Econometric Analysis of Influence of Monetary Policy on Macroeconomic Aggregates in Indian Economy

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Abstract. This study attempts to examine the relationship between macroeconomic indicators of India and its monetary policy over the period 1980 to 2017. The paper studies the correlation between GDP, Balance of Payments, Inflation, Balance budget, Public and such independent variables as international reserves, money and quasi money, interest rate and reserve ratio with the help the linear regression using OLS and ANOVA test in Excel. From the analysis, it is clear that GDP, Public Debt and Inflation have the strongest dependence and significance in relation to monetary indicators.

1. Introduction

Nowadays India is a dynamically developing country, with strikingly high industry, labor resources and diverse mineral raw material resources, hugely progressing scientific and ethical potential, rapidly growing service sector, which includes finances, banking and IT. India is among the leaders of Top-10 countries, with best indicators of industrial and agricultural development. The economy is versatile and composed of agriculture, crafts, manufacturing industry and textile.

Despite the fact, that two thirds of labor force is still employed directly or indirectly in agricultural business, the service sector expands at a fast pace and its role in Indian economy grows every year. India is also the main exporter of highly qualified personnel in IT, financial and programming spheres. Other branches, including heavy industry, pharmaceuticals, bio- and nanotechnology, telecommunications, construction, aviation industry and tourism also demonstrate high potential and rapid growth rates.

GDP growth of India has increased in 2014 to 7.3% from previous 6.9% and 5.1% the year before that. However, in 2016, GDP growth slowed and amounted to 7.1% (in compare with data for 2015, growth was 8%) [1]. As many developing countries, India aims high to increase its economic growth, keep inflation low, minimal public debt and other indicators of economic prosperity [2]. Therefore, the aim of the paper to study the influence of monetary policy on the growth of the Indian economy is important.

The paper is organized as follows. In Section 2, the methodology of creating of model will be given. The variables of the econometric model will be provided in Section 3. Then the data are modelled and analyzed in Section 4. In Section 5, we will draw a conclusion based on the analysis result.

2. Methodology of the model specification

In our work, we will use statistical methods of econometric modeling, which are based on four principles [3]. Using the first principle of the specification, we will include only linear equations in the
We will estimate the coefficients of the model by the method of least squares [4], which is based on minimizing the sum of the squares of the residues. Next, we will check the premises of the Gauss-Markov theorem and the adequacy of the estimated model.

We will suppose that the monetary policy has a direct influence on GDP and the equation is of linear type. Following the 1st principle, we consider Keynesian monetary theory [5], which implies correlation between Reserve requirement, Money supply, Interest rate, Investment and GDP \((X_i, i=1,\ldots,4)\) and we will add the statement of the Lucas’s theory [6]. We will be interested in the influence of the same set of monetary policy factors on various indicators of economic growth \((Y_j)\), so in general the model of econometric equations can be represented in the following general form:

\[
Y_j = \alpha_0 + \sum_{i=1}^{4} \alpha_i X_i + \varepsilon_j; \\
E(\varepsilon_j) = 0; \sigma^2(\varepsilon_j) = \text{const}
\]  

Where \(\varepsilon_j\) is disturbance term normally distributed with a zero mean and a constant variance; \(Y_j\) is a dependent variable; \(X_i\) – independent variable; \(\alpha_i\) – model coefficient; \(i = 1, \ldots,4\) – number of variable or coefficient; \(t\) – moment of time. There are no lag variables in our model.

3. Variables and Data

According to the approaches set forth in the Keynesian monetary theory, taking into account the statements of the Lucas’s theory and the criticisms outlined in the scientific works [7] and [8], we have chosen as the instruments of monetary policy the following independent variables:

**International reserves** – are any kind of reserve funds that can be passed between the central banks of different countries. International reserves are an acceptable form of payment between these banks. The reserves themselves can either be gold or else a specific currency, such as the dollar or euro.

**Money and quasi-money** – comprise the sum of currency outside banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government.

**Interest rate** – the proportion of a loan that is charged as interest to the borrower, typically expressed as an annual percentage of the loan outstanding.

**Requirement reserves ratio** – a central bank regulation employed by most, but not all, of the world's central banks, that sets the minimum amount of reserves that must be held by a commercial bank.

The **dependent variables** are described as follows:

**GDP** – real growth rate (%) – the real economic growth rate measures economic growth, in relation to gross domestic product (GDP), from one period to another, adjusted for inflation - in other words, expressed in real as opposed to nominal terms.

**Public debt** (percentage of GDP) – Debt-to-GDP ratio is the ratio between a country's government debt (a cumulative amount) and its gross domestic product (GDP) (measured in years). A low debt-to-GDP ratio indicates an economy that produces and sells goods and services sufficient to pay back debts without incurring further debt.

**Inflation rate** (Consumer Price Index, %) – measures changes in the price level of a market basket of consumer goods and services purchased by households. he annual percentage change in a CPI is used as a measure of inflation. A CPI can be used to index (i.e., adjust for the effect of inflation) the real value of wages, salaries, pensions, for regulating prices and for deflating monetary magnitudes to show changes in real values.

**Current account** – the record of all economic transactions between the residents of the country and the rest of the world in a particular period (over a quarter of a year or more commonly over a year). Individuals, firms and government bodies make these transactions. Thus, the balance of payments includes all external visible and non-visible transactions of a country.

**Budget balance** (percentage of GDP) – the difference between national government revenues and expenditures, expressed as a percent of GDP. A positive (+) number indicates that revenues exceeded expenditures (a budget surplus), while a negative (-) number indicates the reverse (a budget deficit).

Data, related to macroeconomic indicators changes, is extracted from World Bank and covers 1995-2017, with 2017 statistics not included in calculations and used for comparison with further obtained results.
4. Evaluating and Results
For evaluating of the model coefficients with the aim of establishing the level of dependency of GDP, Exchange rate and Growth rate, Public debt, Inflation rate, BoP on international reserves, such as money and quasi-money, interest rate and reserve ratio and for making appropriate tests, we have used linear regression analysis and additional functions in Excel [9].

After the indicators are calculated we need to obtain $F_{\text{crit}}$, which represents critical value is a point on the test distribution that is compared to the test statistic to determine whether to reject the null hypothesis. If the absolute value of your test statistic is greater than the critical value, you can declare statistical significance and reject the null hypothesis. To find critical value we apply function ‘F.INV.RT’ and indicate probability (5%) and degrees of freedom, which in our case correspond to residual and regression values of ANOVA test.

The value of the $R^2$ is used to determine how strong or weak the regression equation is. If $R^2$ value lies between 0.8 and 1, then we can conclude that the regression equation is strong. However, if the value of the $R^2$ lies between 0 and 0.5, then we can say that the regression equation is a weak one.

The value of the $F$ statistic is used to ascertain the overall significance of the GDP growth rate equation. We compare the value of the $F$ statistic with the value of the critical value of $F$ at a given significance level 5%. If the value of the $F$ statistic is greater than the value of the $F$ critical, then the overall equation is statistically significant.

The statistical significance of the parameters will be established. In testing for the statistical significance of the parameters, we use the $t$-test. It concludes that for a parameter to be statistically significant, the absolute value of the $t$-statistic should be greater than or equal to two. Using the $t$-test, the $t$-critical value is compared with the $t$-statistic at a given significance level (1%). If the $t$-statistic is greater than the $t$-critical value, then, the parameter in question is statistically significant. If otherwise, then, the parameter is not statistically significant.

The coefficients and the intercepts of independent variables are be obtained by using the ordinary least squares estimation technique. As a result of the evaluation we received the following models.

4.1. GDP - real growth rate (%) model

\[
\begin{align*}
\hat{y}_{t+1} &= 6.10 + 0.018 \cdot \text{ir} - 0.09 \cdot M2 - 0.31 \cdot i + 0.48 \cdot \text{rr} \\
R^2 &= 0.42; F = 2.6; F_{\text{crit}} = 3.1
\end{align*}
\]

(2)

Where

$\hat{y}_t$ – estimated value of the real growth rate of Gross Domestic Product, (% to the previous period);
ir – international reserves (bln. USD);
$M2$ – money and quasi money (bln. USD);
i – interest rate (%);
$rr$ – reserve ratio (%).

From the regression results one may conclude, that if the value of all the variables $ir, i, rr, M2$ will be zero, then the GDP growth rate is 6.10, meaning that other variables also influence on the GDP growth rate. This is in complete agreement with the actually observed values of the growth rate of GDP. Actual GDP growth rate for 2016 was 7.1%.

Coefficients, attributed to International Reserves ($ir$) and Reserves Ratio ($rr$) are positive. This means that increasing the International Reserves on one bln. USD will cause GDP growth rate to increase only by 0.018% and 1% increase in Reserves Ratio will cause GDP growth rate to increase by 0.48%.

Coefficients, attributed to Money Aggregate and Inflation are negative, which means the otherwise relation with increase of them values and corresponding effect on GDP.

The value of the constant term and the slope coefficient under International Reserves and Money Aggregate are statistically significant. However, from the regression results of $t$-test the constants under $i$ and $rr$ are statistically insignificant (Tab.1.). Furthermore, according to the $R^2$ test obtained from the regression analysis, we may conclude, that the value 0.42 means that about 42% of the total variation in the GDP growth rate is attributed to independent variables of the equation. It is statistically insignificant since $F < F_{\text{crit}}$. This means that there are other factors that can better explain the GDP growth rate of India.
4.2. Public debt (% of GDP) model

\[
\hat{\text{Debt}} = 57.06 + 0.10 \cdot \text{ir} - 0.53 \cdot \text{M2} + 1.75 \cdot i + 0.71 \cdot \text{rr} \\
R^2 = 0.67; F = 7.15; F_{\text{crit}} = 3.1
\]  
(6)

Where

\( \hat{\text{Debt}} \) – estimated value of Public debt, (percentage of GDP)

We may see that about 67% of the total variation in Public debt of India is attributed to independent variables of the equation. It is statistically significant. Dependency of Public Debt is relatively high on independent variables.

The slope coefficients \( \text{ir}, \text{i}, \text{rr} \) are positive. Important dependence: a 1% increase in interest rate leads to 1.75% increase in Public Debt.

Coefficient of \( \text{M2} \) is negative, which shows a logical reduction in debt when the money supply increases. Factors \( \text{M2}, \text{i}, \text{ir} \) are significant and \( \text{rr} \) is insignificant.

If all \( \text{ir}, \text{i}, \text{rr}, \text{M2} \) are zero, then Public Debt (% of GDP) is 57.06%. The value of the constant term is statistically significant since its t-statistic is greater than 1.7.

4.3. Inflation rate (consumer prices) (%) model

\[
\hat{\text{Infl}} = 1.61 + 0.00093 \cdot \text{ir} + 0.06 \cdot \text{M2} + 0.038 \cdot i + 0.36 \cdot \text{rr}  \\
R^2 = 0.64; F = 6.39; F_{\text{crit}} = 3.1
\]  
(7)

Where

\( \hat{\text{Infl}} \) – estimated value of Consumer Price Index, (%)

We may see that 64% of the total variation in Inflation rate of India is attributed to independent variables of the equation. It is statistically significant since \( F > F_{\text{crit}} \). Linear equation is relatively strong. However, all the Coefficients are insignificant. This means that for the study of inflation within the framework of this model it is necessary to select other factors

4.4. BoP current account (% of GDP) model

\[
\hat{\text{BoP}} = -3.44 - 0.013 \cdot \text{ir} + 0.021 \cdot \text{M2} + 0.21 \cdot i + 0.35 \cdot \text{rr}  \\
R^2 = 0.59; F = 5.07; F_{\text{crit}} = 3.1
\]  
(8)

Where

\( \hat{\text{BoP}} \) – estimated value of Current account.

59% of the total variation in Balance of Payments of India is attributed to independent variables of the equation. It is statistically significant since \( F > F_{\text{crit}} \). Equation’s relationship is medium. Coefficients \( \text{M2}, \text{i}, \text{rr} \) are positive. In the equation there is only one significant factor, this is International Reserves (ir). The negative coefficient under \( \text{ir} \) shows that increasing it by one bln. USD leads to a decrease BoP by 0.013 mln. USD, which is in complete agreement with the real data.

5. T-test

The critical value of Student's statistics for significance level 0.1 and \( df = 20 \) is 1.72 (\( t_{\text{crit}} = 1.72 \)). As we can see from the table 1, several of intercept and the slope coefficients are less than \( t_{\text{crit}} \). This means that the corresponding variables are insignificant and do not influence on macroeconomic indicators of Indian economy is weak.

|        | \( Y_1 \) | Debt | Infl | BoP  | Budg |
|--------|-----------|------|------|------|------|
| \text{Intercept} | 1.70      | 3.70 | 0.39 | -1.32| -3.45|
| \text{ir}      | 1.74      | 2.22 | 0.07 | -1.78| -0.01|
| \text{M2}      | -2.41     | -3.30| 1.50 | 0.78 | 0.02 |
| \text{i}       | -1.38     | 1.76 | 0.14 | 1.30 | 0.22 |
| \text{rr}      | 0.81      | 0.28 | 0.53 | 0.82 | 0.36 |
In general, all the constricted models are completely relevant in economic terms and is important in economic investigations.

6. Conclusion

The research presented in this article made it possible to identify the impact of monetary policy factors on the macroeconomic indicators of the Indian economy. From our analysis, we strongly conclude that there is a positive strong dependence between GDP and Money and Quasi-money. At the same time, there is no great dependence between Public debt and interest rate. Inflation rate is just indifferent to international reserves. Current account does not depend on monetary policy nearly at all. What is more, strong significance between GDP and money supply has been proved, which indicates high sensibility of living costs and monetary indicators, in particular M2 and International reserves. On the other hand, GDP growth rate seems to be completely unrelated, as it under conditions of non-existence of monetary indicators, is just a 1% difference from actual growth rate of 2017. Hence, in terms of desirable increase in growth of GDP in India, policies should be concentrated on money supply and cash equivalents as well banking sphere as they strongly affect PPP. Furthermore, focus on retaining interest rate should also be considered as it greatly affects Public Debt. These conclusions might only be applicable in the short-term as more data and research are need to prove its sustainability in the long-run, which might imply monetary policy effectiveness only temporarily and a need to implement fiscal policy further.

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