An Augmented Taylor rule for India's Monetary Policy: Does Governor Regime Matters?

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Abstract

This paper examined the monetary policy stance in India during the governors' regime of Jalan- Reddy-Subbarao- Rajan. An Augmented Taylor Rule is employed to estimate monetary policy response for each period using monthly data. The results revealed that the governor regime matters in the monetary policy response. When output gap has been an important concern during Jalan, Subbarao and Rajan's period, inflation remained a major concern for Reddy and Rajan's regime. Interestingly, the interest rate is highly responsive to changes in exchange rate during Rajan period. These findings are consistent with the conditions of economy during those periods. In addition, the exchange rate and output gap remained a greater concern for policy maker in post-crisis period. Nevertheless, we find policy inertia during all regimes.

*Key Words:*Monetary policy, Taylor's rule, Inflation, Output gap, Hodrick-Prescott filter.

*JEL Classifications:*C21, C82, E52, E43, P24, P44

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1. Introduction

An important aspect of any central bank's policy is to design an optimal policy framework that would take care of different macroeconomic objectives. In a pioneering work, Taylor (1993) proposed a policy rule for setting bench-mark policy rates in the monetary policy. This thumb rule shows how that central bank revises theirs policy rates to different macroeconomic conditions of an economy. Since then numerous literaturehave focused on Taylor rule for the assessment of policy behaviour of central banks (Clarida et al., 2000; Sauer and Sturm, 2003; Hutchison et al., 2010;Kahn, 2012; Beju and Ciupac-Ulici, 2015; Sheel, 2015;Roeskelley, 2016). There are some advantages of following a rule type policy such as avoiding time-inconsistency problems arising from discretion policy and achieving lower uncertainty through greater transparency. Sheel (2015) advocated that the RBI's monetary stance should be evaluated through Taylor rule. During the late 1990s, the broad objective of India's monetary policy had been to achieve price stability with economic growth (Rangarajan, 2001). But as time passes several developments in macroeconomics emerges as a challenge for the monetary authorities at RBI. In an important note, Mohan (2006)documented that the RBI follows a rebalancing approach between growth and inflation to accommodate various macroeconomic and financial conditions. Later, then governor Reddy (2007) argued that the RBI's priority for monetary policy should be financial stability instead of price stability. He made clear in his statement that policy response may prefer financial stability over other priories if the circumstances so warranted.However, in Rajan'speriod, priories remained more on achieving sustainable growth. He argued that

maintain price stability can foster sustainable economic growth in long run. For this reason, he was criticized for by some bankers and politicians. All this indicates that each governor has a different opinion regarding monetary policy priorities of RBI. So, the monetary policy concerns might differ from one to another. Thus, the macroeconometric models should not be tested only during the time period included in the study but also it should be tested for the different governors' regime.

In this lieu, there is a necessity for anempirical study to reveal whether policy rate is responsive to output, inflation and exchange rate in India during different governors' period. We useExchange rate augmented rule (Taylor, 2001) to empirically evaluate India's monetary policy response during different governs periods[1].The study explicitly tries to observe any such significant changes that have happened in the policy priorities. By analysing Taylor rule for each regime we can measure the performances of one governor relative to its successor.

The remainder of this article is framed as follows. Section 2 discusses the review of literature both in the perspective of Theoretical and Empirical. Section 3 includes methodology.Section 4 explains the data. Section 5 discusses the results. Section5 concludethe study.

2. Review of Literature

2.1 Theoretical Framework

The relationship between money and price (i.e. inflation) can be traced back to the classical thought in terms of Quantity Theory of Money (QTM). The quantity theory of money reveals direct and proportional relationship between money supply and price level. This assumes that the velocity of money is stable in the short run. While output is defined as unchanged,

[1]**B Jalan** (1997m11 to 2003m08), Y.V. **Reddy** (2003m09 to 2008m08), **DSubbarao**(2008m0 to 2013m01),**RRajan** (2013m09 to 2015m05),

because classical economists believed that full employment prevails in an economy. However, full employment may be diluted for the short term but in the long term it will restore though wage-price flexibility. Monetary policy has least role for economic activity rather it causes only inflation that is commonly known as “Classical Dichotomy”(Froyen, 2012). On the contrary, J.M. Keynes (1937) argued that money can influence output through the interest rate. His analysis demonstrated that investment activity can be stimulating though reducing interest rate. Interest rate declines when money supply increases through state action. However, money is neutral in the liquidity trap. Furthermore, monetarist school of thought led by Milton Friedman argued that monetary policy has a greater role in an economy rather than fiscal activity. According to him varying nature of money supply can restore equilibrium and have advocated rule based money growth rather than 'discretionary' practice’. The central idea of monetarism was to establish money neutrality without ignoring the money influence to output in the long run (Friedman and Schwartz, 2008).

Establishing the relationship between exchange rate and monetary policy Mundel and Fleming argued that under floating exchange rate system expansionary monetary policy causes depreciation of exchange rate, a decline in rate of interest, increase in income and increase current account balance. However, money supply has no long-run impact on macroeconomic variable under a pegged exchange rate system (Mundell, 1960: Fleming, 1962).

2.2 Empirical Literature

During the 1990s, the empirical relationship between output, inflation, exchange rate and the interest rate took forward by John B Taylor. His rule is commonly known as Taylor’s type rule. Instead of using output and inflation as the determinant of setting interest rate, he argued output gap and inflation gap as the prominent factor for setting of interest rate(Taylor, 1993).

He made another contribution by introducing exchange rate as an important determinant for interest rate setting(Taylor, 2001). Since then, this rule has been tested by various researcher and also central banks. Wang &Handa (2007) used exchange rate augmented Taylor's Rule under the fixed exchange rate regime to estimate interest rate responsive function of China for the period 1993 to 2003. Their conclusion supports the hypothesis that Central Bank of China follows Taylor's Type rule for setting of interest rate assuming the aim of inflation targeting and output smoothing. Monetary reaction function for the UK (1985-2003) asserts the validity of Taylor's rule (Adam &Girardin, 2005). However, this rule has been showing valid position for the interest setting behaviour of several central banks. Hutchison et al., (2010) used exchange rate augmented Taylors rule for the Indian economy. They considered structural breaks and the data ranges from 1980Q1 to 2008Q4. Their result revealed that output gap is less responsive in earlier phases while it is more sensitive in later phases. Due to few studies and particularly after the global financial crisis era, this paper tries to re-examine interest rate setting for each governor period by assuming interest rate is determined on the changes in output, inflation and exchange in India.

3.METHODOLOGY AND DATA ISSUES

3. 1 Exchange Rate Augmented Taylor's Type Rule and its Representation through OLS Method

According Taylor, (2001) we have used output gap and inflation, exchange rate as independent variable.Theindex of industrial production and Wholesale Price Index represents as the proxy of output and inflation respectively. Ordinary Least Square method have used as the method of estimation.The original Specification of Taylor's Rule (1993) as follows:

$$i_t = \pi_t + r^* + 0.5(\pi_t - \pi^*) + 0.5(y_t) \dots\dots\dots\dots eq(1)$$

Taylor's(1993,2001) assumed as 0.5 coefficients of both inflation gap and output gap; however, in our study we estimated the coefficient using regression analysis. Therefore, we replace the equation one as follows:

$$IR_t = \alpha + \beta_1 \sum_{i=0}^{n} I_{t-i} + \beta_2 \sum_{i=0}^{n} IG_{t-i} + \beta_3 \sum_{i=0}^{n} ER_{t-i} + U_{i \ldots\ldots\ldots eq(2)}$$

Where

IR= Interest Rate (Repo rate)

I= Inflation

IG= Output gap(Y-Y*)

ER= Exchange rate (Exchange Rate Rupee to One Dollar)

From the specification it can be observed that the volatile nature of the actual output around the potential output, inflation, and exchange rate determines interest rate. If actual production is increasing over and above the potential output, the interest rate will rise to bring down output to its equilibrium path and vice versa. Similarly, at high inflation interest rate will be high and vice versa. The Null Hypothesis and Alternative Hypothesis of this study as follows:

H_0: $\beta_2 = 0, \beta_3 = 0, \beta_4$=0::$H_1$: $\beta_2 \neq 0, \beta_3 \neq 0, \beta_4 \neq 0$

We have presumed 10 percentlevel of significance at which null hypothesis can be disproved.

3.2 Data Sources and Variables

The study uses four macroeconomic variables starting from November, 1997 to May, 2015for four governor periods in India. They are Jalan (1997M11 to 2003M08), Reddy (2003M9 to 2008M8), Subbarao(2008m09 to 2013m01) and Rajan(2013m09 to 2015m05). Index of

Industrial production is used as a proxy for output growth. There are several measures of inflation in India; they are broadly divided into two categories, Consumer Price Index and Wholesale price Index. RBI is more active to the wholesale price index for past decades. Therefore, this study used WPI as the proxy variable for inflation.Call money rate is used as policy rate.Nominal Exchange Rate (Rupee/ U.S. Dollar) has used as exchange rate. The variables are collected from database on Indian economy, Reserve Bank of India.

3.3 Methodological Issues

Time series data generally suffers from stationarity problem. Augmented Dick-fuller(1979), Phillips-Perron (1988) test have been utilised to check stationary. We estimate coefficients by assuming interest rate is determined by output gap, inflation and exchange rate (Taylor, 2001). The output gap has calculated by subtracting actual output from its potential output. In India, there is no official measurement of potential output. But, Virmani(2004)estimated that unobserved component models and Hodrick-Prescott (HP) filter has less difference. Therefore,this study used HP filter to measure Potential Output. All variables areconsidered asgrowth rate of monthly data excluding interest rate.

4. Result and Discussion

Before estimating Taylor's rule it is necessary to check stationarity of the time series data. The resultsare reported in Table 1. The purpose of using different unit root test is to cross-validation of results. If a variable is stationary at level, there no need to go for first difference. Therefore, some cells of table 1 remains blank. For space being considered, we are not explaining each and every variable. However, if the P-value fall below level of mentioned level of significance, then the variable is said to be stationary.

Table 1 Unit Root results

Variables/Tests	ADF-Level	ADF-1st Differ	PP-Level	PP-1st Differ
1997m11 to 2003m08				
Interest rate	-4.28 (0.00)***	----	-6.15(0.00)***	----
Output Gap	-2.95(0.04)**	----	-5.25(0.00)***	----
Inflation	-4.04(0.00)***	----	-2.14(0.22)	----
Exchange Rate	-1.23(0.65)	-6.13(0.00)***	-1.18(0.67)	-6.06(0.00)***
2003m09 to 2008m08				
Interest rate	-3.49(0.01)***	----	-3.47(0.01)***	----
Output Gap	-1.77(0.38)	-15.76(0.00)***	-3.73(0.00)***	----
Inflation	-2.39(0.14)	-2.38(0.01)***	-1.20(0.66)	-6.33(0.00)***
Exchange Rate	-1.60(0.47)	-5.03(0.00)***	-1.03(0.73)	-5.06(0.00)***
2008m0 to 2013m01				
Interest rate	-1.49(0.53)	-4.99(0.00)***	-1.86(0.34)	-5.07(0.00)***
Output Gap	-2.80(0.06)*	----	-3.52(0.01)***	----
Inflation	-2.50(0.12)	-3.94(0.00)***	-2.21(0.20)	-4.04(0.00)***
Exchange Rate	-1.39(0.57)	-5.47(0.00)***	-0.75(0.82)	-5.20(0.00)***
2013m09 to 2015m05				
Interest rate	-5.24(0.00)***	----	-4.82(0.00)***	----
Output Gap	-3.55(0.01)***	----	-3.55(0.01)***	----
Inflation	0.59(0.98)	-3.36(0.02)**	0.47(0.98)	-3.36(0.02)**
Exchange Rate	-1.10(0.69)	-3.65(0.01)***	-1.18(0.65)	-3.67(0.01)***
1997m11 to 2015m05				
Interest rate	-5.45(0.00)***	----	-5.45(0.00)***	----
Output Gap	-2.24(0.19)	-23.90(0.00)***	-3.27(0.01)***	----
Inflation	-2.15(0.22)	-6.73(0.00)***	-4.40(0.00)***	----
Exchange Rate	-1.29(0.63)	-10.25(0.00)***	-0.62)0.86)	-10.33(0.00)***

Note: Parentheses represents P-value. ***, **, and * used for 10, 5, and 1 percent level of significance. Source: Authors' Calculations.

The estimated Taylor's rule for different regimes from B. Jalan to R. Rajan, Table 2. Initially, we examined the results for the period of Bimal Jalan (1997M11 to 2003M08). Prior objective of an open economy is to achieve faster growth. The estimated results show that monetary policy is moresensitivetowardschanges in output gap and couldbring the attention of the authority to revise the interest rate by 54 percent. It meansthe monetary authority wasmore responsive tochanges in output gap because the coefficient(0.54) is significant at 10percent level. This pro-growth oriented policy is evident from the history of key policy rates. If we look at the revision of repo rates during this regime, the major revisions favour

the rate easing over time. The repo rate has been revised downward around thirteen times to facilitate the growth of output.[2] Similarly, the Cash Reserve Ratio has been cut twelve times during this period.[3]However, this action by thethen governor has not resulted in highgrowth insteadthe growth rate has declined compared to the previous regime. The average growth rate was 5.38 which is a decline of 1.3 percent compared to the previous regime (Goyal, 2014). Unfortunately, the inflation rate was lower during that regime compared to Rangarajan period. Moreover, inertia is present in the policy decisions as the coefficient of lagged interest rate is statistically significant.

Interestingly, the coefficient of output gap is not a major concern during the Y V Reddy(2003M9 to 2008M8) regime. In this regime, primary focus has to achieve low and stable inflation rate.The coefficient of inflation is significant at 10 percent level, indicating that taming inflation was the major concernof thepolicy makers. This kind of behaviour can be found from the revision of key policy rates such as repo rates and Cash Reserve Ratio(CRR). Unlike Jalan regime, this period shows a major upward revision of key policy rates. The CRR has been hiked sixteen times and the repo rates in seven times throughout the Reddy regime.[4]However, the real GDP growth was 9 percent accompanied by 5.2 percent in inflation (Goyal, 2014). Further, the coefficientof lagged interest rate (0.53)is significant at one percent level revealing that the persistency in the policy decision continued in this regime.

[2]RBI, Database on Indian economy. 2016.http://dbie.rbi.org.in/DBIE/dbie.rbi?site=publications.
[3]RBI, Database on Indian economy. 2016. http://dbie.rbi.org.in/DBIE/dbie.rbi?site=publications.

[4]RBI, Database on Indian economy. 2016. http://dbie.rbi.org.in/DBIE/dbie.rbi?site=publications.

Table: 2 Estimates of Exchange Rate Augmented Taylor's Rule

Period → / Variable ↓	1997m11 to2003m08	2003m09 to2008m08	2008m09 to2013m01	2013m09 to2015m05	1997m11 to2015m05
Inflation	0.27(0.14)	0.20(**0.08**)	0.01(0.86)	0.08(**0.00**)	0.12(**0.06**)
Interest Rate	0.26(**0.06**)	0.53(**0.00**)	0.06(0.21)	0.19(**0.00**)	0.41(**0.00**)
Exchange Rate	0.92(0.31)	0.24(0.26)	0.15(**0.03**)	0.17(**0.07**)	0.30(0.16)
Output	0.54(**0.07**)	-0.01(0.75)	0.05(**0.00**)	-0.04(0.18)	0.02(0.79)
Constant	0.38(**0.06**)	1.71(**0.01**)	1.36(**0.10**)	9.98(**0.00**)	3.24(**0.00**)

Source: Authors' Calculations.

Surprisingly, most of the results differ during Subbarao(2008m09 to 2013m01)period compared to the previous two regimes. The result shows that the monetary authority has given more importance to growth rates as the coefficient of output gap is significant at 10 percent level. This action of central bank is evident from change in the key policy rates of RBI. The main key policy rates such as repo and CRR has been cut by eighteen and nine times respectively.[5] But not surprisingly, the coefficient of exchange rate is significant. This reflects that the exchange rate is also a major concern during this period. The global financial crisis might have changed the pattern of policy response. The need for exchange rate intervention can be justified in the light of two major crises, namely the global financial crisis and the euro zone crisis which took place during this period. The volatility in the exchange rate was also high, and reaches its highest level at 17.4 percent compared to any other periods (Praskash, 2012). Following a pro-growth strategy and controlling exchange rate volatility has reported an ugly figure during Dr.Subbarao period. Unlike previous regime, the real GDP

[5]RBI, Database on Indian economy. 2016. http://dbie.rbi.org.in/DBIE/dbie.rbi?site=publications.

has decelerated to 6.5 percent and the inflation rate has increased to 7.6 percent(Goyal, 2014). This is quite true to say that the crisis has disrupted the macroeconomic stability which in turn resulted in low growth and high inflation. This low growth was due to the low investment which in turn put pressure on the commodity prices (Mohanty, 2010).

Similarly, Taylor's rule has estimated for the R Rajan regime (2013m09 to 2015m05). The estimated result is in line with the recent activities of RBI. The low and stable inflation remained a majorconcern for Rajan. The coefficient of inflation is significant at 1 percent level indicating that the inflation remained the focal point of the policy decisions. GovernorRajan documented that by maintainingstable inflation rates; we can achieve a long-run growth and hence, could stop the further rise in inflation. The latter case is a second round effect which might arise due to low volatility and uncertainty in the inflation process. Interestingly, this action of the governor has produced some good results. The average growth rate has increased to7.1 percent during thisperiod with falling inflation.[6]Though it can't be avoided that the falling global oil price and improving food supply have led to low inflation. But it is noteworthy that the exchange rate concern has been increasing over time, particularly in Rajan period. The exchange rate coefficient is significant at the 1 percent level. It means, the response of interest rate has been stronger to the fluctuations of exchange rate. This implies that governor has givendue importance to the stability of rupee values. The high fluctuations in theexchange rate are due to multiple events such as export contractions, declining crude oil price, FIIs sell off mode, etc. It might be argued that the policy makers now have felt the essence of exchange rate risk along with other macroeconomic objectives.

In addition to different governor's regime, the study also estimated for the full sample period, and found a fascinating result. Only Inflation and lagged interest rate are found to be

[66]RBI, Database on Indian economy. 2016.http://dbie.rbi.org.in/DBIE/dbie.rbi?site=publications.

significant. This implies that the monetary policy has been targeting inflation. Further, the inertia in the policy decisions remained present for the entire period. Therefore, our findings are not with the Hutchison et al. (2010) who argue that the conduct of monetary policy has moved forward to less inertia. Their argument was that, there is no inertia from 1998 to 2008, but our findings suggested that there is presence of inertia.

5. Conclusion

This study empirically tested Augmented Taylor's rule (2001) to capture the interest rate response to output, inflation and exchange rate using Ordinary Least Square, and we documented that as the regimes pass from one period to other, the behaviour of Taylors rule passively explains monetary policy for India. The sample period is considered from 1997 to 2015. The full sample is divided according to the different governs regime. The results reveal that when output gap has been an important concern during Jalan, Subbarao and Rajan's period, inflation remained a major concern for Reddy and Rajan's regime. The interest rate is highly responsive to changes in exchange rate during Rajan period. These findings are consistent with given the conditions of the economy during respective period. In addition, exchange rate, output, and inflation remained a greater concern for the policy maker during full sample period. Nevertheless, we find policy inertia during all regimes except 2008-13 period. Therefore, this study concluded exchange rate augmented Taylors rule is passively explained India's policy. Furthermore, we also documented that Taylors rule exhibit highly with significant monetary policy inertia and not consistent to Hutchison et al. (2010), who noted that less inertia persists after 1998, when none in fact exists. Since India's Monetary Policy is conducted in a discretionary manner and with less transparency, this study will provide insights to the policymaker for conducting the future policy.

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