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Time-Varying Monetary Policy Reaction Function: The Case of Iran

Akbar Komijania[*]

Sayed Mansoor Khalili Araghi[**]

Hossein Abasinejad[***]

Hossein Tavakolian[****]

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Abstract

In this paper, we consider the estimation of a time-varying parameter monetary growth rate reaction function for monetary policy in Iran. In order to deal with implicit inflation targets and time-varying parameters, a two-step procedure is employed in estimation of the time-varying monetary policy reaction function. Considering a monetary policy reaction function with stable coefficients, we first estimate the implicit target values of inflation using Kalman filter procedure. Then, using the estimated inflation targets and explicit targets in the Development Plans, DPs, we estimate two versions of the time-varying parameter monetary policy reaction function to show the difference between what has been done and what should be done to achieve target values of the DPs. Our empirical results reveal that there has been no commitment to the target values of inflation during the first, second and fourth DPs, while the third DP was relatively successful in achieving its targets. The estimated time-varying response of monetary growth to both inflation and output gap suggests that the central bank should have reacted more forcefully to both inflation and output gap in order to achieve the targets of the DPs. The conduct of the monetary policy in recent years has been diverging from what should be done in achieving the targets of the DP.

Keywords: Time-varying monetary policy; Kalman filter; Inflation targets; Development Plans

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* Department of Economics, University of Tehran, Iran.
** Department of Economics, University of Tehran, Iran.
*** Department of Economics, University of Tehran, Iran.
**** Department of Economics, University of Tehran, Iran.

1- Introduction

Today, the primary aims of central banking are price and output stability. In New Keynesian context, short-term interest rate rule suggested by Taylor (1993) has gained considerable attention for price and output stability purposes. Since this seminal work of Taylor, various versions of Taylor rule have been estimated for different economies. Recently, time-varying parameter specification of monetary policy rules has gained a lot of attention. Yüksel, Ozcan and Hatipoğlu (2012) suggest three reasons for unsteady parameter specification. First, as in Favero and Rovelli (2003), Ozlale (2003) and Valente (2003), differing tastes of policymakers toward the structure of the economy and opposing objectives of the monetary policy make the parameters of central bank reaction function change during the time.

For US economy for instance, Judd and Rudebusch (1998), Clarida, Gali, and Gertler (2000), and Orphanides (2004) show that the Fed's interest rate policy has changed since 1979. Using a time-varying parameter model, Cogley and Sargent (2001, 2003) and Boivin (2001) show significant time variation in the policy response to the state of the economy. Although time-varying coefficients has gained considerable attention in modeling the monetary policy rule, but Sims (2001) and Sims and Zha (2002) suggest that time-varying variance of shocks is more important. Estimating a time-varying parameter model for a forward-looking monetary policy rule, Kim and Nelson (2006) show that the conventional division of the sample into pre-Volcker and Volcker-Greenspan periods could mislead the empirical assessment of monetary policy.

Second, relying on a single policy rule equation means that policy makers utilize a given set of information in decision-making while a time-varying parameter reaction function means that broader range of information set is used in building policy decisions. Of course, nonlinearities and asymmetries in the central bank's reaction function can also be a reason of time-varying coefficients of a reaction function. The first source of asymmetry in central bank behavior, as Blinder (1998) points out, is that political pressures of elected political officials make monetary authorities to behave asymmetrically. The second source of this asymmetry stems from uncertainty of the monetary policy on the economy. For instance, Cukierman (1999) develops a model on central bank asymmetric preferences in which

central bank reactivity to inflation shocks will be greater during expansions. Assuming asymmetric loss function for central bank, Nobay and Peel (2003) discuss optimal discretionary monetary policy. Dolado, Dolores and Naveira (2005) find empirical support for asymmetries in the interest rate-setting behavior of four European central banks but none for the US Fed. Castro (2011) also supports this finding. His findings indicate that the European Central Bank and the Bank of England tend to follow a nonlinear Taylor rule, but not the Federal Reserve of the United States. Peterson (2007) shows that good monetary policy is associated with a non-linear Taylor rule: once inflation approaches a certain threshold, the Federal Reserve adjusts its policy-rule and begins to respond more forcefully to inflation. Surico (2007) empirically investigates the relevance of a new framework for monetary policy analysis in which the decision makers are allowed, but not required, to weight differently positive and negative deviations of inflation and output from the target values. He finds that the Fed has had asymmetric preferences only before 1979.

Finally, the third reason for time-varying coefficients of a policy rule is variations in monetary policy transmission mechanism. More precisely, considering a policy rule with fixed coefficients means that there is no policy shifts during the time and this seems not to be the case in lots of economies.

In this paper, we consider estimation of a monetary policy reaction function for Iran that allows for time-varying parameters. However, what is very important in monetary policy in Iran is that unlike other economies, one cannot assume an interest rate rule for the economy of Iran. This is because the Law for Usury (Interest) Free Banking prevents monetary authorities from setting interest rates. The other point is that using a Taylor type rule requires announcement of explicit targets by monetary authorities. Although there have been announced, explicit targets for inflation in Five-year Development Plans, DPs, in Iran but there has never been commitment to these targets, except in third DP. In order to deal with these properties of the economy, a two-step procedure is employed in estimation of the time-varying monetary policy reaction function. Considering a monetary policy reaction function with stable coefficients, we first estimate the implicit target values of inflation using Kalman filter procedure. Then, using the estimated inflation targets and explicit targets in the DPs, we estimate two versions of the time-varying parameter monetary policy reaction function to show the

difference between what has been done and what should be done to achieve target values of the DPs.

The rest of the paper is organized as follows. Section 2 provides a review of Iranian economy since 1988. Section 3 presents the model we use as monetary policy reaction function. Section 4 presents the empirical results obtained from applying the two econometric methodologies described above. Finally, Section 5 concludes.

2- A review of Iranian economy

Before going forward to the model, we first provide a short historical review of Iranian economy. Fig. 1 and 2 depict the macroeconomic condition of the Iran since 1988. During this period, four Development Plans, DPs, have been performed and the fifth DP is started since 2010. In order to investigate better the performance of the DPs, we extract recession and expansion phases using the BBQ algorithm of Harding and Pagan (2002). The shaded areas in Figs 1 and 2 denote recession phases.

The end of the war with Iraq in 1988 ushered a new period of economic development in Iran. Beginning the 1989, the government of the Islamic Republic started its first five-year development plan. Dismantling the extensive controls that had been imposed on the markets after the Revolution and during the eight-year war with Iraq was the first thing that the government started to do (Salehi Esfahani and Pesaran, 2008). During this period, increasing oil revenues resulted in higher investment with subsiding inflation. Due to rising short-term foreign debt, declining oil revenues and balance of payments crisis during the first (1989-93) and second (1994-98) DPs, the post-war recovery was short-lived. The problem was significantly exacerbated by the government's effort to reduce the foreign-exchange market controls and rely on a unified exchange rate. Because of the crisis, devaluation of rial started quickly and made it difficult for domestic firms that had borrowed abroad to pay back their debts. In the event, the government decided to cover a substantial portion of the losses sustained by the borrowers as a result of the devaluation. Since public revenues had fallen and its creditworthiness was low, this entailed a major expansion of the monetary base. The consequence was stagnation of the economy along with a sharp rise in inflation (Fig. 1 and 2) (Salehi Esfahani and Pesaran, 2008, Pesaran, 2000). This, as we will see in the next section, resulted in inflation considerably higher than its target values, except in the early years of the first DP.

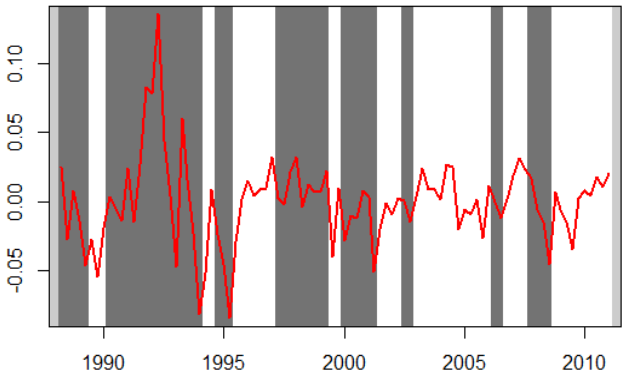


Fig. 1. Quarterly CPI inflation

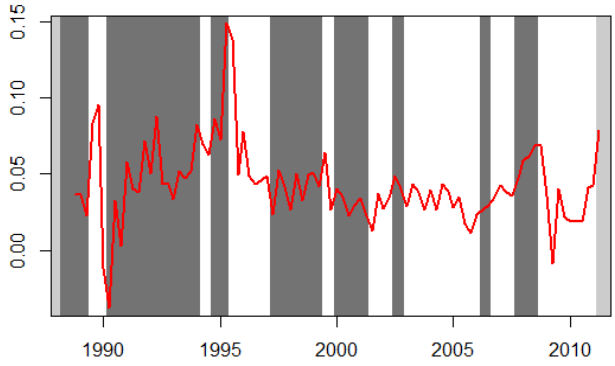
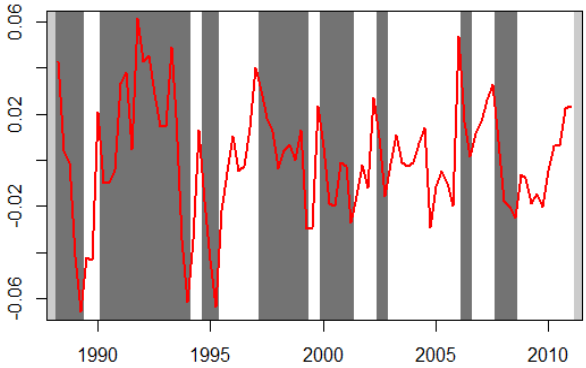


Fig. 2. Output gap using Hodrick-Prescott filter



The third DP (2000-04) was prepared and designed with a view of reforming banking system, and on the basis of the experiences achieved in previous years to make a turning point and structural reforms in the implementation of monetary policies in the history of the Iranian economy. During the course of the third DP, the ease in fiscal sector's pressures on the economy and observance of a fiscal discipline by the government on the one hand, as well as establishment of Oil Stabilization Fund (OSF) on the other hand, led to the implementation of various monetary policies, which could not be implemented for many years.

Major monetary policies in the 3rd Plan were:

1. The government was obliged to prepare annual budget in a way that the probable budget deficit is not be financed through borrowing from the CBI and the banking system,

2. It was determined that increase in the outstanding scheduled facilities of the banks shall be annually reduced by 10 percent over the course of the 3rd Plan.

3. It was determined that government supports in extending facilities to various economic sectors and activities would be in the form of subsidy payment on the lending rate, preferential (administered) credits, and guaranteeing the repayment of its debt within the framework of annual budget laws.

4. The Central Bank, in order to implement monetary policy, was authorized to utilize Central Bank Participation Papers (CBPPs) upon the approval of the Money and Credit Council (MCC).

5. The Central Bank, in order to enhance competitiveness of banks and develop financial markets, shall pave the way for operation of authorized private credit institutions.

6. The Law authorizing Establishment of Private Banks was approved by the Parliament during the term of the 3rd Plan.

Although, low oil income resulted in some short-lived recession periods (Fig.2), these policies were somehow successful in price and output growth stability.

The fourth DP (2005-09) was designed by the Management and Planning Organization before the end of the presidential period of the eighth government of the Islamic Republic, while it came into force during the presidential period of the ninth government who has completely different

economic views. The implementation of the fourth DP started in an environment that its draftsman, i.e. the Management and Planning Organization, had lost its authorization. In fact, it seemed that there is no commitment to this DP by the government. Therefore, unlike the third DP, most period of the second DP was in recession. The fiscal irregularities along with opening preferential lines of credits, due to small firms support policy, led to high monetary growth, reflecting in increasing inflation rate. Meanwhile, housing bubble burst made the economy fell into a recession. Following the high inflation, the central bank implemented a contractionary monetary policy, which helped decreasing inflation but deepened the stagnation.

According to above discussion, there is a wide gap between what has been ratified in the first, second and fourth DPs and what the policy makers have done and only the third DP has satisfactory performance. Of our particular interest is the dis-commitment of policy makers to the explicit inflation targets of the DPs, which we consider it in our model of the next section.

3- The model

We consider estimation of a monetary policy reaction function for Iran that allows for time-varying parameters. However, what is very important in monetary policy in Iran is that, unlike other economies, one cannot assume an interest rate rule for this economy. This is because the Law for Usury (Interest) Free Banking prevents monetary authorities from setting interest rates. Therefore, we should consider high-powered money growth rate as monetary policy instrument. In doing so, we should first show that how we could go from an interest rate rule to a monetary growth rate rule. Orphanides (2003) reformulates Friedman's monetary growth rule in terms of the family of policy rules investigated in the Brookings study reported in Bryant, Hooper, and Mann (1993). Indeed, this monetary growth rate rule is an alternative specification of the broad interpretation of the Taylor rule that is consistent with the attainment of the policy objectives of price stability and maximum sustainable growth. We use an adjusted form of this monetary growth reaction function for Iran in a way that it fits to what is observed in data.

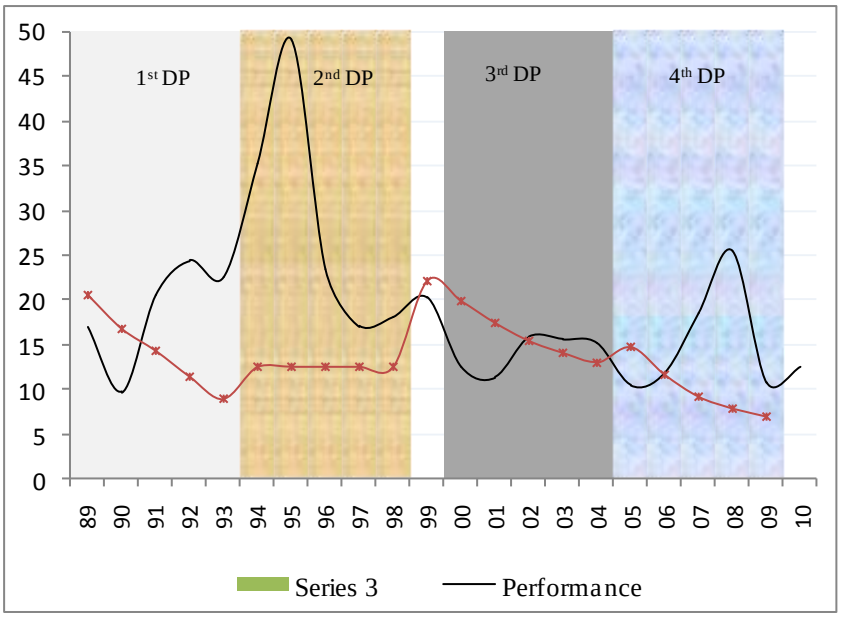


Fig 3: Annual Inflation and its Targets During 4 Five-year Development Plans.

The other point is that using a Taylor type rule requires announcement of explicit targets by monetary authorities. Although there have been announced, explicit targets for inflation in Five-year DPs, there has never been commitment to these targets, except in the third DP. Fig. 3 provides a summary overview of inflation dynamics and its target values in Iran during these DPs. According to Fig. 3, there is a wide gap between target and occurred inflation during the first, second and fourth DPs and only the third DP have inflation near to its target. According to the discussions of the previous section, we can say that the target values of inflation have been implicitly in the mind of policy makers and they have never announced them explicitly to the public. In other words, there is a desired level of inflation in monetary authorities' mind, which can be completely different from what is announced as targets of the DPs and the deviation from this desired level makes the central bank to set monetary growth rate. Since monetary authorities have always sensitivity toward the policy objectives of price stability and maximum sustainable growth and central bank always reacts to

high inflation and low output growth, this assumption seems to be the case in Iran.

Following Orphanides (2003), we introduce the following reaction function for monetary policy in Iran:

$$\dot{m}_t = \beta_1 + \beta_2 \dot{m}_{t-1} + \beta_3(\pi_t - \pi_t^*) + \beta_4(y_t - y_t^*) + \varepsilon_t \qquad (1)$$

Where $\dot{m}_t$, is money base growth rate, π_t is inflation, y_t is actual output, π_t^* is inflation target and y_t^* is potential output. As it is clear, this monetary policy reaction function has some differences with that of Orphanides (2003). The most important difference is that here we use output gap while Orphanides considers the nominal income deviation from nominal income target. Indeed, Orphanides argues that how one can show Friedman's monetary growth rule in terms of the family of policy rules investigated in the Brookings study. However, our empirical investigation shows that such a model does not fit with Iran's data while Eq. 1 has the best fitness.

As mentioned above, there is no commitment to target values of inflation in DPs. Therefore, we first estimate the implicit targets. To do so, we assume that the coefficients of monetary policy reaction function are stable and estimate the implicit target values of inflation using the following state-space model:

$$\begin{aligned} &\dot{m}_t = \beta_1 + \beta_2 \dot{m}_{t-1} + \beta_3(\pi_t - \pi_t^*) + \beta_4(y_t - y_t^*) + \varepsilon_t, \qquad \beta_3, \beta_4 < 0 \\ &\pi_t^* = \rho \pi_{t-1}^* + u_t, \qquad u_t \sim i.i.d.N(0, \sigma_u^2) \end{aligned} \qquad (2)$$

Where we have assumed that inflation target follows an AR(1) process and its coefficient is close to one. This assumption ensures that inflation targets in each period are close to previous and next ones. We use these estimated target values of inflation to estimate a time-varying parameter monetary growth rule, which shows what has happened in terms of monetary policy. We also use inflation targets mentioned in development plans to show what should be done as monetary policy to achieve these target values. Therefore, the time-varying form of Eq. 1 would be

$$\begin{aligned} &\dot{m}_t = \beta_{1t} + \beta_{2t} \dot{m}_{t-1} + \beta_{3t}(\pi_t - \pi_t^*) + \beta_{4t}(y_t - y_t^*) + \varepsilon_t, \\ &\beta_{1t} = \alpha_1 + \alpha_2 \beta_{1t-1} + \xi_{1t} \\ &\beta_{3t} = \alpha_5 + \alpha_6 \beta_{3t-1} + \xi_{3t} \\ &\beta_{4t} = \alpha_7 + \alpha_8 \beta_{4t-1} + \xi_{4t} \end{aligned} \qquad (3)$$

Where we assume that time-varying parameters follow AR(1) processes and $\xi_{it} \sim i.i.d.N(0,\sigma_i^2),\ i=1,...,4$. The estimation of this state-space model shows differing tastes of policymakers toward the structure of the economy.

4- Estimation results

To estimate Eq. 2 and 3, we use quarterly data on monetary base, Consumer Price Index, CPI, inflation and non-oil real Gross Domestic Product, GDP, covering the period 1988:2-2011:1.[1] To calculate the growth rate of monetary base we consider the first difference of the log of monetary base. We also use Hodrick-Prescott filter of the log of GDP as a measure of output gap.

The estimation results of Eq. 2 are reported in Table 1.

Table 1: Estimation results of Eq. 2.

β_1	β_2	β_3	β_4	ρ	Log Likelihood
0.051	0.472	-2.743	-1.824	0.942	-103.15
(0.018)	(0.064)	(0.812)	(0. 963)	(0.261)	

Standard errors in parenthesis

The results of Table 1 show that all the coefficients are statistically significant. The estimated coefficients suggest that the central bank responses more forcefully to inflation than output gap. As we expected, the estimated AR(1) coefficient of inflation target is close to one, suggesting that target value of each period is close to that of previous and next periods.

The estimated state variable of this state-space model, i.e. implicit inflation target along with inflation targets of DPs are depicted in Fig. 4. Since inflation targets of DPs are set annually, here we consider one fourth of annual inflation target as quarterly inflation target. Of our particular interest is the difference between estimated target and the targets of DPs. In Fig. 4, we observe that the implicit inflation target during the first DP is

1- The data are based on Persian calendar, which starts on March 20. Therefore, we assume that the first quarter in Persian Calendar is approximately the second quarter in Gregorian calendar.

lower than announced inflation target in DP, having downward trend at first and then turning to an upward trend. This suggests that during the first DP, the inflation targets of monetary authorities have been less than that of the DP at first and then have approached to each other.

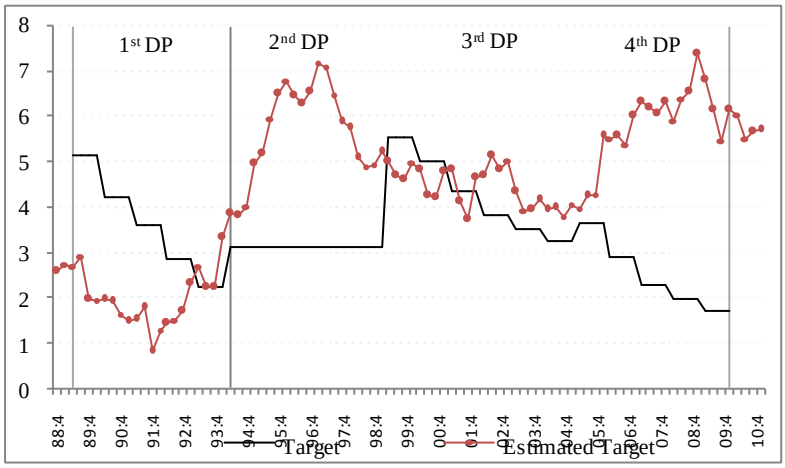


Fig. 4. Estimated and announced inflation targets

Comparing Figs. 3 and 4 show that downward trend of implicit inflation target results in lower inflation during the first two years of the first DP while upward trend of inflation targets results in higher inflation than explicit inflation targets of the DP. Although the inflation targets are constant during the second DP, the estimated inflation target suggests that there is no commitment to that and the explicit inflation targets of monetary authorities are completely different from inflation targets of the DP. However, these two targets are close to each other during the third DP, suggesting that this DP has been successful in achieving its inflation targets. Fig. 4 shows also that, estimated target diverges from inflation target in fourth DP. This result seems to be in accordance with what happened during this period. High monetary growth was actually a good sign that showed reduced sensitivity of monetary authorities to inflation during the fourth DP.

Table 2: Estimation results of Eq. 3.

	$\pi_t^* =$ inflation targets of DPs	$\pi_t^* =$ estimated inflation targets
α_1	0.106 (0.008)	0.063 (0.012)
α_2	0.570 (0.086)	0.341 (0.141)
α_3	0.258 (0.041)	0.261 (0.052)
α_4	0.359 (0.100)	0.391 (0.134)
α_5	-0.365 (0.098)	-0.425 (0.104)
α_6	0.747 (0.068)	0.693 (0.075)
α_7	-0.436 (0.094)	-0.688 (0.109)
α_8	0.614 (0.084)	0.379 (0.098)
Log Likelihood	-87.63	-84.17
LR	31.04*	37.96*

Standard errors in parenthesis
*Significant at 1% level.

We use these two inflation targets to estimate two versions of Eq. 3 to show what central bank has done and what it should have done to achieve the inflation targets of the DPs. Table 2 reports the estimated coefficients of Eq. 3 using both estimated and DP inflation targets.

All coefficients are significant at 1% significance level. The likelihood ratio test statistic for the null hypothesis of constant regression coefficients for both models indicates that we can reject the null hypothesis in favor of time-varying reaction of monetary policy to both inflation and output gap. The estimates of the intercepts of time-varying coefficients of both inflation and output gap are negative. Therefore, time-varying coefficients of monetary policy rule are negative on average, which is in accordance with what we expected. The estimated time-varying coefficients of inflation and output gap in two scenarios are depicted in Fig. 5 and 6 respectively, along with the recession phases in shaded areas.

In Fig. 5 and 6, we observe that the central bank responses to both inflation and output gap, during three years of the first DP were less than what it should do to achieve the targets of the DP. This is why during this period we observe lower targets of inflation in Fig. 4 and negative output

gap in Fig. 2. However, during last years of the DP, the response to inflation was near to what it should be done. Therefore, the estimated inflation targets were close to the explicit inflation targets of the DP. Meanwhile, the response to the output gap was weak. In particular, a more forceful response to the negative output gap might help recovering the economy in this period. What should be noted in Fig. 5 and 6 is that the central bank's response to both inflation and output during the last two years of the first DP is the lowest throughout the whole sample. This is because of the foreign debt crisis, which resulted in a substantial devaluation of the national currency.

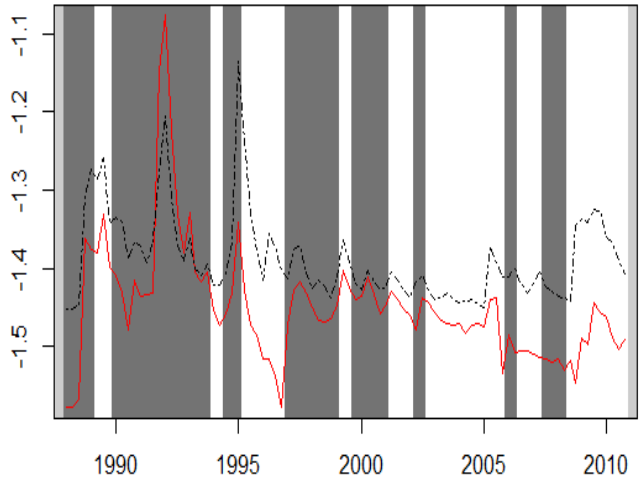


Fig. 5: Time-varying response of monetary growth rate to inflation, model with inflation targets of DPs ( ), model with estimated inflation targets ( )

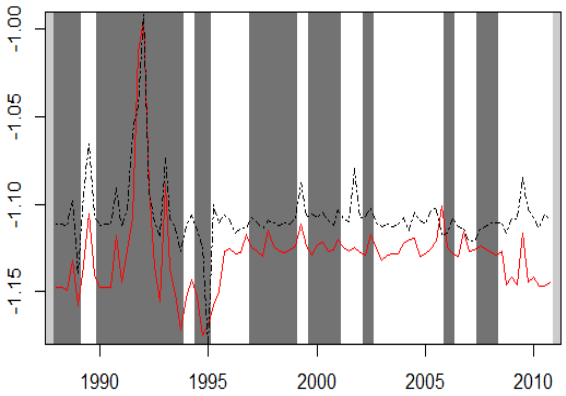


Fig 6: Time-varying response of monetary growth rate to output gap, model with inflation targets of DPs ( ), model with estimated inflation targets ( )

In early years of the second DP, there is a wide gap between the central bank's response to inflation and what it should respond to achieve the inflation targets of the DP. It seems that the early objective of the central bank in this period was output rather than price stability. In fact, monetary authorities tried to recover the economy form recession and kept this policy throughout the whole period of the fourth DP. This is reflected in the form of higher inflation targets during this DP in Fig. 4, declining inflation in Fig. 1 and relatively stable output in Fig. 2. However, monetary authorities understood the costs of high inflation and they soon started to decline their inflation targets.

Fig. 5 also shows that the central bank's response to inflation during the third DP was less volatile and near to what should be done. However, Fig. 6 suggests that it should respond a little more to output gap during the recession of 2001-02. Despite some short-lived recessions, our results show that the response of the central bank to both inflation and output gap was in accordance with the objectives of the plan. Nevertheless, it seems that the third DP would be more successful if monetary authorities reacted more forcefully to output gap.

The estimated time-varying coefficients of both inflation and output gap shows that the conduct of the monetary policy in recent years has been diverging from what should be done in achieving the targets of the DP. In particular, the central bank response to inflation and output gap far less than what it should be, and the inflation targets of monetary authorities are far more than target values of the DP. This shows that there is no commitment to the targets of the fourth DP and monetary policy is conducted independent of the DP.

5- Concluding remarks

In this paper, we consider estimation of a monetary policy rule for Iran that allows for time-varying parameters. However, the Law for Usury (Interest) Free Banking prevents monetary authorities from setting interest rates. Therefore, we should consider high-powered money growth rate as monetary policy instrument. In doing so, we consider a monetary growth rate rule which is an adjusted form of the family of policy rules investigated in the Brookings study reported in Bryant, Hooper, and Mann (1993). A

historical review of the inflation dynamics shows also that in most periods there was no commitment to the inflation targets of the Development Plans. Therefore, we also consider the actual inflation targets implicitly in the mind of the policy makers, which should be estimated.

In order to deal with implicit inflation targets and time-varying parameters, a two-step procedure is employed in estimation of the time-varying monetary policy reaction function. Considering a monetary policy reaction function with stable coefficients, we first estimate the implicit target values of inflation using Kalman filter procedure. Then, using the estimated inflation targets and explicit targets in the Development Plans, DPs, we estimate two versions of the time-varying parameter monetary policy reaction function to show the difference between what has been done and what should be done to achieve target values of the DPs.

Our empirical results reveal that there has been no commitment to the target values of inflation during the first, second and fourth DPs, while the third DP was relatively successful in achieving its targets. The estimated time-varying response of monetary growth to both inflation and output gap suggests that the central bank should have react more forcefully to both inflation and output gap in order to achieve the targets of the DPs. The conduct of the monetary policy in recent years has been diverging from what should be done in achieving the targets of the DP.

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