate variance in season 24 appears to its maximum value (56%). The shares of GDP and relative inflation shock are12% and 3% that confirm the research findings in impulse response analysis.

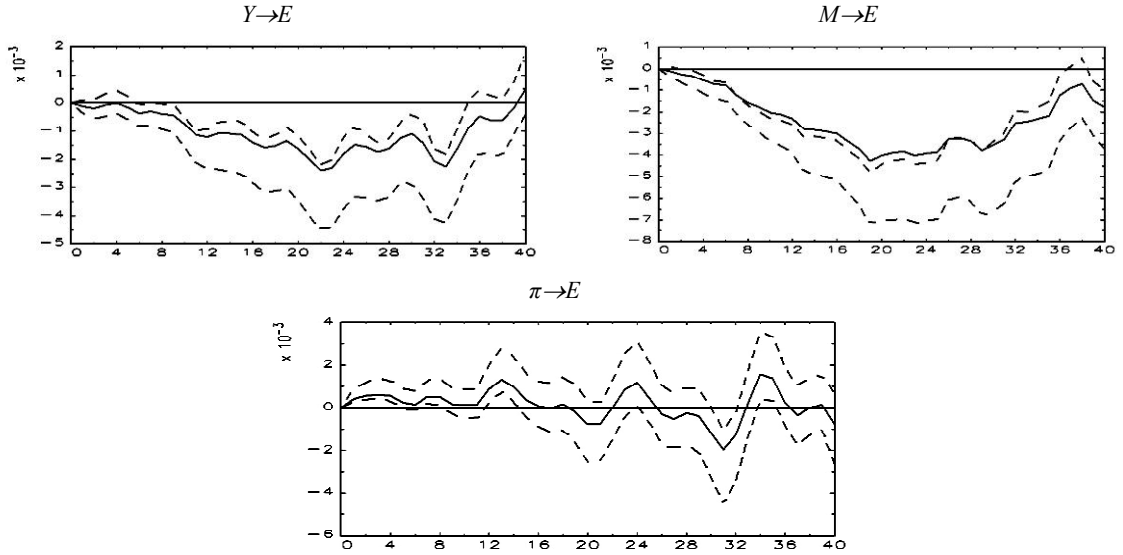

Figure (1) Impact response analysis of other variables than the exchange rate
Source: Authors

Table 6: Forecast error variance of all variables with respect to exchange rate changes

Period	E			
	ε^{E}	ε^{M}	ε^{Y}	ε^{π}
1	1.00	0.00	0.00	0.00
4	0.94	0.01	0.00	0.04
8	0.82	0.11	0.01	0.05
12	0.60	0.32	0.05	0.03
24	0.30	0.56	0.12	0.03
40	0.44	0.43	0.10	0.03

***Source*:** Authors

5. Conclusion

This study has discussed exchange rate monetary overshooting phenomenon through using time series data, cointegration and VEC approaches to examine the relationship between exchange rate and monetary variables in Iran in the short run and long run.

Generally the results have suggested the existence of a long-run equilibrium relationship between the model variables and confirm the occurrence of exchange rate overshooting in short run and long-run. Results also have shown the sensitivity and importance of the monetary policy adopted, because monetary policy are known as one of the effective factors in determining exchange rates in Iran. In addition, the results of estimating model have represented a positive and significant effect of money relative supply on exchange rates. These results have been fully consistent with models of monetary exchange rates and reflect sensitivity of exchange rates to monetary shocks in long-run. Results have indicated a significant negative effect on the relative production to exchange rate and have shown increase in domestic production relative to United State production, leads to decreasing in exchange rate or reinforce national currency. These results have been consistent with the monetary literature. Because Iran's gross domestic product is dependent mostly on oil revenues in a very high level, an increase in foreign exchange earnings from oil exports can be have a significant impact in strengthen the national currency. On the other hand, in times of economic growth, foreign investors can be optimized to the future of the country and decided to invest more, then the domestic currency value is increased.

In addition, the results of model simulations of monetary exchange rate, based on impulse response function have confirmed the exchange rate overshooting phenomenon to the response to monetary innovations in the long run. Results suggest that monetary shocks affect the nominal exchange rate so that an unexpected monetary expansion appears as a recurrent overshooting in exchange rate.

References

1. Akiba, H. (1996), "Exchange-Rate Sensitive Demand for Money and Overshooting," *International Economic Journal*, 10(2), 119–129.
2. AKhbari, M. (2006), Trend Test of the Monetary Exchange Rate Movements In The Period 1978-2004," *Economic Research*, 75, 43-74.
3. Bahmani-Oskooee, M. and O. Kara (2000), "Exchange Rate Overshooting in Turkey," *Economics Letters*, 68, 89–93.
4. Bahmani-Oskooee, M. (1995), "The Decline of the Iranian Rial during the Post-Revolutionary Period: The Monetary Approach and Johansen's Cointegration Analysis," Canadian Journal of Development Studies, 16 (2), 90-277.
5. Bhandari, J. S. (1985), "A Look at 'Overshooting' in a Two-Tier Float Exchange Rate System," *Economics Letters*, 19, 57–61.
6. CBI, Central Bank of Iran's Balance Sheet (various years), www.cbi.ir
7. Duasa, J. (2009), "Impact of Exchange Rate Shock on Prices of Imports and Exports," *International Economics Studies*, 34(1), 59-68
8. Dornbusch, R. (1976), "Expectations and Exchange Rate Dynamics," *Journal of Political Economy*, 84, 1161–1175.
9. Driskill, R. (1981), "Exchange Rate Overshooting, the Trade Balance, and Rational Expectations," *Journal of International Economics*, 2(4), 361–377.
10. Federal Reserve, Factor Affecting Reserve Balance (various years), http://www.federalreserve.gov/
11. Frankel, J. (1979), "On the Mark: A Theory of Floating Exchange Rates based on Real Interest Differentials," *American Economic Review*, 69, 610-622.
12. Goldfajn, I. and P. Gupta (2001), Overshooting and Reversals: The Role of Monetary Policy, Central Bank of Chile, Working Paper, No. 126, 279–302.
13. Hall, P. (1992), the Bootstrap and Edge worth Expansion, New York: Springer.
14. Johansen, S. (1995), Likelihood-based Inference in Cointegrated Vector Autoregressive Models, Oxford: Oxford University Press.
15. Kolmann, R. (1997), the Exchange Rate in a Dynamic-Optimization Current Account Model with Nominal Rigidities: A Quantitative Investigation, IMF Working paper, No. 432.
16. Lutkepohl, H, Kratzig, M. 2004. Applied Time Series Econometrics, Cambridge:

Cambridge University Press.
17. Nieh, C. and Y. Wang (2005), "ARDL Approach to the Exchange Rate Overshooting in Taiwan", *Review of Quantitative Finance and Accounting*, 25, 55–71.
18. Papell, D. H. (2004), Activist Monetary Policy and Exchange Rate Overshooting: The Deutsche Mark/Dollar Rate, University of Houston-Department of Economics, Working Paper, No. 27.
19. Taghavi, M. (1999), "Balance of Payments and Exchange Rates Monetary Approach," *Journal of Political and Economic Information*, 133, 133-139.
20. Yavari, K. and H. Qaderi (2004), Factors Affecting Exchange Rate Market Parallel: the Real Exchange Rate and General Price Level in Iran, *Journal of Economic Research*,18, 34-56
21. Wallace, M. S. (1979), "the Monetary Approach to Flexible Exchange Rates in the Short Run: An Empirical Test," *Review of Business and Economics Research*, 15, 98-102.