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RESEARCH PAPER

Fiscal and Monetary Policy Interaction in Iran: A TVP-VARMA Model

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Abstract
The importance of monetary and fiscal policy coordination, in view of the financial crises of recent decades, has increased more and this has led countries to adopt coherent and coordinated policy combinations to deal with the adverse effects of crises on the economy. To examine the situation of coordination and interaction between monetary and fiscal policy in Iran we use a time-varying parameter VARMA model with stochastic volatility. Following Klime et al. (2016) which is based on Sargent and Surico (2011), we drive law-frequency relationship between inflation and government fiscal stance which reflects a time-varying indicator of the interaction and coordination of monetary and fiscal policy, because if the monetary and fiscal policy is coordinated, the relationship between inflation and the government's financial situation will be low. The results show different monetary and fiscal policy interactions during different presidential era. The highest level of coordination between the two policymakers occurred in the final years of the second term of the presidency. However, in the third term of the presidency, the level of interaction between the two policymakers increased. Finally, in the last years of this period, the two policymakers have moved towards coordination, and this trend has continued in the next presidential period, and the least turmoil in this coordination has occurred in the last period.
Keywords: TVP-VARMA, Monetary Policy, Fiscal Policy, Policy Interaction.
JEL Classification: E63, E52, E62.

Introduction

Because of financial crises in recent decades, the importance of coordination between monetary and fiscal policies has been increased and it has forced countries to devise coherent policy combinations to cope with crises. Coordination between monetary and fiscal policies means that although these policies have different target priorities, but they move in one direction and promote each other's positive effects or at least do not crowd-out each other. Actually, even if monetary and fiscal policies are designed and implemented based on effective and targeted instruments, these policies might not achieve their goals in some cases if they have not been made coordinated with each other. The result of uncoordinated monetary and fiscal policies is suboptimal and poor economic performance. For example, under some conditions the monetary policy goal of price stability might result in higher levels of budget deficit.

On the other hand, some complications that might result from uncoordinated monetary and fiscal policies are because of different lengths of time periods that it takes for monetary and fiscal policies to affect the economy. Generally speaking, fiscal policies need longer time

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periods than monetary policies to have their complete effect on the economy. Because of that, the lack of coordination between monetary and fiscal policies ultimately cause these policies to not achieve their optimal goals.

In order to survey the existing situation in Iranian economy based on empirical results, we use a vector auto-regressive model with time-varying coefficients and stochastic volatility. Following Klime et al. (2016), the approach applied here will follow Sargent and Surico (2011), which in turn was based on Lucas (1980). Based on this approach, in order to study the low-frequency relationship, the data under study must be somehow filtered. To demonstrate two key implications of Quantity Theory of Money based on U.S. data for the period 1953-1977, Lucas (1980) used near unit slopes of univariate regressions of moving averages of inflation and interest rate on money growth. These two implications are: with given changes in quantity of change in money growth, it will be result in equal changes in inflation rate, as well as in nominal interest rate.

Sargent and Surico (2011) use this logic and also apply a TVP-VAR model, in which unfiltered data has been applied, and introduce a different approach to check the Quantity Theory of Money. Klime et al. (2016) use the same approach to study interactions of fiscal and monetary policies. In fact, they apply the Sargent and Surico approach on the coefficient of budget deficit in inflation equation. Based on Fiscal Theory of the Price Level (FTPL), they argue that an increase in this coefficient would imply dominance and greater effect of fiscal policy compared with monetary policy and finally less independence of central bank.

Coordination between monetary and fiscal policies, as key pillars of macroeconomic policy, could result in better policy making. In recent decades, a wide variety of macroeconomic policies are adopted by authorities in Iran. But many experts believe that these policies sometimes counteract and non-coordination is a major obstacle in achieving macroeconomic objectives. This study aims to investigate the effectiveness of monetary and fiscal policies in different presidential terms, considering their coordination or counterbalance and using quarterly time-series data for 1990: Q1 through 2017: Q4. The TVP-VAR model and the logic used to quantify the coordination between monetary and fiscal policies in each period of time is the main difference between this study and other studies about Iran.

The remainder of this paper is organized as follows. Section 2 provides a general description of the interaction between monetary and fiscal policies and importance of coordination of these policies. Section 3 deals with the methodology. Section 4 presents the empirical results and finally; section 5 consists of conclusions and recommendations.

The Interaction between Monetary and Fiscal Policies

The interaction between monetary and fiscal policies mainly depends on type of budget deficit financing and mode of managing monetary policy. The stance of monetary policy affects the government's ability in financing budget deficit by limiting or broadening the available resources for deficit financing. At the same time, the government strategy in budget deficit financing might cause some limits in operational independence of monetary authorities (Laurens and Piedra, 1998).

Using an extended game introduced by Tabellini (1986), Engwerda et al. (2016) show that the more active policies are used to track debt to its equilibrium level and the smaller this equilibrium level becomes, the more fiscal and monetary authorities are concerned about noise in Iran. They also show that the future uncertainty plays a major role in optimal policy settings in Iran: The less uncertainties leads central bank and government to a more cooperative settings and much disturbances in economy makes fiscal leadership more appropriate.

In addition, Büyükbaşaran et al. (2020) argue that while monetary policy is mainly

responsible for price stability, fiscal policy deals primarily with debt stabilization as well as output stabilization. As fiscal and monetary authorities conduct their policies according to their goals, these policies sometimes counteract depending on the state of the economy and their priorities. Macroeconomic effects of each policy are affected by this interaction. Therefore, the interaction between monetary and fiscal policies plays a vital role in understanding and managing macroeconomic policies.

The Effect of Fiscal Policy on Monetary Policy

The same way that monetary policy can directly affect the ability of fiscal authorities to finance budget deficit, the government financing strategy can affect monetary policy and impose some restrictions on operational independence of central bank. Actually, public debt management can affect many monetary variables such as interest rate and price level and because of that, sound and effective government financing can make the role of central bank to control money growth more effective.

Fiscal policy can directly affect monetary policy. For example, suppose that an expansionary government fiscal policy leads to a huge increase in budget deficit. Generally speaking, there are 5 alternative financing sources for government budget deficit: 1- transfer of resources from central bank (central bank direct credit); 2- volunteer purchase of government debt in domestic market by private sector; 3- forced financing of government debt by institutions (such as government securities in a captive market in which some institutions such as banks and pension funds are asked to invest a certain proportion of their portfolio in these securities); 4- foreign borrowing; and 5- taxes.

In the first case, if expansionary fiscal policy leads to high level of budget deficit and at the same time the central bank does not have sufficient independence, there is a possibility that the government monetizes its deficit. In that case, expansionary fiscal policy leads to expansionary monetary policy; credit creation for government by central bank leads to higher level of domestic credit in general. This policy leads to higher inflationary pressure, exchange rate devaluation, lower international reserves, balance of payments problems, and even banking and currency crises. Even if the government finances budget deficit through non-monetary instruments, such as financial market securities, there is still some concerns for monetary authorities; especially, for the crowding-out effect. If the size of government presence in financial markets increases, the government can be seen as a competitor for private sector and the cost of borrowing for private sector increases and this increase can harm economic growth and development.

On the other hand, volunteer purchase of government debt is a more preferred financing strategy; because it limits negative reactions, such as inflationary pressure, to increased budget deficit (Laurens and Piedra, 1998). If market signals are transparent, then volunteer purchase of government debt can produce timely and reliable information about any given level of government financing to decision-makers and the public.

Forced purchase of government debt securities can lead to financial repression. On the other hand, foreign government debt financing can lead to over-reliance on foreign borrowing. In the extreme case, over-reliance on foreign government debt financing leads to exchange rate and BOP risks and these risks might be concerns for central banks.

Finally, if budget deficit is financed by taxes, it can affect price level and inflation. If governments increase indirect taxes, sales tax or VAT, to finance budget deficit, it does have direct effect on price levels and can lead to price-wage spiral and because of that, inflation and inflationary expectations will increase (Hilbers, 2005). In addition to public debt management, other types of government financing operations can affect monetary policy. For example, fluctuations in government deposit with central bank can change monetary base instantly.

In addition to these direct channels, there are some indirect channels through which fiscal policy can affect monetary policy by changing expectations or uncertainty in economy. For example, a stable or growing budget deficit can be interpreted by market participants as an economic instability or they might expect high level of budget deficit and consequently the government urgent need to borrow. These expectations make them uncertain about government financial stance and it decreases the credibility of fiscal and monetary policy combinations. These complications consequently lead to instability in securities and currency markets. Actually, high ratio of public sector debt to GDP is interpreted by market participants as a threat to credibility and efficiency of monetary policy. This is because of future government income risk or as a precursor to weak fiscal policy stance. These issues can significantly decrease the average maturity of government debt securities and increase the reliance of government debt financing on monetary base. In this situation, monetary authorities become restricted in implementing their desired policies (Laurens and Piedra, 1998).

The Necessity for Coordination of Monetary and Fiscal Policies

The main objective of macroeconomic policies in any country is to attain a stable macroeconomic environment in order to achieve sustainable economic growth. Since monetary and fiscal policies affect each other through several channels and also because lack of coordination makes macroeconomic environment unstable, so choosing effective and coordinated monetary and fiscal policies does have undeniable role in reaching macroeconomic goals in a country. As noted by Corsetti et al. (2019), monetary policy alone may fail to stabilize economic activity and Inflation satisfactorily and accommodative monetary and fiscal policy together may be necessary to stabilize economic activity. Actually, since monetary and fiscal policies affect many economic parameters such as level and structure of savings, investment, production, employment, balance of payments, size and structure public spending policies, budget deficit or surplus, deficit financing and money in circulation, so the coordination between monetary and fiscal policies is not a need but a necessity. Lack of coordination between these two policies might cause undesired economic outcomes such as fiscal instability, high interest rates, increasing inflation, declining economic growth and etc.

The coordination between monetary and fiscal policies does not mean to use monetary and fiscal instruments simultaneously, but the goal is to control and direct these policy instruments to achieve desired target variables (Sehovic, 2013).

In general, coordination of monetary and fiscal policies can be achieved in two ways: firstly, it can be done continuously between monetary and fiscal authorities by joint decision-making about designing and implementing policies and secondly, by rules, acts and processes that minimize undesired interaction between monetary and fiscal policies. It is worth mentioning that the optimal choice between these two kinds of coordination depends on country-specific properties and the level of institutional development (Sehovic, 2013). Although monetary and fiscal policies each face its own targets, resources, constraints and rewards and each is designed and implemented by a different public body, but effective implementation of monetary and fiscal policies needs a broad coordination between these authorities; and the final effect of policies in each type depends on the effect of other policy areas on them. Actually, effective coordination makes policy decision-makers more successful in achieving their policy goals (Laurens and Piedra, 1998).

Hanif and Arby (2008) categorize the main reasons for the need to coordinate monetary and fiscal policy as:

- choosing joint and consistent goals for monetary and fiscal policies to achieve sustainable

non-inflationary growth;
- facilitating effective implementation of previous decisions by sharing information and consulting between monetary and fiscal authorities in order to achieve the set of monetary and fiscal targets.
- choosing monetary and fiscal policies consistent with sustainable policies.

Regarding the necessity of coordination between monetary and fiscal policies, we have to bear in mind that these policies are designed and implemented by two different bodied that have their own goals, resources, constraints, strengths and weaknesses. Because of that, there is a possibility that these two policies can be implemented out-of-line with each other and neutralize positive effects of each other, as Büyükbaşaran et al. (2020) pointed out. To avoid this trap, monetary and fiscal authorities must have constant interaction with each other in order to make consistent decisions about strategies, scope of policy instruments and their results. By doing so, they increase the chance of achieving desired economic goals. For example, if the goal of monetary authorities is to reduce inflation by a contractionary monetary policy, in the absence of coordination, fiscal authorities might react to this policy by implementing an expansionary fiscal policy and disable the effects of monetary policy.

Another important issue regarding the necessity for coordination of monetary and fiscal policies is the different time period needed by monetary and fiscal policies to affect the economy. Compared with monetary policy, it takes more time for fiscal policy to affect the economy and economic agents react to fiscal policy adjustments with some lags. On the other hand, monetary policy implementation affects the economy relatively fast and economic agents react quickly to monetary policy. Because of that, coordination of monetary and fiscal policies ensures that monetary and fiscal authorities understand this timeline difference between the two policies and consider it when they design and implement macroeconomic policies.

If this understanding does not exist, then this difference in required time to affect the economy can cause lack of coordination between monetary and fiscal policies and in turn, these policies cannot be as effective as possible. So, coordination between monetary and fiscal policies should be achieved in short-run and long-run. In short-run, policy coordination should be implemented in order to stabilize price levels. This coordination includes monetary policy and the method of financing public debt. In long-run, on the other hand, it is necessary to have a policy combination that ensures economic equilibrium with stable growth (Laurens and Piedra, 1998).

Also, when the economy is facing an exogenous shock, interaction between policies plays an effective role in stabilizing the economy. Tule et al. (2020) Show that in countries where macroeconomic stabilization mechanism exists through effective tax and transfer system, like the United States and the European Union, shocks to any part of the macroeconomy, for the most part is counterbalanced with little direct intervention through monetary or fiscal actions. However, in economies like Nigeria, where such stabilization vehicles are non-existent or poorly managed, misalignment of monetary and fiscal policies could aggravate the impact of the shock and subsequently cause more damage to the economy.

In addition, as mentioned before, each of monetary and fiscal policies have their own instruments. Although each of these instruments help policy-makers to achieve their goals, but instruments of any specific policy (fiscal or monetary) might affect more than one policy goal and because of that, the instrument might cause another policy not to be as effective as possible. For example, expansionary fiscal policy can help achieve high economic growth rates. But if the resultant budget deficit is financed by central bank, inflation rate will rise. On the other hand, contractionary monetary policy implemented to stabilize prices can reduce economic growth if it causes interest rate to increase. In these cases, more than one policy instrument is needed to achieve desired economic outcomes and because of that, suitable level

of these policy instruments should be designed and implemented by coordinated action of monetary and fiscal authorities (Tule et al., 2011).

Wang (2018) presents evidence of both long-run and short-run dynamic interactions between unconventional monetary policy and fiscal policy. He focuses on the U. S. and Japan because while the U. S. and Japan are both at the same level of economic development, it is well known that the two countries have contrasting financial structures. His findings show that fiscal policy acts as the leading indicator in the monetary-fiscal policy combination in the U. S., whereas in Japan, monetary policy acts as the leading indicator in the monetary-fiscal policy combination. In addition, in comparison to the U. S., the monetary-fiscal policy combination in Japan has been found to have less impact on macroeconomic variables during the period of unconventional monetary policy. These findings indicate that monetary policy and fiscal policy reinforce each other more in supporting the macroeconomy in the U. S.

Drumond and De Jesus (2016) use a small-scale post Keynesian model to analyze the compatibility of an active fiscal policy in an open economy with a managed exchange rate regime. A particularly important result of 99 their study relates to the monetary policy role in guiding expectations. Their findings show that in the presence of active wage negotiations, the absence of a (believable) coordination mechanism of inflation expectations may lead to a heightened distributive conflict and, ultimately, to economic instability. They conclude that although a solution for tackling this problem would be to assign the monetary authority two policy targets. However, the failure to repeatedly meet the inflation target would in itself cause a serious problem regarding expectations.

Lawal et al. (2018) and Chatziantoniou et al. (2013) examined the effect of fiscal and monetary policies interaction on stock market. They identified the two main channels through which these policies interactions influence stock market returns: (i) The impact of government inter-temporal budget constraint on monetary policy; and (ii) The effect of fiscal policy on monetary variables. Their results suggest the importance of incorporating both the monetary and fiscal policies in a single model when formulating stock market policy as their interaction exerts significantly on stock market behavior, thus both policies should be considered in tandem and not in isolation.

Most of the research done in this area emphasize that in cases in which there is a coordination between monetary and fiscal authorities about goals and instruments of implementing policies, the outcomes are much more efficient than cases in which coordination does not exist. The reason is that implementing uncoordinated monetary and fiscal policies might cause inconsistency in goals of these policies and because of that, the effectiveness of monetary and fiscal policies might be reduced. Most important studies in this area include Sargent and Wallace (1981); Laurens and Piedra (1998); Kuncor and Sebayang (2013); Gerba and Hauzenberger (2013); Kliem, Kriwoluzky and Sarferaz (2015); Patrick and Longa (2016); Al-shawarby and El Mossallamy (2019); Afonso et al. (2019); Mason and Jayadev (2018); and Lawal et al. (2018) among many others.

TVP-VARMA Model with Stochastic Volatility

In this section, first we have a look at a general TVP-VARMA model with stochastic volatility and time-varying coefficients. Since the intended model is estimated by Bayesian approach, in the rest of this section, we explain the conjugate prior distributions for model parameters as well as Gibbs efficient sampling method. The reader should beware that in the following discussion, the analysis is conducted conditional on initial observations $y_0, \dots, y_{1-p}$ and assumed primary factors $f_{1-p} = \cdots = f_0 = 0$. Additionally, it is assumed that the VARMA model is specified with intercept μ.

with above explanations, VARMA(p,q) model is defined as:

$$y_t = X_t\beta + \Phi_{0,t}f_t + \Phi_{1,t}f_{t-1} + \cdots + \Phi_{q,t}f_{t-q} + \eta_t \quad (1)$$

in which $X_t = I_n \otimes (1, y_{t-1'}, ...y_{t-p'}), \beta = vec((\mu, A_1, ..., A_p)'), \eta_t \sim \mathcal{N}(0, \Lambda)$ and Λ is diagonal matrix. Also, f_t and η_t are $n\times1$ vectors. Suppose that $\phi_{i,t}$ denotes free parameters in row *i* of $(\Phi_{0,1}, \Phi_{1,t}, ..., \Phi_{q,t})$.One must keep it in mind that $\phi_{i,t}$ has dimension $k_i = i - 1 + nq$. Then, the transition equation is:

$$\phi_{i,t} = \phi_{i,t-1} + \xi_{i,t} \quad (2)$$

in which $\xi_{i,t} \sim \mathcal{N}(0, \Psi_{\phi_i})$ is for $i = 1, ..., n,\ t = 2, ..., T$ with $\Psi_{\phi_i} = diag(\psi_{\phi,i,1}, ..., \psi_{\phi,i,k_i})$. The initial state is in form of $\phi_{i,1} \sim \mathcal{N}(\phi_{i,0}, \Psi_{\phi_0})$ in which $\phi_{i,0}$ and Ψ_{ϕ_0} are constant and definite matrices.

Furthermore, stochastic volatility enters into model by allowing the latent factors to have time-varying volatilities. $f_t \sim \mathcal{N}(0, \Omega_t)$ in which $\Omega_t = diag(e^{h_{1,t}}, ..., e^{h_{n,t}})$. Also, the logarithm of each equation`s volatility follows an independent random walk process as below:

$$h_{i,t} = h_{i,t-1} + \zeta_{i,t} \quad (3)$$

in which $\zeta_{i,t} \sim \mathcal{N}(0, \varphi^2_{h,i})$ is for $i = 1, ..., n,\ t = 2, ..., T$. The logarithm of volatilities begin with value $h_{i,t} \sim \mathcal{N}(h_{i,0}, V_{h_i,0})$ in which $h_{i,0}$ and $V_{h_i,0}$ are constant and certain values. For the sake of simplicity, we take the symbols $h_t = (h_{1,t}, ..., h_{n,t})', h = (h_{1'}, ...h_{T'})', \psi^2_h = (\psi^2_{h,1}, ...\psi^2_{h,n})'$.

The initial value of model parameters are determined according to coefficients of a VAR model with constant coefficients. Suppose that $\hat{b}$ and $\hat{S}_t = (\hat{s}_{ij})$ are the least squares estimations of coefficients and covariance matrix of a VAR(*p*) model. Then, Gibbs sampling begins with initial values of $\beta = \hat{b}, \phi = 0, h_{i,1} = ... = h_{i,T} = log\hat{s}_{ii}, i = 1, ..., n$ and $f \sim \mathcal{N}(0, O_h)$ in which $O_h = diag(e^{h_{1,1}}, ..., e^{h_{n,1}}, ..., e^{h_{1,T}}, ..., e^{h_{n,T}})$. Eventually, the initial values of $\Lambda, \psi^2_\phi, \psi^2_h$ are obtained with conducting the fourth step of Gibbs sampling. Other details regarding model estimation in this study is based on Chan and Eisenstat (2017).

The Sargent and Surico (2011) Approach

The Sargent and Surico (2011) approach is, in fact, a combination of approaches adopted by Lucas (1980) and Whiteman (1984). The latter argues that the Lucas scatter diagram estimates the sum of regression coefficients with long two-sided distributed lag. Then, he illustrates that how the population value of that coefficient is related to the parameters of state-space form of a vector autoregressive or DSGE model.

Lucas (1980) plots moving average of inflation and nominal interest rate on the *y* axis against the same moving average of money growth on the axis *x*. Lucas (1980) calculates the moving average $\bar{x}_t(\beta) = \alpha \sum_{k=-n}^{n} \beta^{|k|} x_{t+k}$ for a scalar series x_t and $\beta \in [0,1)$ in which selection of α based on $\alpha = \dfrac{(1-\beta)^2}{1-\beta^2-2\beta^{n+1}(1-\beta)}$ makes the sum of coefficients equal to one.

Whiteman (1984) shows that deriving a straight line within the scatter diagram of moving

averages is an unconventional method of calculating the sum of coefficients in a regression with long two-sided distributed lag. Suppose that $\{y_t, z_t\}$ is a covariance-stationary bivariate process with unconditional average of zero, and take the infinite least squares prediction of y_t on past, present, and future of z to be as follows:

$$y_t = \sum_{j=-\infty}^{\infty} h_j z_{t-j} + \epsilon_t \tag{5}$$

In which ϵ_t is a stochastic process that satisfies the orthogonal condition of population $E\epsilon_t z_{t-j} = 0 \ \forall j$. Suppose that spectral densities of y and z are defined respectively as $S_y(\omega)$ and $S_z(\omega)$ and the cross-spectral density is defined as $S_{yz}(\omega)$. Suppose that Fourier transform $\{h_j\}$ is $\tilde{h}(\omega) = \sum_{j=-\infty}^{\infty} h_j e^{-i\omega j}$. Then

$$\tilde{h}(\omega) = \frac{S_{yz}(\omega)}{S_z(\omega)} \tag{6}$$

and the sum of coefficients in distributed lag regression is

$$\sum_{j=-\infty}^{\infty} h_j = \tilde{h}(0) = \frac{S_{yz}(0)}{S_z(0)} \tag{7}$$

Whiteman (1984) showed that for a B with value near one, the regression coefficient b_f of Lucas moving average $\bar{y}_t(\beta)$ on moving average $\bar{x}_t(\beta)$ satisfies the following relationship:

$$b_f \approx \frac{S_{yz}(0)}{S_z(0)} = \tilde{h}(0) \tag{8}$$

Since this study is looking for a low-frequency relationship between two variables, the suggestion made by Lucas (1980) is used here. For this study, the variables under consideration are inflation rate and budget deficit. Assuming the regression coefficient of budget deficit on inflation rate is b_f one can approximate, based on Whiteman (1984) approach, the regression coefficient as follows:

$$b_f \approx \frac{S_{\pi d}(0)}{S_d(0)}$$

In which S_d is the spectral density of budget deficit $d$and $S_{\pi d}$ is cross-spectral density of inflation π and budget deficit d in zero frequency. In order to estimate this relationship using unfiltered data in TVP-VAR model, we follow the Sargent and Surico (2011) approach. Accordingly, the TVP-VAR model is written as the following state-space form:

$$\begin{aligned} X_t &= \hat{A}_{t|T} X_{t-1} + \hat{B}_{t|T} w_t \\ y_t &= \hat{C}_{t|T} X_t \end{aligned} \tag{9}$$

in which X_t is state vector $n_x \times 1$, Y is $n_y \times 1$ vector of observable variables, ω_t is $n_\omega \times 1$ Gaussian stochastic vector with zero mean and unit covariance matrix that is distributed evenly and independently during the time. The matrices $\hat{A}$, $\hat{B}$, and $\hat{C}$ matrices are functions of vector of time-varying structural parameters. Therefore, the spectral density correspondent to matrix *Y* in time *t* is

$$S_{Y,t|T}(\omega) = \hat{C}_{t|T}\left(I - \hat{A}_{t|T}e^{-i\omega}\right)^{-1}\hat{B}_{t|T}\hat{B}_{t|T'}\left(I - \hat{A}_{t|T'}e^{-i\omega}\right)^{-1}\hat{C}_{t|T'} \tag{10}$$

So, the low-frequency relationship between budget deficit and inflation rate in period *t* is calculated as follows:

$$\hat{b}_{f,t|T} = \frac{S_{\pi,d,t|T}(0)}{S_{d,t|T}(0)} \tag{11}$$

Also, Klime et al (2016) use the same approach for studying the coordination and interaction between the fiscal and monetary policy in Germany, the U.S., and Italy. And based on low-frequency relationship between government fiscal stance and inflation, find the periods that reflect a interaction between fiscal and monetary policies. They argue that, generally, such a situation is created due to dominance of fiscal policy and absence of independent central bank. These results hold particularly for cases of the U.S. and Italy: in the first years of the period under study, 1965 to 1999, there is a much higher level of interaction between fiscal and monetary policies, and in last years of the under-study period the monetary policy-maker`s control on inflation is increased and the interaction between the two types of policy-makers is decreased. For Germany, the results indicate that in the whole sample period, low-frequency relationship between inflation and fiscal stance of government is zero and it is because of existing sensitivity in Germany to inflation after the hyperinflation seen in 1921-23 period and this result is matched with the evidence.

Using the same approach in the next section, we check the relationship between inflation rate and government fiscal stance in Iran.

Empirical Results of TVP-VARMA Model

As it is said in previous sections, we aim in this study to explore the low-frequency relationship between budget deficit and inflation rate by using a TVP-VARMA model. For doing this, a TVP-VARMA model has been used based on the data of economic growth, inflation rate, monetary base growth and the ratio of budget deficit to GDP. The data used here includes gross domestic product in 2004 prices, consumer price index in 2011 prices, monetary base, and budget deficit to GDP ratio. The data has a quarterly frequency and is from 1990Q2 to 2017Q4. The source of all the data used in this study is Central bank of I.R. of Iran. In TVP-VARMA model applied in this study, the growth rate of variables is defined on a year-on-year basis. Therefore, assuming $X_t$is an indicator of the level of a variable, its growth rate will be defined $\dot{X}_t = \frac{X_t - X_{t-4}}{X_{t-4}} \times 100$. Since the growth rate of variables is given in percentage point, the budget deficit to GDP ratio is also given in percentage point. The graphs of used data are reported in Figure 1.

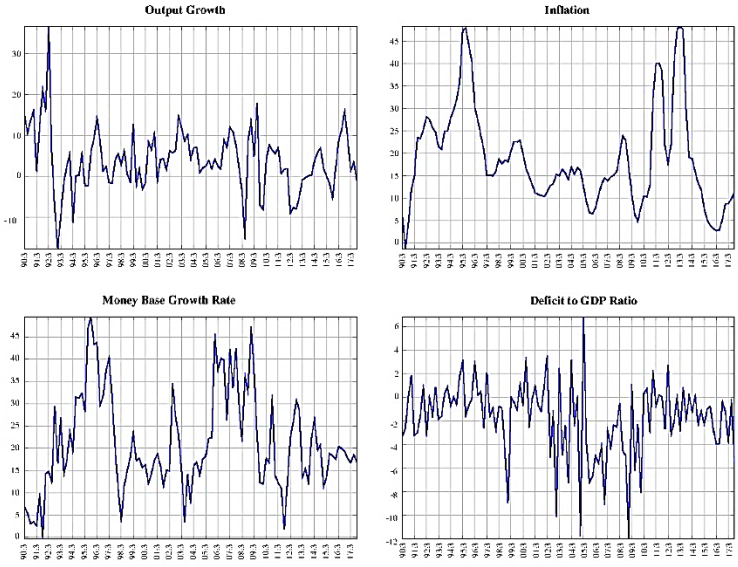

Figure 1. Data Used in TVP-VARMA Estimation
Source: Research finding.

In this study, budget deficit to GDP ratio is taken as the measure of government fiscal stance, and based on its relationship with inflation, the low-frequency relationship between budget deficit and inflation is drawn out. In addition, the coordination between fiscal and monetary policy will be analyzed; since we must have a low inflation rate in case of coordination between fiscal and monetary policies. And in case of a period in which government fiscal stance leads to high inflation, we will conclude that the coordination between the two types of policy-makers is low in that period. For this purpose, the variable Y in our TVP-VARMA model is defined as $y = [\Delta x_t, \pi_t, \Delta M_t, d_t]$ in which Δx_t, π_t, ΔM_t and d_t are respectively economic growth, inflation, nominal monetary base growth rate, and the ratio of budget deficit to GDP. In this study, the codes generated by Chan and Eisenstat (2017) are used in order to estimate the model.[1]

With these explanations and using Sargent and Surico (2011) approach which was discussed in detail in the previous section, after the estimation of TVP-VARMA model with stochastic volatility and after rewriting it in state-space form of equation 9, spectral density similar to equation 10 is extracted and finally, low-frequency relationship between budget deficit and inflation rate in each period is calculated using equation 11.

After estimating TVP-VARMA model with stochastic volatility in form of equation 4 and derivation of low-frequency relationship between inflation rate and government fiscal stance i.e. budget deficit to GDP ratio, the coefficient $\hat{b}_{f,t|T}$ is obtained according to equation 8 which is shown in figure 2. In this figure, low-frequency relationship between inflation rate and the government budget deficit ratio is reported for confidence intervals of 85% and 95%. Since we are looking for coordination and interaction between fiscal and monetary policies, and the fact that the relationship may not be the same in different presidential administration periods, the average of coefficient $\hat{b}_{f,t|T}$in post-revolution administrations is shown in the graph in form of horizontal dot-lines (with standard deviation of coefficient $\hat{b}_{f,t|T}$. The estimation results of $\hat{b}_{f,t|T}$in figure 2 show that the relationship between inflation rate and government fiscal stance has had different properties in different administration periods. In Reconstruction Government, the relationship between inflation rate and government budget deficit begins with the lowest value and with considerable increase in years 1990 and 1991.

1. These codes can be downloaded from the link http://joshuachan.org/code/code_TVPVARMA.html

After that, the relationship stabilizes in the middle years of this administration. But, again in the last years of this presidency, the relationship has a significant increase, and this fact results in the highest variance among the various administrations, notwithstanding the lowest average of inflation dependency on government fiscal stance. In other words, despite the fact that there was a short period of stable coordination between fiscal and monetary policies, lack of coordination occurred for many times in the entire period of this administration that eventually ended in high confrontation of the two policies.

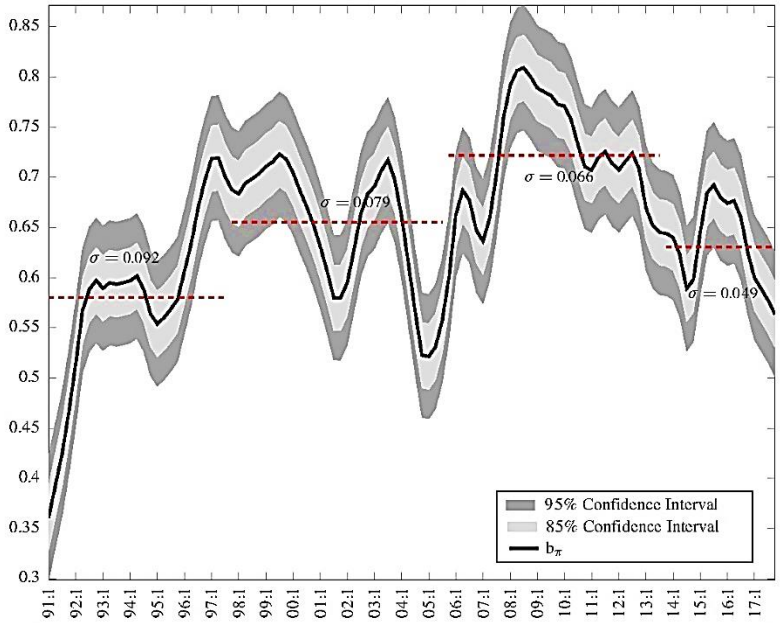

Figure 2. Low-Frequency Relationship between Budget Deficit and Inflation Rate in the Entire Period under Study
Source: Research finding.

In the second presidency period in our sample, we see higher degree of low-frequency relationship between inflation and budget deficit compared to the first government under study, but the standard deviation in this period $\sigma = 0.079$ is less than that in the previous term $\sigma = 0.092$. The important point for this period is that the confrontation between fiscal and monetary policies has been decreasing in this period. And in spite of the fact that $\hat{b}_{f,t|T}$ was substantially higher than the average in the first two years of this presidency, in most of the years, particularly the last years, the relationship was lower than the average. If we ignore the first years of our sample (1990-1992) as they were just after the war ended and the economic situation was not like the other years, the lowest value for $\hat{b}_{f,t|T}$is seen at the end of the second presidency in this study, which implies the highest level of coordination between the two policies.

Although the highest level of coordination between the fiscal and monetary policies has taken place at the end of the second presidential government in our sample, the level of interaction between monetary and fiscal policies has increased heavily as the next administration took office, and it has been continuing to increase to the point that the highest level of interaction between the two policies happened in year 2008. However, this interaction between monetary and fiscal policies follows a declining trend and we observe a higher level of coordination after year 2008. These factors cause this period to experience the highest value of $\hat{b}_{f,t|T}$, the lowest level of coordination between the two policies with relatively high standard deviation as well. So, one can label this period as the period with the highest level of disaccord between monetary and fiscal

policies that led to maximum reaction of inflation rate to government fiscal stance. The decreasing trend of interaction between monetary and fiscal policies has continued in first year of the last administration so far. But after a mild increase in middle years of this administration, we observe a decreasing trend again. And that's the reason why this period has the lowest standard deviation in terms of coordination between monetary and fiscal policies. Because of low level of $\hat{b}_{f,t|T}$in two first years of the sample, however, the first administration in our sample remains with the highest level of coordination and the last administration has the next highest rank. It must be noted that the last administration includes only one term, while all the other presidency periods contain two 4-year terms. And we should bear it in mind when comparing the last administration with others.

In Figure 2, unconditional standard deviation of parameter $\hat{b}_{f,t|T}$is reported. The variance of TVP-VARMA model has stochastic volatility and the changes in stochastic volatility in different times can be analyzed as well. In figure 3 the stochastic volatility of four variables in TVP-VARMA model are reported. Based on this figure, the variance of growth rate in each presidency is relatively stable, but its general trend is descending over time. Therefore, lowest level of growth rate volatility is seen in the last years of our sample. The highest level of volatility is for inflation in our model. In spite of high level of volatility in inflation at the starting time of our sample, its trend is completely decreasing in the first and second administrations in our sample. And in the second presidency period volatility is in its lowest level with minimal changes. On the other hand, inflation volatility has a sharp jump in the third administration and it returns to levels equal to early years of the sample period. Finally, it experiences a significant fall again in the fourth presidency period.

Also, stochastic volatility of monetary base growth rate in the first administration is relatively increasing which lasts more or less in the second presidency period. However, the highest level of volatility in growth rate of monetary base is seen in the third administration which, after a surge in the first years of this presidency, it decreases in a completely descending trend. The decreasing trend continues until the last years of our sample. Regarding stochastic volatility of budget deficit to GDP ratio, we see an increasing trend in the first years of sample, while in the second administration the trend goes decreasing. As the third presidency period begins, the trend becomes increasing again and then it falls in last years of this period. Eventually, the trend is increasing in the last presidency period, notwithstanding the lower level of volatility.

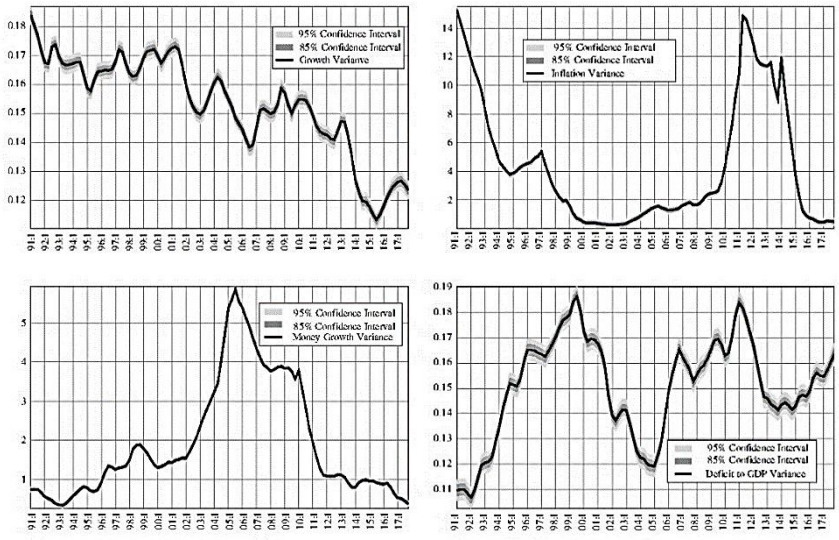

Figure 3. Stochastic Volatility of TVP-VARMA Model
Source: Research finding.

The comparison of low-frequency relationship between inflation and government fiscal stance in figure 2 and stochastic volatility of budget deficit to GDP in figure 3 indicates that in the first years of our sample period, the interaction between monetary and fiscal policy was increasing and also with increasing stochastic volatility. And this has led to experiencing the highest level of inflation in this period. It can be said that in the second presidency period, we see a relative increase in coordination of monetary and fiscal policies, and this phenomenon is accompanied by decreasing volatility. But in the third administration, the interaction between two policies and inflation stochastic volatility are increasing. In the last presidency period, the volatility of this relationship has been increasing, despite reduction in the interaction between the two policies.

Finally, our results are in parallel with those find by Klime et al (2016) for Italy, Germany and the U.S. They find that for Italy and the U.S, the low-frequency relationship between fiscal stance and inflation is low during periods of an independent central bank. However, such a relationship is around zero during all sample period for Germany; that is there is a strong commitment to maintain price stability by Bundesbank. Although the approach used here is different with many other studies, but our results are highly in align with many of them including Engverda et al. (2016); Patrick and Longa (2016); Al-shawarby and El Mossallamy (2019); Afonso et al. (2019); Mason and Jayadev (2018); and Lawal et al. (2018).

Conclusion

In this study we used a TVP-VARMA model with stochastic volatility based on Chan and Eisenstat (2017) using the data for economic growth, inflation rate, monetary base growth rate and budget deficit to GDP ratio in order to study the state of coordination and interaction between monetary and fiscal policies in Iranian economy. After that, using this model as well as Sargent and Surico (2011) approach, which in turn follows the approaches adopted by Sargent (1980) and Whiteman (1984), the low-frequency relationship between inflation rate and government fiscal stance i.e. budget deficit to GDP ratio has been calculated. This time-varying parameter acts as an indicator of interaction and coordination between monetary and fiscal policies. That is because in case of coordination between the two policies, the relationship between inflation and government fiscal stance would be low. This means that, in achieving the goal of controlling inflation, the central bank has adequate independence from government fiscal position and therefore, the government fiscal stance has little influences on inflation. With the same logic, a high value of low-frequency relationship between inflation and government fiscal stance would result in interaction between monetary and fiscal policies.

The results illustrate that coordination and interaction between monetary and fiscal policies vary in different presidency periods in Iran. In early years of first period of presidency in our sample, we see the highest level of coordination between monetary and fiscal policy. Perhaps, the reason must be that after the war, different government finance resources has led to output growth and these resources did not result in inflation so much. The evidence of this claim would be the increasing trend of interaction between monetary and fiscal policies in this period, so that the highest standard deviation of $\hat{b}_{f,t|T}$took place in this period. If we set aside the first years of our sample period with this logic, it can be inferred that the highest level of coordination between fiscal and monetary policies has happened in the last years of second presidency period. However, the level of interaction between the two policies was increasing in the third period of presidency, and the highest level of interaction between fiscal and monetary policies was in the middle years of this administration. And finally, in the last years of this period, the two policies have improved in terms of coordination, and the improving trend has continued in next administration. Also, in the last administration, we see the lowest level of volatility in coordination.

As emphasized by many studies (Sargent and Wallace (1981), Laurens and Piedra (1998), Kuncor and Sebayang (2013), Gerba and Hauzenberger (2013), Kliem, Kriwoluzky and Sarferaz (2015), Patrick and Longa (2016), Al-shawarby, and El Mossallamy, (2019), Afonso et al. (2019), Mason and Jayadev, (2018) and Lawal et al. (2018)), implementing uncoordinated monetary and fiscal policies might cause inconsistency in goals of these policies and because of that, the effectiveness of monetary and fiscal policies might be reduced. Although there are some periods of higher coordination of fiscal and monetary policies, but the results of this study reveal that there has been an overall low level of coordination between these two policies in Iran. Therefore, it is recommended that authorities use a low-frequency relationship index such as that introduced in this study to be able to dynamically check the coordination between fiscal and monetary policies over time. Besides, our results indicate that there is a significant relation between inflation and coordination of monetary and fiscal policies so that the higher this coordination, the lower is inflation. Accordingly, a disciplinary set of monetary and fiscal policies is highly recommended. To do so, obeying monetary and fiscal policy rules by the authorities and commitment to them can play a major role.

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