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Fiscal Deficit and Inflation: Cointegration and Causality Analysis

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Abstract:
This study, using annual data covering the period 1980-81 to 2011-12, investigates the long run relationship and causal link between fiscal deficit and inflation in India. Study uses unit root tests along with Engel- Granger and Johansen co integration techniques to investigate presence of long run equilibrium between the two. Results showed that equilibrium condition is sensitive to econometric model chosen for analysis, while causality test established direction of causality from fiscal deficit to inflation only. Thus results are in support of monetarist approach which supports curtailment in deficits to control inflation. As such for over all macroeconomic stability involving controlled rise in prices, any monetary policy in isolation cannot be effective unless goals of fiscal policy are also brought in line with monetary policy targets.

Keywords*: Budget deficit, co integration, inflation, Public finance, government expenditures*

1. Introduction

Inflation beyond certain limits has always been a dreaded macroeconomic phenomenon. As such there has been a long standing interest, both in academia as well as policy making institutions, in analyzing the phenomenon of inflation. The oil price shocks of 1973-74 and 1979 had compelled nations like India to go for higher fiscal deficits so as to finance the increasing imports. These periods of higher fiscal deficits were associated with rising price levels also and since then, fiscal deficits have been regarded as an important determinant of inflation in India. The inflationary situation gathered momentum in early 1980s, assumed serious proportions in mid and late 1980s with economy reeling under double digit inflation. Pertinently this decade was also a decade of heavy government expenditures resulting in larger deficits. Although inflation reduced to single digit and was reined in for some time during 1990s under the new economic policy, the prices of consumption goods continued to rise in last decade resulting in increased miseries for masses. The concomitancy of mounting fiscal deficits and rising inflation is so close and corresponding that cause and effect relationship between the two can not be ignored. This study purports to probe into pros and cons of any such relationship by resorting to empirical analysis of time series data, pertaining to Indian economy.

2. Background Theory

Literature in context of relationship between deficits and inflation is suggests various mechanisms whereby fiscal deficits and inflation influence each other. The origin of this relationship is found in the quantity theory of money as postulated by classical economists. In the basic formulation of Irving Fisher if there are n commodities in the economy and given that price of each commodity is p_i for the ith commodity and quantity sold of commodity is Q_i then we can have

$$P_1Q_1 + P_2Q_2 + P_3Q_3 \ldots\ldots\ldots + P_nQ_n = \ldots\ldots\ldots\ldots (01)$$

P and Q are the indices for price and quantity of goods and as such total monetary expenditure of the goods will be given by PQ. If M is the total money stock in economy then in the process of exchange of these goods the average turnover i.e. , velocity (V) of the money will be given by

$$V = \frac{PQ}{M} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Or $$MV = PQ \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Equation (3) represents the standard form of Fisher's equation of exchange. This is based on two important assumptions;

- economy is operating at full employment
- the velocity of circulation is constant in the short run .

In symbolic terms

$$M\overline{V} = P\overline{Q} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

So M is directly related to p. If M changes P will also change by the same proportion .The policy implication of this is that if government increases money supply, price will also increase and real money balances held by the public will not actually increase. Treating V and Q as constants equation (4) can be written as;

$$P = KM \qquad \text{Where } K = {}^{V}/_{Q} \text{ is constant.}$$

A change in money supply will result into the same change in price level. It is for this reason that classical economists regarded money supply as main cause for inflation.
Taking total differential of equation 3 we have

$$M\partial V + V\partial M = P\partial Q + Q\partial P \ldots\ldots\ldots\ldots\ldots (5)$$

Again treating Q and V as constants we have

$$V\partial M = Q\partial P$$

Or $$\frac{\partial P}{\partial M} = \frac{V}{Q} \qquad \ldots\ldots\ldots (6)$$

Elasticity of price with respect to money supply (e_m^p) will be given by

$$e_m^p = \frac{\partial P}{\partial M}\{\frac{M}{P}\} \qquad \ldots\ldots\ldots\ldots (7)$$

$$e_m^p = \frac{V}{Q}\frac{M}{P} \qquad \ldots\ldots\ldots\ldots\ldots (8)$$

Using equation 2 in 7 we have

$$e_m^p = 1 \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

It implies that proportionate change in price level will be equal to proportionate change in money supply. This idea was popularized by monetarists who argued that problem of rising prices is due to widening government deficits, which result in increasing money supply, which in turn causes inflation. The government deficits financed by sales of bonds exert upward pressure on interest rates. Since monetary authorities usually conduct monetary policies by controlling interest rates rather than money supply, they have to increase money supply to stabilize the interest rate. Thus government deficits lead to increase in inflation via increase in money supply. Friedman (1968), the leading monetarist argued that monetary authorities can control the inflation rate, especially in the long run, by controlling the money supply. Deficits can lead to inflation if economy is operating at full employment level, but only to the extent that they are monetized. Thus, money financed deficits are inflationary; bond financed deficits need not to be so. Miller (1983), however presented a different explanation whereby he asserted that government deficits are generally inflationary in nature, irrespective of whether the deficits are monetized or not. It is possible through private monetization or crowding out; non-monetized deficits lead to higher interest rates. Higher interest rates would crowd out private investment and reduce the growth rate of real output with given money supply, resulting in higher price levels. In case interest rates are pegged or stable then bond financed deficits call for expansion of money supply that would again lead to inflationary pressures. Sargent and Wallace(1981) have supported the proposition that central bank will be obliged to monetize the deficits either now or in later periods. Such monetization results in increase in money supply and rate of inflation, at least in the long run. Further, they showed that if time paths of government spending and taxes are exogenous, bond financed deficits are non sustainable because it will push interest rates excessively high and central bank will eventually have to monetize the deficits. This will increase the money supply and inflation in the long run.
The above monetarist approaches focus on the role of deficits causing inflation in an economy. However, the relationship between the two may be other way around i.e., in some economies higher deficits may be due to higher inflation. This view was propounded by Olivera (1967).his argument was; government expenditure adjusts at faster rate to inflation due to governments desire to maintain real expenditure at the planned level and on the other hand, revenue collections lag behind. Thus inflation results in larger deficits which are financed by banking system, particularly the central bank of a country, leading to further increase in money supply and the price level.

3. Empirical Reviews

Since the nexus between government deficits and inflation is widely debated in economic literature many empirical attempts have been made in the economic literature to test the propositions of different economists in this context. This section will highlight some important research works in this regard covering different countries and different time periods. Barro (1978), using the data over the period between 1954 to 1970, tested the inter relationship between deficits, money supply and inflation for US economy and found that it is the government expenditure rather than government deficits that influenced monetary growth. Nikasen (1978) using data for US economy found that government deficits have significantly increased the level of federal spending but do not have any significant effect on the inflation rate operating either through growth rate of money or independent of it. Re-examining these findings Hamburger et al. (1981) concluded that growth rate of money supply strongly influenced by government expenditures rather than deficits. Mcmillin et al. (1982) tested the relationship between federal deficits and growth of money supply in US for two different time periods i.e. from 1961-74and 1961-78. Applying the Hilderth-Lu technique, they found in neither period was money supply significantly influenced by budget deficits.

In contrast to the above results, Darrt (1985) examined empirically the link between deficits and inflation in US during the post 1960s period. The estimation results, using OLS technique, suggested that both monetary growth and federal deficits significantly influenced inflation during 1960s and 1970s.in addition he found that federal deficits bore a stronger and more reliable relationship to inflation than monetary growth. Darrat (2000) utilized an Error Correction Model (ECM) to investigate if high budget deficits have any inflationary consequence in Greece. He found that deficit variable exerts a positive and statistically significant impact upon inflation in Greece. Giannares and Kolluri (1985) examined the monetarist proposition in the context of ten industrialized countries. The study found evidence of direct and indirect effects of budget deficits on inflation only in case of US economy. Sarma (1982) examined the inter relationship among inflation deficits and money supply. Using structural equation model the study found government expenditure adjusts at a faster rather than government revenue to inflation leading to higher budget deficits and as a consequence increasing money supply and price level. Rangarajan and Arif (1990) verified the relationship among money supply output and prices in Indian context. The empirical results show that price effect of increase in money supply is stronger than output effect. Further, they found that government revenues do not keep pace with expenditures, as nominal income increases; this widens the resource gap and hence influences the prices. Besides these enlisted studies that point towards uni-directional causality from deficits to inflation, there are studies that empirically confirm bi directional causality for these two variables .These include Aghevli and khan (1978); Ahking and miller (1985); Hondroyiannis and Papapetrous (1997) and some other studies also. Furthermore, Blejer and Khan (1984) confirmed two way causation between fiscal deficits and inflation and noted that fiscal deficits whether financed from borrowing from public or banking system are necessarily inflationary in character. From the empirical results presented above it is clear that there is no consensus on the causality and mechanism (if relationship exists between the two) whereby higher deficits lead to inflationary pressures.

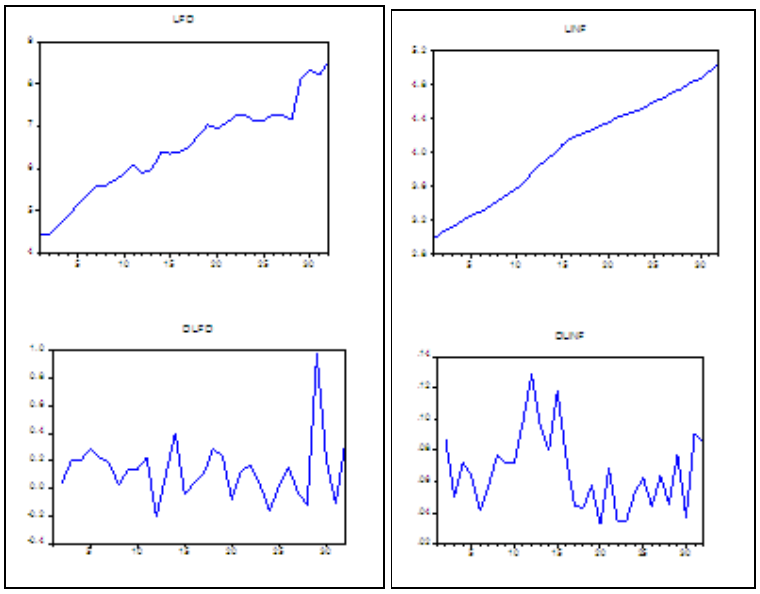
4. Empirical Analysis

4.1. Data

The two variables under consideration are fiscal deficit and inflation. For inflation measurement we have taken WPI index with 2004-05 as common base period for the data ranging from 1980-81 to 2011-12. Data for both the variables was taken from Handbook of Statistics on Indian Economy (RBI Publication). Data splicing was used for having common base period in case of WPI values before taking their logarithm. Data for deficits is also taken in logarithm form and original figures were in crore rupees as unit.

4..2. Unit Root Test

As a first step in time series data analysis both the variables were checked for their stationarity using Augmented Dicky Fuller (ADF) test. The actual behaviour of variables is presented in graphs below while the results of test are presented in tables (01 & 02):



LFD: fiscal deficit in log form
LINF: WPI index in log form

DlFD: first difference of LFD
DLINF: first difference of LINF

Fiscal deficit (Level)			Inflation (Level)		
Model	**t-statistic**	**P-value**	**Model**	**t- statistic**	**P-value**
With intercept	-0.4955	0.871	With intercept	-1.2703	0.6304
With intercept and trend	-2.7442	0.227	With intercept and trend	-2.8988	0.1783

Table 1

Fiscal deficit (first difference)			Inflation (first difference)		
Model	**t-statistic**	**P-value**	**Model**	**t- statistic**	**P-value**
With intercept	-5.3699	0.0001	With intercept	-3.457	0.0166
With intercept and trend	-5.550	0.0005	With intercept and trend	-3.378	0.0534

Table 2

From the results of test it is clear that both the variables are non stationary in their level forms while both turn stationary at their first difference, although significance level will have to be considered slightly higher than 5% in case of inflation. Thus both are of I(1) i.e., integrated of order one.

4.3. Co integration Analysis

The results of Unit root test show that all the variables follow random walk process. However it does not imply that in the long run variables could not show convergence i.e., long run equilibrium. To carry out an analysis for such a possibility we go for co integration analysis between fiscal deficits and inflation as represented by whole sale price index. For this we apply following two econometric techniques.

4.3.1. Engel Granger Test

We take residuals from following two equations

$$LFD = \alpha + \beta(LINF) + U1 \quad \ldots\ldots\ldots\ldots\ldots (10)$$

$$LINF = \alpha + \beta(LFD) + U2 \quad \ldots\ldots\ldots\ldots\ldots (11)$$

On applying the Engel Granger test upon U1 and U2 which involves the following two regressions

$\Delta U1_t = \rho U1_{t-1}$ ..... (12)

$\Delta U2_t = \rho U2_{t-1}$ ..... (13)

The results of these two regressions are presented in Table (3)

Variable	t- statistic	P value	Result
U1	-2.664022	0.0095	stationary
U2	-2.601142	0.011	Stationary

Table 3

From table it is clear that both the residuals are stationary which implies presence of a long run equilibrium relationship between two variables, as suggested by this test.

4.3.2. Johansen's Maximum Likelihood Co-integration test

In order to reaffirm our results we apply more advanced technique of co integration analysis as suggested by Johansen (1988) and Johansen and Juselius(1990).Since this technique is based on VAR analysis ,as a first step we select the lag length for VAR involving LFD and LINF as two variables.

No. of lags	0	1	2	3
AIC value	-4.606330	-4.571528	-4.642684*	-4.491436

Table 4

Based upon AIC criteria we take number of lags to be equal to 2.Next this test involves the estimation of following VAR so as to find out the values of two statistic suggested by this test.

$$Z_t = A_1 Z_{t-1} + A_2 Z_{t-2} + \ldots\ldots + A_k Z_{t-k} + \mu_t \quad \ldots\ldots\ldots (14)$$

Where $Z_t = [LFD_t \quad LINF_t]'$ is a vector of two variables, which can be compared to single equation dynamic model for two variables with K lags.

Equation (14) in Vector Error Correction form can be written as

$$\Delta Z_t = B_1 \Delta Z_{t-1} + B_2 \Delta Z_{t-2} + \ldots\ldots + B_{k-1} \Delta Z_{t-k-1} + \pi Z_{t-1} + \mu_t \quad \ldots. (15)$$

Where $B_i = [I - A_1 - A_2 - \ldots\ldots - A_k]$, (i= 1, 2,…, k-1)

And $\pi = [I - A_1 - A_2 - \ldots\ldots - A_k]$.

Since we assume here two variables only π will be a 2×2 matrix which contains information regarding the long run relationship. In fact $\pi = \alpha\beta'$, where α will include speed of adjustment to equilibrium while β' will be long run matrix of coefficients .This test furnishes two statistics for determining the number of cointegrating relationships , and both involve estimation of Eigen values and rank of matrix π.The results of two tests statistics with different model selections are presented in tables (05,06,07)

Model: A

Intercept (no trend) in CE ,no intercept no trend in VAR

Rank Test (Trace)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None	0.238867	9.953038	20.26184	0.6445
At most 1	0.079206	2.310535	9.164546	0.7154

(Maximum Eigen value)

Hypothesized No. of CE(s)	Eigen value	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.238867	7.642502	15.89210	0.5909
At most 1	0.079206	2.310535	9.164546	0.7154

Model B:
Intercept in CE and VAR, no trend in CE and VAR

Rank Test (Trace)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None	0.165663	5.456324	15.49471	0.7586
At most 1	0.007007	0.203908	3.841466	0.6516

(Maximum Eigen value)

Hypothesized No. of CE(s)	Eigen value	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.165663	5.252417	14.26460	0.7097
At most 1	0.007007	0.203908	3.841466	0.6516

Model C
Intercept in CE and VAR, Linear trend in CE, no trend in VAR

Rank Test (Trace)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None	0.204667	11.21967	25.87211	0.8624
At most 1	0.146057	4.578838	12.51798	0.6575

Rank Test (Maximum Eigen value)

Hypothesized No. of CE(s)	Eigen value	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.204667	6.640829	19.38704	0.9235
At most 1	0.146057	4.578838	12.51798	0.6575

From above analysis it is clear that all the models accept the null hypothesis of no co integration i.e., no. of co integration equations established is zero implying thereby that two variables do not move towards any long run equilibrium. Same trend is followed by both Trace and maximum eigen value statistic as such we conclude absence of any long run co integration equation between two.

5. Bi-Variate Causality Test

Since co integration analysis provided mixed results we could not clearly infer about the long run relationship between two. Still, we would like to know if there exists any causality relationship between two variables. For this we use granger causality test. The rough idea behind this test is that time does not move backward, i.e., if event A happens before event B then this ere is possibility that B is causing A. The econometrician Edward Leaner prefers the term Precedence to causality of this nature while Francis Diebold prefers to call it predictive causality. For, applying this test, variables should be stationary. since variables under consideration are non stationary we apply the test upon their first differences to make the necessary inferences. The results of Granger causality test are presented in table (8):

Table results reveal that null hypothesis of non co integration could not be rejected in first case while it could be rejected in second case. This implies that fiscal deficits granger cause inflation and for reverse causation we do not have sufficient evidence.

6. Conclusion

This paper, using annual data for fiscal deficit and inflation for period between 1980-81 to 2011-12 of India economy, gauges the long run relationship between two variables that are of utmost importance for macroeconomic stability. Results of the study revealed that equilibrium relationship is sensitive towards model specification used for equilibrium analysis. While Engel-Granger co integration test supports long run relationship between two, causality test establishes direction of causality from fiscal deficits to inflation in Indian context. Thus, results are in favour of monetarist approach which prescribes control over deficits for stabilizing price levels. Results suggest that although, execution of monetary policy may be determined by central bank, stability of prices and overall macroeconomic environment will heavily be dependent on the fiscal decisions made by the government. In order to control prices government should cut the size of budget after due examination of inflationary impacts of various expenditures.

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