Impact of macroeconomic factors on inflation: An assessment on Indian economy by using vector auto-regressive modeling

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A B S T R A C T

Inflation is the sustained rise in prices of commodities. Central Banks have the critical responsibility of ensuring price stability; however, every attempt should be made to ensure that price stability should not hit economic growth. Thus, it becomes imperative for Central Banks to determine the key fiscal and monetary factors that have greatest impact on domestic price levels. Based on these factors, it can tackle the problem of inflation effectively and efficiently. Further, there are several global price indices and factors that need to be factored in while tackling problem of inflation. The objective of the current study is to empirically determine the macroeconomic factors that play a significant role in influencing inflation in India. The study considers international food and oil price indices amongst other macroeconomic variables such as fiscal deficit, index of industrial production, exchange rate, MIBOR, and money supply in order to explain inflation. Monthly data for each of the above variables was collected for the research period 2000-10. The study is based on Vector Auto-Regressive modeling. The Augmented Dickey-Fuller Unit Root Test was performed to test for stationarity of all of the time series data. The results of the Granger causality tests indicate that fiscal indicators such as fiscal deficit and international factors such as international food and oil price indices play a significant role in influencing inflation. The research outcomes conform to the results of several earlier studies.

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A R T I C L E I N F O

Article history:
Submitted:
June, 2016
Re-edited:
December, 2020
Keywords:
Inflation, fiscal and monetary factors, macroeconomic factors, vector autoregressive modeling, Granger causality test
JEL Classification:
E31, E63

Introduction

Inflation is a highly controversial economic concept which has seen many modifications ever since it was first defined by neoclassical economists. For them inflation is a monetary phenomenon: prices of commodities tend to increase only because of increase in money supply. For example, Friedman (1968) asserted that inflation as always and everywhere a monetary phenomenon and could occur only by a more rapid increase in the quantity of money than output. Keynes (1936) had earlier disputed such an argument by negating the fundamental neoclassical assumption of full employment. He argued of the existence of underemployment in the economy, so that an increase in money supply would lead to an increase in aggregate demand, which in turn would lead to an increase in output and consequently employment. There are several different theories explaining inflation, such as cost-push theory of inflation (Batten, 1981), demand-pull theory of inflation (Barth and Bennett, 1975), and demand-shift theory of inflation (Schultze, 1959). According to cost-push theory, inflation results basically when the increase in money wages is more rapid than the increase in productivity of the workers. Commodity prices are increased to account for the rise in cost of production. Wages are further raised to factor in the rise in cost of living. Thus prices rise because of the continuation of wage-cost spiral. Demand pull theory of inflation is a traditional explanation of rise in prices. It takes place when aggregate demand is high, while the supply of goods is less. Goods are in short supply either because resources are fully utilized or production cannot be increased rapidly to meet the increasing demand. “Too much money chasing too few goods” defines demand pull theory of inflation.

Schultze (1959) pointed out that prices and wages are flexible upward in response to excess demand but they are rigid downward. Inflation or rise in prices shift from high demand industries to lower demand industries because of the downward rigidity of prices. Wages will be bid up in excess demand industries and the wages in demand deficient industries will follow the rising trend. The above theories cite many reasons for price rise. Now there is a general acceptance that the inflation is not just a monetary phenomenon.
but fiscal factors also contribute in rise in commodity prices. Thus tackling inflation requires an appropriate mix of monetary and fiscal policies.

India has been experiencing significantly high levels of inflation in the aftermath of the global financial crisis of 2007-08. This may be partly due to the fiscal and monetary expansionary policies adopted by Government of India and Reserve Bank of India (RBI) during crisis, and partly due to reform measures such as the Sixth Central Pay Commission, high subsidy programs, social sector schemes such as the Mahatma Gandhi National Rural Employment Guarantee Act and Right to Education, and so on, which have resulted in a significant increase in disposable income. Though such expansionary policies helped India to overcome the threat of the global economic crisis, they may also have contributed to inflation. In response to the inflationary situation the RBI increased key policy rates several times, reaching the peak of the interest rate cycle. In the mid-quarter review announced in September 2012, the repo rate stood at 8%, and the cash reserve ratio was revised downward by 25 basis points to 4.5%.

Financial year 2011-12 started with a headline inflation of 9.7%, touching double digits in September 2011, and then coming down to 6.7% in January 2012. However, the headline WPI inflation remained at around 7%, while consumer price inflation was at nearly 10%. The high levels of food inflation in 2010-11 were due to increase in prices of cereals, vegetables, and sugar, while the main contributory factors in 2011-12 were milk, egg, meat, fish, and edible oils. Crude oil prices have also increased considerably, from US$69.76 per barrel in 2009-10 to US$85.09 per barrel in 2010-11, and to US$109.97 per barrel in 2011-12. Also, there has been considerably high inflation in several commodities globally, such as silver, cotton, groundnut oil, gold, and coal.

One of the key objectives of fiscal and monetary policies is stability in commodity prices. Several studies have examined the impact of fiscal and monetary factors on inflation, and a few studies have considered the impact of international macroeconomic factors such as oil prices and exchange rates on inflation. The present study considers a mix of all three categories of variables in studying inflation in India. The subsequent sections give a list of factors considered and the rationale behind selecting of those factors.

The remainder of the paper is divided as follows. The second section provides a review of some of the pertinent studies in this area, identifying certain areas which require further study. The third section explains the methodology adopted in the study. The fourth section analyzes the research outcomes. The fifth section concludes and makes certain recommendations based on the research findings.

**Literature Review**

Several studies have tried to understand, model, and forecast inflation. Several studies have also tried to determine the factors influencing inflation. Basu (2011) stressed the importance of a proper understanding of economic theories for addressing the menace of high inflation. Pattanaik and Nadhanael (2011) argued that high inflation impedes economic growth, and proposed an inflation threshold level of 6% in order to achieve sustainable growth. The monetarists argue that inflation is a monetary phenomenon, i.e. it can be controlled by controlling the money supply (Friedman, 1968). On the other hand, the structuralists argue that inflation arises out of certain structural impediments in the economy of developing countries. Increase in investments lead to increase in demand of consumer goods, and consequently leads to rise in prices because of inelastic supply (Keynes, 1936).

Fisher (1930) proposed a relation between nominal interest rate and rate of inflation; in perfectly functioning capital markets, the nominal rate of interest is the sum of the equilibrium real interest rate and the inflation rate. Along with so many divergent theories, the problem of measuring and forecasting inflation is complicated further because of statistical modeling errors (Cecchetti, 1996). Further, to simplify the task of measuring inflation, many analysts and Central Bankers focus on core inflation rather than overall or headline inflation, which is shown to be inappropriate (Bullard, 2011).

Understanding inflation requires multiple viewpoints. It is as much a fiscal phenomenon as it is a monetary phenomenon. With globalization and inter-connectedness of national economies with the international economy, several international factors also need to be considered while studying inflation. Many studies have used fiscal indicators to measure and forecast inflation. Catao and Terrones (2003) found a strong positive association of fiscal deficit with inflation. A similar study by Agha and Khan (2006) concurred with the research outcomes Catao and Terrones (2003) that fiscal sector is dominant in explaining price movements. Some studies in India have also examined the determinants of inflation. John (2003) analysed the impact of monetary aggregates and nominal effective exchange rates on price movements in India using vector auto-regressive (VAR) model and Granger causality tests, and found strong linkage of monetary aggregates and nominal effective exchange rates on inflation. Virmani (2003) used an Error Correction Model (ECM) to study inflation in India. Pattanaik (2010) used a co-integrated vector autoregressive model to study the determinants of inflation in India, and found a mix of demand and supply side factors to be significant. Khundrakpam and Pattanaik (2010) found a significant relationship between fiscal deficit and inflation, and they estimated that a 1% increase in fiscal deficit would lead to 0.6% increase in inflation. Kar (2010) analyzed seasonality of WPI inflation in India using autoregressive models. Singh (2012) provides a overview of inflation modeling in India.

**Research and Methodology**

The objective of the study is to analyse the impact of various macroeconomic factors influencing inflation in India. To this end, the study considers the following macroeconomic variables: fiscal deficit (FD), international food price index (FPI), international oil
price index (OPI), the Mumbai Inter-Bank Offer Rate (MIBOR), money supply measured by M3, index of industrial production (IIP), and exchange rate (USD/INR). Inflation is measured by percentage change in WPI.

The research period is 2000-10 (ten years). Monthly historical time series data of the above variables were collected for the purpose of this study from the official websites of Reserve Bank of India (RBI)\(^1\), Central Statistical Organization (CSO) in Ministry of Statistics and Program Implementation (MOSPI)\(^2\), and United Nations’ Food and Agriculture Organization (FAO)\(^3\) websites. The selection of the above macroeconomic factors was based on a number of reasons.

The primary determinants were obtained from literature review. Further, as highlighted in the India Development Report 2011 and the Economic Survey Report 2011-12, international prices are seen as impacting domestic inflation, specifically, high prices of certain commodities and crude oil in the international market has contributed to higher price levels in India; thus, international prices such as FPI and OPI were considered for the study. The inflation rates were calculated from the various indices such as FPI, OPI, and WPI were calculated using the usual formula: \(r_t = \frac{P_t - P_{t-1}}{P_{t-1}}\), where \(P_t\) is the index of the current month and \(P_{t-1}\) is the index value in the corresponding month previous year.

To test for stationarity of the macroeconomic variables, the augmented Dickey-Fuller unit root test was carried out, of the form \(\Delta r_t = \alpha + \beta t + \gamma r_{t-1} + \delta_1 \Delta r_{t-1} + \ldots + \delta_k \Delta r_{t-k}\), where \(\Delta\) is the first difference operator of the time series \(r_t\). The lag structure was determined using Akaikes Information Criterion. The null hypothesis \(H_0: \gamma = 0\), which would mean that the series is non-stationary; rejecting this in favour of the alternative hypothesis \(H_1: \gamma < 0\) would imply that the series is stationary. To test for Granger causality of the macroeconomic variables on inflation, the following vector auto-regressive (VAR) model was used:

\[
IR_t = \alpha + \sum_{j=0}^{k_1} \beta_{1j}FD_{t-j} + \sum_{j=0}^{k_2} \beta_{2j}FPI_{t-j} + \sum_{j=0}^{k_3} \beta_{3j}OPI_{t-j} + \sum_{j=0}^{k_4} \beta_{4j}MIBOR_{t-j} + \sum_{j=0}^{k_5} \beta_{5j}ER_{t-j} + \sum_{j=0}^{k_6} \beta_{6j}IIP_{t-j} + \sum_{j=0}^{k_7} \beta_{7j}MS_{t-j} + \sum_{j=1}^{m} \gamma_j IR_{t-j} + U_t
\]

where \(IR\) represents inflation rate, \(FD\) represents the fiscal deficit, \(FPI\) represents the international food price index, \(OPI\) represents the international oil price index, \(MIBOR\) represents the Mumbai Inter-Bank Offer Rate, \(ER\) represents the INR-USD exchange rate, \(IIP\) represents the Index of Industrial Production, and \(MS\) represents the M3 money supply. The lag structure was determined using the Akaikes Information Criterion.

The restricted model is obtained by removing a variable along with all its lags to study the effect of Granger causality of a variable on the inflation rate.

The significance of each variable is tested using the F-test: \(F_{val} = \frac{RSS_{URM} - RSS_{ARM}}{DF_{URM} - DF_{ARM}} / RMS_{URM}\), where \(RSS_{URM}\) is residual sum of squares of the restricted VAR model, \(RSS_{ARM}\) is the residual sum of squares of the unrestricted model, \(DF_{URM}\) and \(DF_{ARM}\) are the degree of freedom of the unrestricted model, and \(RMS_{URM}\) is the degree of freedom of the restricted model.

The Granger causality test was repeated for the time periods 2000-06 (pre-crisis) and 2000-10.

**Empirical Data and Analysis**

The results of the augmented Dickey-Fuller unit root tests for 2000-06 and 2000-10 are presented in Table 1 and Table 2, respectively. The results of the ADF unit root tests indicate that all of the variables under consideration for the study were stationary in both of the research periods.

The results of the Granger causality tests for the periods 2000-06 and 2000-10 are summarized in Tables 3 and 4, respectively.

In the period 2000-06, the macroeconomic variables FPI, OPI, ER, and IIP were found to have significant impact on inflation. The causal relation between IIP and inflation may be due to business cycle. In the period 2000-07, India’s GDP grew by almost 7%, and in the period 2005-08, by an average of about 10%. During these latter years, the Indian economy was in a prosperity phase of the business cycle, with demand, output, employment, and income all at a high levels, tending to raise prices. However, wages, salaries, rentals, interest rates, and taxes do not tend to rise in proportion to the rise in prices. The gap between prices and costs increases the margin of profit. The economy is engulfed in waves of optimism.

\(^{1}\) http://www.dbie.rbi.org.in
\(^{2}\) http://www.mospi.gov.in
\(^{3}\) http://www.fao.org
Table 1: Results of ADF tests 2000-06

| Variable | Coefficient | Std. Err. | T Stat | P-value |
|----------|-------------|-----------|--------|---------|
| FD       | -1.2623     | 0.3344    | -3.7748| 0.0003**|
| FPI      | -0.2017     | 0.0691    | -2.9187| 0.0052**|
| OPI      | -0.0947     | 0.0431    | -2.1968| 0.0317* |
| MIBOR    | -2.3022     | 0.3365    | -6.8425| 0.0000**|
| ER       | -0.0979     | 0.0382    | -2.5634| 0.0127* |
| IIP      | -0.2508     | 0.1030    | -2.4353| 0.0172* |
| MS       | -1.3540     | 0.6241    | -2.1696| 0.0341* |
| IR       | -0.1887     | 0.0690    | -2.7348| 0.0083**|

* significant at 5% ** significant at 1%

Source: authors’ calculations

Table 2: results of ADF tests 2000-10

| Variable | Coefficient | Std. Err. | T Stat | P-value |
|----------|-------------|-----------|--------|---------|
| FD       | -0.6835     | 0.2270    | -3.0108| 0.0033**|
| FPI      | -0.8449     | 0.2122    | -3.9811| 0.0001**|
| OPI      | -0.0989     | 0.0391    | -2.5262| 0.0132* |
| MIBOR    | -0.1877     | 0.0738    | -2.5429| 0.0123* |
| ER       | -0.0737     | 0.0281    | -2.6230| 0.0100**|
| IIP      | -0.2109     | 0.0895    | -2.3561| 0.0205* |
| MS       | -11.8098    | 1.4566    | -8.1080| 0.0000**|
| IR       | -0.1485     | 0.0650    | -2.2838| 0.0245* |

* significant at 5% ** significant at 1%

Source: authors’ calculations

Table 3: Granger causality tests 2000-06

| Variable | F Stat | P-value |
|----------|--------|---------|
| FD       | 0.2924 | 0.8307  |
| FPI      | 3.1181 | 0.0330* |
| OPI      | 4.0860 | 0.0107* |
| MIBOR    | 0.1593 | 0.9233  |
| ER       | 3.1475 | 0.0319* |
| IIP      | 3.0601 | 0.0354* |
| MS       | 0.5583 | 0.6447  |

* significant at 5% ** significant at 1%

Source: authors’ calculations

Higher profit expectations further increase investment, which is helped by liberal bank credit, with the key policy rates at reduced levels making cost of capital cheaper and increased credit facility to the industry sector. This in turn induced IIP growth during the period. Such increased investments are mostly in fixed capital, plant, equipment, and machinery, leading to considerable increase in the economic activity by increasing the demand for consumer goods and further increasing price levels, thus the higher levels of inflation. The causal relation between FPI & OPI and inflation indicates a higher integration of Indian economy with the world.
economy. Paradoxically, there was found to be a negative relation between international oil prices and domestic prices, perhaps due to increasingly high domestic oil subsidies. The Kirit Parikh Committee Report indicates a continuous increase in government expenditure on oil subsidies during 2003-09. Thus, domestic oil prices were relatively insulated from international oil prices. However, increase in domestic oil subsidy affects the fiscal position of the economy in terms of widening of fiscal deficit.

Table 4: Granger causality tests 2000-10

| variable | F stat | p-value |
|----------|--------|---------|
| FD       | 3.0281 | 0.0215* |
| FPI      | 2.5800 | 0.0424* |
| OPI      | 2.0347 | 0.0960  |
| MIBOR    | 1.0896 | 0.3664  |
| ER       | 2.2321 | 0.0897  |
| IIP      | 1.2812 | 0.2832  |
| MS       | 0.7199 | 0.5805  |

* significant at 5% ** significant at 1%

Source: authors’ calculations

In the period 2000-10, only the macroeconomic variables FD and FPI were found to have significant impact on inflation. A possible reason for this may be due to the Fiscal Responsibility and Budgetary Management Act (FRBM), enabling the Government of India to bridge their fiscal deficit. The deficit was down to little more than 3% in 2007. At the time, global commodity prices were relatively stable, not exerting much influence on domestic prices. The situation however changed drastically with the financial crisis in 2007-08, when the fiscal deficit widened considerably on account of expansionary fiscal measures undertaken by the Government of India and global commodity prices also became more volatile, which together may have fuelled inflation.

Conclusions

The results of the study indicate that fiscal deficit plays an important role in influencing inflation in India. Fiscal deficit affects price levels in two ways. Fiscal deficit indicates increase in governmental expenditure. Firstly, if governmental expenditure on subsidies and other social sector schemes increase, then it would lead to an increase in the per capita real income of the rural people. This happened during the Eleventh Five Year Plan (2007-12), with the real wages of rural workers increasing on an average by 16% annually, which in turn increased the aggregate demand of goods and services resulting to demand-pull inflation. This conforms to the results of earlier studies by John (2003) and Khundrakpam and Pattanaik (2010). However, if the expenditure is made towards building infrastructure and increasing production capacity, then it would lead to faster growth in the economy. This happened in the period 2007-10. The global financial crisis affected India’s GDP during two quarters of 2007-08, following which India recovered, registering a growth rate of above 8% during 2009-11. The growth in the GDP in turn led to increase in employment levels. Unemployment level decreased from 8.3% in 2004-05 to 6.6% in 2009-10 according to 66th Round of National Sample Survey Organization’s Survey on Employment (2009-10). Increase in employment pushed up the aggregate demand, which further pushed up the domestic price levels in the economy.

The results of the study also suggest that international food price and oil price indices influence domestic price levels, reflecting greater integration of domestic economy with international economy. This is in accordance with the findings of the India Development Report (2011) and the Economic Survey Report 2011-12, which indicated that some international commodity prices were very high, causing higher levels of domestic inflation. On the other hand, oil subsidy provided by the Government of India has ensured insulation of domestic oil prices from fluctuations in international oil prices. This has compounded the fiscal deficit, as indicated by Kirit Parikh Committee Report.

In conclusion, fiscal policies in general seem better suited in tackling inflation problem when compared with monetary policies.

There were certain limitations inherent in the study. The use of econometric methods such as VAR has various intrinsic limitations (Watson, 1994). Further, the choice of lag lengths may have a bearing on the results. Thus, the results need to be further verified across different time periods to ascertain their robustness. Also, the study considers only certain macroeconomic variables; other variables may be included to examine their bearing on the results.

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4 Faster, Sustainable and More Inclusive Growth: An Approach to the Twelfth Five Year Plan. New Delhi: Planning Commission, Government of India, available at: http://www.planningcommission.nic.in

5 India Development Report. New Delhi: Oxford University Press.

6 Economic Survey 2011-12. New Delhi: Oxford University Press.
Acknowledgement

Initial version of this paper has been published in IJDSA Draft issue in 2016. Article has been re-edited and published in IJDSA.

References

Agha, A.I. and Khan, M.S. (2006). An empirical analysis of fiscal imbalances and inflation in Pakistan. State Bank of Pakistan Working Papers

Barth, J. R. and Bennett, J. T. (1975). Cost-push versus Demand-pull Inflation: Some Empirical Evidence. Journal of Money, Credit & Banking, 7(3), 391-397.

Basu, K. (2011). Understanding Inflation and Controlling It, New Delhi, India.

Batten, D.S. (1981). Inflation: The Cost-Push Myth. Federal Reserve Bank of St. Louis Review, 63(6), 20-26.

Ballard, J. (2011). Measuring Inflation: The Core is Rotten. Federal Reserve Bank of St. Louis Review, 93(4), 223-33.

Cecchetti, S.G. (1996). Measuring Short-Run Inflation for Central Bankers. Cambridge, M.A.

Catao, L. and Terrones, M.E. (2003). Fiscal Deficits and Inflation, IMF Working Papers.

Fisher, I. (1930). The Theory of Interest. Philadelphia: Porcupine Press.

Friedman, M. (1968). The Role of Monetary Policy. American Economic Review, 58(1), 1–17.

John, R.M. (2002). Inflation in India: An analysis using Post-Liberalization data. IGIDR Working Paper.

Kar, S. (2010). A Periodic Autoregressive Model of Indian WPI Inflation. Margin - The Journal of Applied Economic Research, Vol. 4(3), 279–292.

Keynes, J.M. (1936). The General Theory of Employment, Interest and Money. London: Macmillan (reprinted 2007).

Khundrakpam, J.K. and Pattanaik, S. (2010). Global Crisis, Fiscal Response and Medium-term Risks to Inflation in India. Reserve Bank of India Occasional Papers, Vol. 31(2), 1-29.

Pattanaik, A. (2010). Study of Inflation in India: A Cointegrated Vector Autoregression Approach. Journal of Quantitative Economics, Vol. 8(1), 118-129.

Pattanaik, S. and Nadhanael, G.V. (2011). Why Persistent High Inflation Impedes Growth? An Empirical Assessment of Threshold Level of Inflation for India. Reserve Bank of India.

Parikh, K. S. (2010). A Viable and Sustainable System of Pricing of Petroleum Products. New Delhi: Government of India.

Schultze, C.L. (1959). Recent Inflation in the United States. Study Paper No. 1 for Joint Economic Committee, Study of Employment, Growth, and Price Levels, Washington.

Singh, B.K. (2012). An Assessment of Inflation Modelling in India. Indian Council for Research on International Economic Relations, Working Paper No. 259.

Virmani, V. (2003). Modeling Inflation in India - An Error Correction Approach, available at: http://www.indiainfoline.com/impa.pdf

Watson, M.W. (1994). Vector Autoregressions and Cointegration. in Engel, R. and McFadden, D., Handbook of Econometrics IV. Amsterdam: Elsevier, 2844-2915.

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