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The effect of inflation uncertainty on budget deficit: Evidence from Iran

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Abstract

Statistics show that in some countries (generally less developed) with high inflation there exists a large budget deficit. Since the statistical evidence can suggest how inflation and budget deficiency are related, it can be used to find the best monetary policy to obtain a balanced state budget. The main objective of this study is to evaluate the effect of inflation uncertainty on budget deficiency in Iran in the period of 1970-2013. For this purpose, first, using GARCH approach, uncertainty index is modeled and then using ARDL model, the relationship between inflation uncertainty and budget deficiency is investigated. The results show that since an increase in inflation uncertainty reduces government revenues, it leads to budget deficiency. Also, the results from error correction model shows that the error correction coefficient is -0.62 and if the model diverge from its long run equilibrium, 62 percent of the error would disappear in each period.

Keywords: Inflation, Uncertainty, Budget deficit, ARDL approach, GARCH.

1 Introduction

Macroeconomic policy makers seek to sustain real economic growth with low inflation rate and a reduction in the budget deficits. Macroeconomists, central banks' managers and policy makers have warned about the costs associated with high and variable inflation. The presence of inflation imposes negative externalities to economic efficiency. Inflation leads to uncertainty in the profitability of investment projects. As a result investment strategies become more conservative and ultimately it leads to lower levels of investment in government revenues and the budget deficiency.

On the other hand, inflation can reduce a country's competing power by making its exportation relatively more expensive and as a result affecting its balance of payment. Besides, borrowing and lending decision making can be difficult in the presence of inflation and it is possible that firms might even be forced to allocate more resources to compensate the effects of inflation. Inflation uncertainty is an important determinant of costs of inflation, but there is not empirical or theoretical consensus about the relationship between inflation uncertainty and budget deficiency. According to Freidman (1977), increase in the average rate of inflation leads to more uncertainty about inflation rate and lower economic efficiency.

This paper seeks to investigate the effect of inflation uncertainty on budget deficit. Budget deficit is the state that total government expenditures exceed total government revenues. Wallace (1981) discusses the "monetary dominance and \ fiscal dominance" regimes in the relationship between fiscal deficits and inflation. Given that the budget deficit is jointly determined by bond sales to the public and seigniorage created by a monetary authority, if the monetary authority implements a monetary policy independently, then the fiscal authority faces a budget constraint imposed by the monetary authority when it formulates the fiscal policy. Under this circumstance, the monetary authority can control the money supply, and fiscal deficits do not lead to inflation. In contrast, in a fiscal dominance regime, the monetary authority cannot control the money supply, and fiscal deficits lead to inaction under such fiscal dominance. According to Ackay et al.(1996), there are two possible channels through which higher deficit lead to higher inflation. Firstly, the government's borrowing requirements normally increase the net credit demands in the economy, driving up the interest rates and crowding out private investment. The resulting reduction in the growth rate of the economy will lead to a decrease in the amount of goods available for a given level of cash balances and hence the increase in the price level. Secondly, deficit can also lead to higher inflation even when central banks do not monetize the debt when the private sector monetizes the deficits. This occurs when the high interest rates induce the financial sector to develop new interest bearing assets that are almost as liquid as money and are risk free. Thus, the government debt not monetized by the central bank in monetized by the private sector and the inflationary effects of higher deficit policies prevail. In a monetarist economy, the monetary authority independently determines seigniorage and can control inflation. However, Sargent and Wallace (1981) argue that the monetary authority's control over inflation is limited. Namely, if the fiscal authority dominates the monetary authority, then the fiscal authority independently announces all current and future deficits, such that the monetary authority is constrained by the demand of government bonds and monetizes the deficit. Accordingly, the government runs persistent deficits with seigniorage and produces inflation, and fiscal deficits and inflation are dynamically correlated.

Against this background, attention has increasingly been given to the role of fiscal policy in determining inflation. The main result of the seminal paper by Sargent and Wallace (1981) is that the effectiveness of monetary policy in controlling inflation depends critically on its coordination with fiscal policy. In their model, tighter monetary policy could lead to higher inflation under certain circumstances, even when the traditional relation between money and the price level holds. The rationale is that, with the demand for government bonds given and in the absence of changes in future fiscal policy, a part of government obligations has to be covered by seigniorage at some point in the future.

A similar line of reasoning lies behind the fiscal theory of the price level (FTPL). Apart from seigniorage financing, traditional analysis of the fiscal impact on inflation focus mostly on Keynesian aggregate demand considerations, public wage spillovers to private sector wages, and taxes affecting marginal costs and private consumption (Elmendorf and Mankiw, 1999).

The FTPL identifies the wealth effect of government debt as an additional channel of fiscal influence on inflation and, amid debates on the coherence of the theory (Buiter, 1999; Niepelt, 2004), has spawned an extensive literature (Woodford, 1994; Sims, 1994; Loyo,1999; Christiano and Fitzgerald, 2000; Canzoneri, Cumby, and Diba, 2001; Cochrane, 2001; Woodford, 2001; Gordon and Leeper, 2002; Cochrane, 2005). This theory posits that increased government debt adds to household wealth and, hence, to demand for goods and services, leading to price pressures.

This study is guided by the following research questions: What is the relationship between inflation and budget deficit in Iran? Does inflation uncertainty have significant effect on Iran' budget deficit?

Since government of Iran has consistently run its economy with a budget deficit and high inflation, this paper re-investigate the effect of inflation uncertainty on budget deficit in the Iranian economy by using quarterly data for the period of 1970- 2013.

In this paper the effect of inflation uncertainty on budget deficit is tested by using time series data of Iran over the period 1970 - 2013. This paper consists of four sections. Section 1, discusses the introduction, in which the background and rationale of the study is outlined. Section 2, covers the review of literature, the relationship between inflation uncertainty and budget deficit. Section 3, covers the details of the data and research methodology employed in this study and reports the findings and discussions. The final section contains the conclusions.

2. Literature review

An extensive theoretical and empirical literature has been developed to examine the relationship between the budget deficit and inflation. At a theoretical level, according to Akcay et al. (1996), the correlation from deficit to inflation is generally a difficult one to establish. Hamburger and Zwick (1981) argue that, from the monetarist view, budget deficits can lead to inflation, but only to the extent that they are monetized. Alavirad and Athawale (2005) argue that the basis of theory, the relationship between budget deficit and inflation is extensive. The monetarist theory postulates that money supply drives inflation. In the other theoretical studies, for example, Metzler (1951), Patinkin (1965), Friedman (1968), Sargent and Wallace (1981), Dywer (1982), and Miller (1983) has argued that government deficit spending is a primary cause of inflation. On the other hand, some empirical literatures have investigated the relationship between government budget deficit and inflation. For example, Edwards and Tabellini (1991) in their study found that budget deficits are an important determinant of inflation. They used cross section techniques for a wide sample of developed countries. Spinelli (1991) assessed the relationship among these variables for an extended period (1875-1975) in Italy. In doing so, they confirmed the positive long-term causal direction from budget deficit to money growth and from money growth to inflation, emphasizing the effects very according to the degree of central banking independence and the type of monetary policy regime. Evidence from Ackay (1996) study about the relationship between the general level of prices and budget deficit in Turkey shows that, budget deficit growth had a positive effect on increased price levels in Turkey. Solomon and de Wet (2004) studied the relatively high inflation rate and high fiscal deficit for a prolonged period for the economy of Tanzania. The study concluded that " due to monetization of the budget deficit, significant inflationary effects are found for increases in the budget deficit. Alavirad and Athawale (2005) investigate the impact of budget deficit on inflation in Iran, by employing the ARDL model and based on the annual data from 1960 to 1999. The result show that budget deficit has a major impact on inflation in Iran. Albert (2008) in his study investigates the impact of a budget deficit on inflation in Zimbabwe over the period of 1980—2005. Due to massive monetization of the budget deficit, significant inflationary effects are found for increase in the budget deficit. Pekarski (2008) in his study contributes to the literature on budget deficit and inflation in high inflation economies. The main finding of this study is that recurrent outbursts of extreme inflation in these economies can be explained by a certain hysteresis effect associated with public finance. It is also showed that the division of the operational budget deficit into the part that is subject to negative inflation feedback and the part that is inflation-proof, has implication for both the discussion of the inflationary consequences of budget deficit and the proper design of stabilization policy. Lozamo (2008) evidence of the causal long-term relationship between budget deficit, money growth and inflation in Colombia, using the vector error correction model with quarterly data. His conclusion supported by hypothesis would be the most appropriate approach to understanding the dynamics of these variables. Zonuzi and et al (2011) considered the relationship between budget deficit and inflation in Iran. To cary out a test of no structural break against an unknown number of breaks in the Iranian macroeconomic variables, they use the endogenously determined multiple break test developed by Bai & Perron (2003). As, there is a structural break in the time series date, we use Perron(1990) unit root test to test of stationarity. This paper employ Bounds test approach to cointegration proposed by Pesaran et al. (2001) to investigate the long-run relationship between budget deficit and inflation. The key findings from the empirical studies investigating the relationship between the budget deficit and inflation indicated strong evidence towards supporting a significant and positive relationship between budget deficit and inflation in Iran. At the end, we obtained volatility of budget deficit by using GARCH model, and showed that, volatility of budget deficit has a positive effect on the inflation too.

3. Model and Data

3.1 ARCH and GARCH Model

In testing the effect of inflation uncertainty on budget deficit, generalized autoregressive conditional heteroscedasticity (GARCH) models and its extensions are common methods used in the inflation uncertainty literature since the estimated conditional volatilities can serve as better proxies for inflation uncertainty. ARCH and GARCH Models Like most other financial data, exchange rate and inflation in Iran are known to be volatile. It may not be appropriate to model it with ordinary least square; OLS which is the commonest modeling technique because the basic assumptions concerning the means and variance of stochastic term. (The white noise assumption) for which the estimates of this technique will be accepted as robust may not hold. Besides, this problem may also make one to cast doubt on the inferential procedure because it may cause incorrect rejection of the null hypothesis i.e. type 1 error. As a result of this, this study consider two different but unique models that take into consideration the volatile nature of financial data like exchange rate and inflation into consideration. The models are ARCH and GARCH. The GARCH is respectively made up of the mean equation (1) and conditional variance equation (2) below. Except the inclusion of last period's forecast variance (λδ2 t-1), the GARCH model is the same as the ARCH. The mean equation of the inflation rate model and conditional variance of inflation rate are therefore specified as follows:

$$INFLATION_t = \beta_0 + \beta_1 INFLATION_{t-1} + \varepsilon_t \quad (1)$$

$$\sigma^2_{\varepsilon_t} = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \alpha_2 \sigma^2_{t-1} \quad (2)$$

Where ε_t is the residual of Eq.(1), $\sigma^2_{\varepsilon_t}$ is the conditional variance of the residual term taken as inflation uncertainty at time t, and n is the lag length. Eq. (1) is an autoregressive representation of inflation. Eq.(2) is a GARCH(1,1) representation of the conditional variance.

3.2 The Autoregressive Distributional Lag Specification

Since fiscal deficits and inflation are dynamically correlated, we consider a general ARDL (p; q) model. This method is applicable without considering models variables as I(0) or I(1).In other words, it is unnecessary to divide variables into correlated variables of grade one or zero in this method. ARDL has been shaped based on dynamic approach and it is as follows in bi- variables state:

$$y_t = \beta_0 + \sum_{j=1}^{p} \beta_j y_{t-j} + \sum_{i=o}^{q} \alpha_j x_{t-i} + \varepsilon_t \quad (3)$$

In this relation, dependent variable is a function of level values and it can be rewritten with ARDL and its delay values are as follows:

$$B(L)y_t = A(L)x_t + \varepsilon_t$$

In this relation (L) is delay operator as $-\beta_3 L^3 - \cdots - \beta_p L^p,\ 1 - \beta_1 L^1 - \beta_2 L^2$ and delay operator A(L) as $\alpha_0 + \alpha_1 L^1 + \alpha_2 L^2 + \cdots + \alpha_q L^q$. ARDL examines co integration of the model variables in addition to estimation without consideration of the parameters. In order to have dynamic model with long term balance, it is necessary that sum of i=1,2,…..,p is less than one. For test, t is obtained by following relation and it is compared to Beranchi , Dolado and Master critical quantities.

$$t = \frac{\hat{\beta}_i - 1}{se(\hat{\beta}_i)}$$

If calculated t is bigger than Beranchi, Dolado and Master critical quantity, estimated regression has long term balanced relationship and in other case the variables are not integrated. In case of co integration of the variable, it can be investigated the short term dynamicity and movement toward balance. Shin and et al (1996) showed that the long term relationship between model variables is estimated by ECM coefficient. So that if ecm(-1) is between 0 and 1 and it is significant from statistical view point then there is a long term relationship between the variables. For estimation of this model, it is necessary to estimate the relationship by OLS for all possible combinations based on variables different delays. Maximum delays are estimated by the author based on number of observations. In next step, among measured regressions, one regression is selected based on four Akaeik, Schwirtz-Byzen, Hannan rules and determination coefficient. In final step, coefficients related to long term model are proposed based on ARDL. In this model, in addition to long term relationship the ECM is proposed.

4. Empirical Result

4.1. ADF Unit Root Test

Nelson and Plosser (1982) argue that almost all macroeconomic time series typically have a unit root. Thus, by taking first differences the null hypothesis of nonstationarity is rejected for most of the variables. Unit root tests are important in examining the stationarity of a time series because nonstationary regressors invalidates many standard empirical results and thus requires special treatment. Granger and Newbold (1974) have found by simulation that the F-statistic calculated from the regression involving the nonstationary time-series data does not follow the Standard distribution. This nonstandard distribution has a substantial rightward shift under the null hypothesis of no causality.

Thus the significance of the test is overstated and a spurious result is obtained. The presence of a stochastic trend is determined by testing the presence of unit roots in time series data. Non-stationarity or the presence of a unit root can be tested using the Dickey and Fuller (1981) tests.

The test is the t statistic on φ in the following regression:

$$\Delta Y_t = \beta_0 + \beta_1.trend + \rho Y_{t-1} + \sum_{i=0}^{\infty} \varphi_i \Delta y_{t-i} + \varepsilon_t \quad (4)$$

Where Δ is the first-difference operator, ε_t is a stationary random error.

The results of the unit root tests for the series of variables are shown in Table 1. The ADF test provides the formal test for unit roots in this study.

Table 1. Results of unit root test

Variable	ADF Test	
	ADF t-statistic	Critical values (5%)
GDP	-2.12	-2.93
TAX	-1.18	-2.93
OIL	-2.05	-2.93
GOV	-2.78	-2.93
M1	-1.10	-2.93
BD	-4.02	-2.93
INFLATION	-5.48	-2.93

Note: The optimal lags for the ADF tests were selected based on optimising Akaike's information Criteria AIC, using a range of lags. We use the Eviews software to estimate this value.

Table (1) shows that with ADF, GDP, TAX, OIL, GOV and M1 has a unit root at level, and it is stationary at first differences. While, BD and INFLATION has not a unit root at level and they are stationary at level.

4.2. Augmented multivariate GARCH model

Table (2) reports the estimates of a GARCH model of inflation uncertainty. The mean and conditional residual variance equations for inflation are reported in Eqs. (1) and (2) of Table 2.

Table 2- Inflation uncertainty an augmented GARCH model

Variable	Coefficient	Z statistic	Prob
INTERCEPT	0.0009	2.29	0.02
RESID(−1)^2	0.65	2.06	0.03
GARCH(-1)	0.28	2.24	0.02
	F= 2370.2(0/000)		$R^2 = 0.99$

Results shows that Iran inflation is a highly persistent stationary process. Also we see that the variance of inflation innovations is significantly higher in each. There is also a highly significant and stationary GARCH process in the conditional variance of the inflation residuals.

4.3 Tests of Cointegration

The cointegration test is based in the methodology developed by Johansen (1991), and Johansen and Juselius (1993). Johansen's method is to test the restrictions imposed by cointegration on the unrestricted variance autoregressive, VAR, involving the series. The mathematical form of a VAR is

$$y_t = \theta_1 y_{t-1} + \cdots + \theta_p y_{t-p} + \vartheta X_t + \varepsilon_t \qquad (5)$$

where y_t is an *n*-vector of non-stationary *I(1)* variables, x_t is a *d*-vector of deterministic variables, $\theta_1, .., \theta_p$ and ϑ are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated with each other but are uncorrelated with their own lagged values and other right-hand side variables. We can rewrite the VAR as (Eq. (6)):

$$\Delta_{y_t} = \prod_{y_{t-1}} + \sum_{i=0}^{\infty} \Gamma_i \Delta_{y_{t-i}} + \beta_{xt} + u_t \qquad (6)$$

Where (Eq. (7))

$$\Pi = \sum A_i - I_t \quad that \;\; \Gamma_i = -\sum A_j \qquad (7)$$

Granger's representation theorem asserts that if the coefficient matrix n has reduced rank r<n, then there exist n x r matrices α and β each with rank r such that $\pi = \alpha\beta'$ and $\beta' y_t$ is stationary. Here, r is the number of cointegrating relations and each column of β is a cointegrating vector. For n endogenous non-stationary variables, there can be from (0) to (n-1) linearly independent, cointegrating relations.

Having established that the variables are integrated of the same order, we proceed to testing for cointegration. The Johansen-Juselius maximum likelihood procedure was applied in determining the cointegrating rank of the system and the number of common stochastic trends driving the entire system. We reported the maximum eigen-value statistic and critical values at five per cent (5%) in the table below. The result of multivariate cointegration test based on Johansen and Juselius cointegration technique reveal that there are three cointegrating equations at 5% level of significant.

Table 3. Results of Johansen's Cointegration Test

Null Hypotheses	Alternative Hypotheses	Max-Eigen Statistic	Critical Value (5%)
H0	H1		
r=0	r=1	61.23	55.98
$r \leq 1$	r=2	54.95	40.07
$r \leq 2$	r=3	51.67	33.78
$r \leq 3$	r=4	26.64	27.85
$r \leq 4$	r=5	19.36	21.13
$r \leq 5$	r=6	13.18	14.26
$r \leq 6$	r=7	0.28	3.84

Since we have evidence of cointegration in the first step, we move to the next step of estimating the ARDL model to get the long run and short run dynamics of inflation uncertainty budget deficit relationship.

4.4 ARDL model estimation

The ARDL lag structure (1, 0, 0, 0, 0, 0, 0) is automatically selected based on Schwarz Bayesian criteria, after setting 2 as the maximum lags to be used. However, the lag structures selected by the AIC and Hannan- Quinn criterion appear the same as those selected by the SBC in this study.

This relation shows that there is a direct relationship between inflation uncertainty and budget deficit. In short run coefficient, sum of delay coefficients with dependent variable is subtracted from one and it is divided into standard deviation and the result is -2.79. Since this figure is less than critical value of Benrah, Dolado and Master table (-3.27) from absolute value view point, thus H0 is accepted as having long term relationship. The following results are obtained:

Table 4 – Long run model

Variable	Coefficient	t-statistic	Prob
GDP	0.23	4.28	0.02
TAX	-0.12	-5.92	0.01
OIL	-0.10	-2.48	0.00
GOV	3.04	3.01	0.00
MI	1.15	3.69	0.00
INFLATION UN	0.12	6.23	0.03
INTERCEPT	2.26	2.34	0.04

The coefficient of the government expenditure (GOV) is positive and significant at 5 per cent level which implies that fiscal theory of price level works in Iran in the long run. A one unit increase in the government expenditure increases inflation and budget deficit by 3.04 percentage points in the long run, holding the effects of all other variables constant. So, the fiscal deficit is an important determinant of Iran's inflation. As fiscal theory argues, an increase in the budget deficit, with no possibility of revenue surplus, will lead the government to borrow more either from the central bank or from the private sector by issuing debt instruments. Seigniorage as well as other public debt instruments have inflationary effects on the economy. So, the result is similar to the theory. The coefficient of GDP is positive and significant at 5 per cent level. The study finds that if real GDP or output increases by 1 per cent then budget deficit increase by 0.23 percentage points approximately in the long run, holding all other effects on inflation constant. The coefficient of inflation uncertainty is positive and significant at 5 per cent level. The study finds that if inflation uncertainty increases by 1 per cent then budget deficit increase by 0.12 percentage points approximately in the long run, holding all other effects on inflation constant.

Error correction coefficient shows percentage of adjustment of dependent variable imbalance toward long term relationship in each period. In this article, ECM(-1) is -0.62 that shows that 0.62 is adjusted from short term imbalance to long term balance every year.

5. Conclusion

Inflation leads to uncertainty in the profitability of investment projects. As a result investment strategies become more conservative and ultimately it leads to lower levels of investment in government revenues and the budget deficiency. On the other hand, inflation can reduce a country's competing power by making its exportation relatively more expensive and as a result affecting its balance of payment. Besides, borrowing and lending decision making can be difficult in the presence of inflation and it is possible that firms might even be forced to allocate more resources to compensate the effects of inflation. Inflation uncertainty is an important determinant of costs of inflation, but there is not empirical or theoretical consensus about the relationship between inflation uncertainty and budget deficiency. The study has attempted to assess the impact of inflation uncertainty on budget deficit in Iran over the past 43 years through ARDL approach. The paper also made use of ARCH and GARCH model in the test of inflation rate volatility in Iran. Undoubtedly, governmental budget deficit has been considered in economic issues since last decade. Although economists have different viewpoints in this case, but most of them believe that budget deficit is harmful and probably it is dreadful. The results show that since an increase in inflation uncertainty reduces government revenues, it leads to budget deficiency. Also, the results from error correction model shows that the error correction coefficient is -0.62 and if the model diverge from its long run equilibrium, 62 percent of the error would disappear in each period.

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