Efficacy of New Monetary Framework and Determining Inflation in India: An Empirical Analysis of Financially Deregulated Regime

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Abstract

Against the backdrop of the new monetary policy framework, this paper analyses the determinants of inflation in the deregulated financial regime. The paper upfront has been kept free from adherence to any particular school of thought on inflation, particularly fiscal theories of price determination (where inflation targeting is emphasised) and the monetarist axioms. Using the ARDL methodology, the determinants of inflation based on Wholesale Price Index (WPI) and the Consumer Price Index (CPI) have been empirically tested for the financially deregulated period. The results reveal that the supply-side variables are indeed significant and have a considerable effect on inflation. This result has policy implications especially in the context of a shift from discretion to rule-based monetary policy in the context of India.

KEYWORDS: Inflation, Supply Side, ARDL
JEL CODES: C 22, E 31, E 51, H 62

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I. Introduction

Inflation determination models are broadly threefold. One set of recent studies provide the inflation determination models within New Keynesian framework, which is based on the assumption that monetary policy is conducted by means of central-bank policy rule (Clarida, Gali, and Gertler, 2000; Svensson and Woodford,2005; Taylor, 1999; Woodford, 2003). The core of such analysis is the rule based monetary stance based on the period-by-period adjustment of the policy rate by more than one for one in response to incipient movements in inflation – thereby satisfying the condition that is widely referred to as the Taylor Principle (McCallum 2008). This set of research forms the recent "fiscal theories of price determination" or fiscalist approaches. In contrast, the second set of studies followed the Friedman's famous axiom, "inflation is always and everywhere a monetary phenomenon" (Friedman and Schwartz, 1963). Such research, which attributed the root cause of inflationary pressures to expansionary monetary policies (the growth of the money supply), has what become to be known as the "monetarist" tradition (Friedman, 1968; Friedman and Schwartz, 1963). The third set of empirical models relate to inflation being termed as eclectic, or can be referred to as untidy models as it cannot adhere to the strict theoretical framework of monetarism and it incorporates structural parameters along with monetary and fiscal variables. The inflationary phenomenon in India is complex, and it is highly inconclusive to adhere to the fiscalist path or monetarist adage to determine inflation, especially in the deregulated financial regime. It is untidy in India in the sense that it cannot be determined within the neat monetarist models as monsoon failures, or oil shocks can trigger inflation. The structuralist models of inflation, emphasizing on the supply side factors, found relatively relevant for the context of India (Balakrishnan, 1991).

In India, there is still widespread debate concerning the factors that cause inflation and their respective strengths. In this paper we shall try to incorporate all the relevant factors that can possibly affect inflation within the theoretical framework of Lucas (1973) which perceives aggregate price level as a result of a comprehensive interaction of aggregate supply and aggregate demand factors; and shall empirically test it using the official data from the Handbook of Indian Statistics, Reserve Bank of India (hereafter RBI) and Ministry of Statistics and Policy Implementation, Government of India.

This paper is all the more relevant having been developed against the backdrop of a 'New Monetary Framework' between the RBI and the central government giving the RBI more autonomy to pursue a policy of Inflation-Targeting. The aim of this paper is to bring forth the relationship between the supply side factors and the other parameters of inflation with respect to India during the financially deregulated regime. The paper is organized into five sections. Section I briefly deals with the conceptual backdrop of the paper and reviews the empirical literature. Section II deals with the analytical framework and section III interprets data. Section IV presents the econometric model, methodology, and results. Section V concludes.

II. Conceptual Backdrop and Empirical Literature

The RBI and the Central Government signed an agreement in February 2015 devising a 'New Monetary Framework' that agrees to give greater autonomy to the RBI concerning its monetary policy. Against the backdrop of the new monetary policy framework agreement between the Government of India and the RBI in February 2015, this paper empirically investigates the determinants of inflation in India. As per the new monetary framework, the objective of the monetary policy would predominantly be to maintain price stability while keeping growth in mind. Is inflation strictly a monetary phenomenon in India? There are equally convincing discourses that highlight that supply side shocks determine inflation, in addition to the monetary determinants. However the new monetary policy framework indicated a shift from discretion to rule-based monetary policy – inflation targeting - in the context of India, and to peg the policy rates based on inflationary expectations and output gap (RBI, 2014). This also calls for central bank independence and suggests a move towards the New Macroeconomic Consensus (NCM)[2]. However, a large section of economists and policy makers still have their reservations about the use of inflation-targeting monetary policy in a developing country like India. (Sheel, 2014; Mahajan, Saha and Singh 2014).

One of the hypothetical reasons could be that if the central bank is not independent, the government engages in seigniorage financing of the deficit and turn increases the money supply and inflationary pressures in the economy. However, such kind of deficit financing had been contained, taking a cue from the seminal Chakravarty Committee Report to review the Working of the Monetary System, 1985 in controlling monetized deficits. What independence Central Bank seeks, hence, attains a new dimension in the backdrop of fiscal rules. With the shift from seigniorage financing to bond financing of fiscal deficits, the indication towards inflation targeting and central bank independence take a different perspective. This perspective may be linked to the hypothetical situation of a 'fiscal dominance' scenario of unsustainable debts through bond financing and the eventual monetization of deficits, termed as 'Unpleasant Monetary Arithmetic' by Sargent and Wallace (1975) that inflation today or tomorrow is the only flexible policy option.

Inflation determination in the context of a developing country like India is complex. Existing models like Phillips Curve model, monetarist model, supply-side model or structuralist model alone cannot explain the inflationary phenomenon in the context of developing economies. India has a large pool of unorganized sector. A study by National Commission for Enterprises in the Unorganized Sector (NCEUS)

[2] Arestis (2009) for the details of NCM.

in 2005 estimated that out of the 485 million persons employed in India, 86 percent or 395 million worked in the unorganized sector, generating 50.6 percent of the country's GDP. Therefore, as stated by Bhattacharya (1984), Philips curve model is not strictly applicable to India because the organized labour market is only a minor segment of total labour market. Moreover, in unorganized sector, wage rate has no direct relationship with labour productivity and therefore, not a significant determinant of commodity price level.

The monetarists have, however, argued that developing economies are constrained by supply-side bottlenecks and, therefore, inflationary pressures are created in the developing economies due to the excess money supply. Because of supply-side bottlenecks, excess money supply cannot generate output through technological advancements and real resources cannot be augmented by a mere expansion of money supply (Bhattacharya and Lodh, 1990). They also ruled out the trade-off between inflation and economic growth.

On the other hand, the supply-side economists have argued otherwise. They have laid the great amount of stress on the structural disequilibrium in the growth process. Moreover, in pure *supply-side* models, inflation can occur without rise in money supply but in modified *supply-side* model, money supply expands along with price level but the direction of causality can either be from money to price or vice-versa (Bhattacharya and Lodh, 1990). It is also noted that in s*upply-side school*, there is a trade-off between growth and inflation which was ruled out by the monetarists as noted in the above section but the trade-off occurs not due to Phillips curve type wage-unemployment relationship but due to differential growth of output and demand between sectors. The study also noted that the Rational Expectations model appear to be invalid for developing countries. They argued that for expectations to be rational there should be perfect information to all economic agents. But in developing countries, information is asymmetric. The presence of vast informal sector is a major obstruction to the free flow of information. The empirical studies on inflation based on Rational Expectations Model in the context of developing countries is almost non-existent as the assumptions of homogeneous market or homogeneous production behavior and perfect information appear to be practically irrelevant. This auger well when looked in the context of India that has a major part of its population working in the informal sector.

In the context of developing countries, studies by Siddique (1989), Saini (1982), Nachane and Nadkharni (1985), Dornbusch and Fischer (1981), Ramachandran (1983), Bhalla (1981), Aghveli and Khan (1978), Darrat (1986), Onis and Ozmucur (1990), Minhas (1987) have broadly conducted empirical experiments to determine the direction of causality between inflation and money supply, with some of these studies specifying structural models of inflation while others draw inferences about causality using data exploratory and diagrammatic representations. The empirical evidence from India has shown that inflation modeling is broadly based on elements of both monetarists and supply-side model together rather than going strictly by either monetarist models or supply-side models. The inflation models developed in the context of India by Ahluwaliah (1979), Bhattacharya (1984), Pandit (1978) and Bhalla (1981) combined the elements of structural, monetarist, Keynesian, cost-push theories and Lewis model.

Balakrishnan (1991) has provided a comprehensive and coherent analysis of inflationary phenomenon in India within the framework of structuralist model for Indian economy for the period between 1950 and 1980 and he has also compared the explanatory power of the model based on structuralist framework with that of a simple version of a model based on monetarist framework and found statistical evidence in favour of structuralist model. His results have attributed excess demand as the reason for inflation. In Bayesian econometric framework, Balakrishnan, Rao and Vani (1994) analyzed the price behaviour in the context of India and the statistical evidence favoured structuralist model to monetarist model.

Some of the studies on inflation have also incorporated fiscal policy variable. Bhattacharya (1984) had stressed on the fiscal policy impact on inflation. Aghveli and Khan (1978) found a feedback relationship between money and prices in the context of Brazil, Columbia, Dominican Republic and Thailand. He explained his results in the structural model that monetary supply shock leads to increases in prices via the quantity theory mechanism, the increase in inflation leads to an increase in government expenditure (but not to a corresponding increase in revenues), thus creating a budget deficit, which is financed by money creation, which then leads to a further increase in prices.

Bhalla (1981) and Saini (1982) estimated augmented versions of monetarist models by inclusion of additional variables into the monetarist model. Dornbusch and Fischer (1981) estimated an equation derived from standard IS-LM-AS model that includes budget deficit and money growth as causal factors of inflation. In three countries of their sample- Guatemala, Israel and Sri Lanka - monetary growth did not provide an adequate explanation for inflationary pressures in the economy. As for the budget deficit, it was found positive and significant in Israel. The results of Bhalla (1981) showed that in developing countries like India, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand and Taiwan, there exist some indirect effects of budget deficit on inflation through the coefficients of lagged monetary growth. Sadanand Pustry (2012) concluded that a major cause of inflation in India is the increase in the fiscal deficit (especially revenue deficit) of not only the central government but also the state governments. To add to the above argument, a paper by Kumar and Mitra (2012) had stated that restrictive monetary policy alone is insufficient to control inflation unless accompanied by a coordinated reduction in budget deficits.

The paper by Mohanty and Klau (2001) concluded that firstly, the output gap is a significant determinant of inflation in all countries, though the precise influence is difficult to establish. Secondly, supply-side factors seem to play more than a passing role in the inflation process. The results by Dua and

Gaur (2009) showed that the supply-side factors do affect inflation in agrarian economies. Mishra and Roy (2011) explained inflation in India with a focus on food price inflation. They stated that food price inflation is typically higher than non-food inflation. Deepak Mohanty and Joice John (2014) stated that monetary policy impact on inflation has remained broadly unchanged. Their paper underscores the role of monetary policy and fiscal policy in the reduction of inflation irrespective of the nature of the shock.

As discussed in earlier studies on inflation model in the context of India, the monetarist approach is highly inadequate to explain the inflationary phenomenon in India. In next section, we try to identify the key determinants of the inflationary process in the context of developing countries, incorporating both demand side and supply side factors.

III. Analytical Framework

The analytical framework of the inflation model for this paper is derived from Lucas (1973), where he viewed aggregate price level as a result of the interaction of aggregate supply and aggregate demand factors. The aggregate supply schedule depends on the deviation of actual output from the potential output in the economy. We can start by specifying Lucas (1973) aggregate supply function:

$$\pi^*_t = p_t - p_{t-1} = \alpha + \beta_1 (y_t - y^*) \tag{1}$$

where current inflation depends on the current output gap, and y* is the potential output.

As Lucas (1973) argued, the aggregate demand function is drawn up by the set of demand-shift variables like monetary and fiscal policies and variations in the external sector. The aggregate demand thus can be specified as follows:

$$y_t = y_{t-1} + \beta_2 \, \dot{sei}_t + \beta_3 i_t + \beta_4 def_t + \beta_5 k_t \tag{2}$$

SEI_t is the seigniorage, I_t is the real rate of interest, DEF_t is fiscal deficit and K_t is capital flows.

Deducting y^* from both sides of the equation (2), and applying it to equation (1), we get

$$\pi^*_t = \alpha + \varphi_1 (y_t - y^*) + \varphi_2 sei_t + \varphi_3 def_t + \varphi_4 i_t + \varphi_5 k_t + \nu_t \tag{3}$$

It is to be noted that the variable GAP (the deviation between potential output and actual output scaled to actual output) alone may not be a powerful variable to capture the supply-side effects of inflation when compared to rainfall in the context of India. Balakrishnan (1991) has highlighted the role of food grains in the inflation model of India. They noted that no models of the inflationary process in India had found it possible to do without ‘money’ as a statistically significant variable. Therefore, it does suggest that money play a role, although certainly not an exclusive role, in determining the dynamics of price movements. The food grain price is in turn highly correlated with rainfall. Therefore, we used rainfall to proxy the supply-side variable in the equation. In the light of above discussions, we re-modified the inflation equation using supply-side variable along with output gap.

$$\pi^*_t = \alpha + \varphi_1 ss_t + \varphi_2 \dot{sei}_t + \varphi_3 def_t + \varphi_4 i_t + \varphi_5 k_t + \varphi_6 og_t + \nu_t \tag{4}$$

IV. Interpreting Data

The period of estimation is the financially deregulated regime. The process of financial deregulation started in India since 1991. The highlights of financial deregulation are interest rate deregulation, a phased reduction of cash reserve requirement and statutory liquidity ratio, simplifying directed credit programmes, development of money markets, etc. The administered interest rates were simplified since 1992-93 (Chakraborty 2002, 2010). The deregulation of interest rates has been accompanied by the introduction of new instruments like 14-day and 182- day auction Treasury Bills in addition to the 91-day and 364-day auction Treasury Bills.

The WPI inflation rate in India fell to a low of -2.65 percent in April 2015, the sixth successive month of deflating prices. Inflation rates in India are quoted as changes in the WPI or CPI for all commodities. The variables that have been included in the model are output gap, seigniorage, gross fixed deficit, amount of rainfall, real rate of interest and capital flows. The output gap is defined as follows.

OG = [(Actual GDP-Potential GDP)/Potential GDP] *100 (5)

This is also known as the "economic activity index" (Congdon 1998; Tanzi 1985). It can be seen from the equation that "output gap," or index of economic activity, is defined as the difference between actual and trend/potential level of national output as a percentage of trend/potential output.

Definitionally speaking, the potential level of output would be higher than the actual, as resource utilization is maximized at the potential level. However, it is argued that cyclical factors, such as a recession or boom, can cause the actual to be below or above the potential output, respectively (Tanzi 1985). The major problem of estimation of the "output gap" lies in the estimation of the potential level of output.

The Hodrick-Prescott filter (HP filter) is the method used for the derivation of the potential output. The idea of this filter is to decompose a non-stationary time series, such as actual output, into a stationary cyclical component and a smooth trend component (Y_t and Y_t^* denote the logarithms of actual and trend/potential output respectively) by minimizing the variance of the cyclical component subject to a penalty for the variation in the second difference of the trend component. This results in the following constrained least-square problem:

$$Min \ \sum_{t=1}^{T}(Y_t - Y_t^*)^2 + \ \lambda \sum_{t=2}^{T-1} \left[(Y_{t+1}^* - Y_t^*) - (Y_t^* - Y_{t-1}^*)\right]^2 \tag{6}$$

The first term in the equation is a measure of fit. The second term is a measure of smoothness. The Lagrange multiplier (λ) is associated with the smoothness constraint and must be set *A priori.* As a weighting factor, it determines how smooth the resulting output series is. The lower the λ, the closer potential output follows the actual output.

Seigniorage is defined as the change in the nominal stock of reserve money (Buiter, 2007). There was an increasing recognition that seigniorage causes inflation (Dornbusch and Fischer 1981; Van Wijnbergen 1989; Buiter 1990; and Easterly and Schmidt-Hebbel 1994). Technically, seigniorage is a change in reserve money divided by GDP at current prices. This is the most commonly used definition of seigniorage. It can be expressed by the following equation:

$$S_1 = \frac{\Delta M_t}{Y_t} \tag{7}$$

S_1 = seigniorage revenue;

ΔM_t = change in reserve money;

Y_t = GDP at current prices.

The paper encountered the problem of selecting appropriate interest rates among the plethora of available interest rates in the financial market. The real 91-day Treasury Bill Rate was selected from the spectrum of rates of interest in India due to its relevance in acting as the reference rate of interest. The next task is to transform the Treasury Bill rate (91 days) into a real rate of interest.

According to the Fisher hypothesis, the nominal rate of interest (γ^n) is given by

$$\gamma^n = \gamma^r + \pi^e \qquad \textit{(ex ante equation)} \tag{8}$$

$$\gamma^n = \gamma^r + \pi \qquad \textit{(ex post equation)} \tag{9}$$

where γ^r is the ex ante real rate of interest; π^e and π are, respectively, the expected and real rate of inflation. The real rate of interest in any period is thus postulated to evolve as a deviation between the nominal rate of interest and the rate of inflation (WPI). The ex-ante real rate of interest is derived by subtracting the expected rate of inflation from the nominal rate of interest.

Moreover, since we are analyzing data for the deregulated period, we have used real Treasury bill rates to study the effect of interest rates on inflation. To study the effects of the supply side we have used the amount of rainfall for the month of July. The rainfall effects the food grains production significantly in India and, therefore, acts as a good proxy for the supply side factors. The capital flows contain both the foreign direct investment as well as the foreign institutional investments.

Table 1: Correlation Matrix

	wpi	sei	def	ss	og	k	i	cpi
wpi	1.000							
sei	0.0736	1.0000						
def	-0.0856	-0.1521	1.0000					
ss	0.2094	0.3897	-0.2241	1.0000				
og	0.1585	-0.4332	-0.1343	0.1196	1.0000			
k	-0.1151	0.1372	0.8844	-0.0763	-0.1204	1.0000		
i	-0.6743	-0.0820	0.1770	-0.0831	0.0539	0.1855	1.0000	
cpi	0.5735	-0.0018	0.0087	0.1801	0.4250	0.0756	-0.4493	1.0000

Source: *(Basic data): Handbook of Indian Statistics, Reserve Bank of India (various years) and CSO, Ministry of Statistics and Policy Implementation (various years)*

Table 1 provides the correlation coefficients of variables used in the model. The coefficients revealed that there is no significant correlation between the variables used as determinants in the model.

V. Econometric Model Specification and Results

The inflation function to be empirically tested in the paper is stated in the following form, and all variables are in log form.

$$\pi^*_t = \alpha + \varphi_1 ss_t + \varphi_2 \dot{sei}_t + \varphi_3 def_t + \varphi_4 i_t + \varphi_5 k_t + \varphi_6 og_t + \nu_t \qquad (10)$$

where ss_t denotes the amount of rainfall, sei_t is the seigniorage, def_t is fiscal deficit, i_t is the real rate of interest, k_t is the capital flows and og_t is the output gap.

In this paper, we make use of autoregressive distributed lag (ARDL) testing method to empirically evaluate the factors that cause inflation. For investigating the long-run equilibrium (co-integration) among time-series variables, several econometric methods have been proposed in the last two decades. Some of the most commonly used methods for the co-integration tests include the residual based Engle-Granger (1987) test, maximum likelihood based Johansen (1991; 1995) and Johansen-Juselius (1990) tests. However, due to the low power and other problems associated with these test methods, the OLS based autoregressive distributed lag (ARDL) approach to cointegration has become popular in recent times. The main advantage of ARDL modeling is that it can be applied when the variables are of the different order of integration (Pesaran and Pesaran 1997).

Another advantage of this approach is that the model takes sufficient numbers of lags to capture the data generating process in a general-to-specific modeling framework (Laurenceson and Chai 2003). Moreover, a dynamic error correction model (ecm) can be derived from ARDL through a simple linear transformation (Banerjee et al. 1993). The ecm integrates the short-run dynamics with the long-run equilibrium without losing long-run information. It is also argued that using the ARDL approach avoids problems resulting from non-stationary time series data (Laurenceson and Chai 2003).

The co-integration test methods based on Johansen (1991; 1995) and the Johansen-Juselius (1990) require that all the variables be of equal degree of integration, i.e., I(1). Therefore, these methods of co-integration are not appropriate and cannot be employed. Hence, we adopt the ARDL modeling approach for co-integration analysis in this paper. In ARDL methodology, the first step is to check the stationarity of variables and if it is a mix of I(0) and I(1) variables, but not I(2), then we can proceed with ARDL methodology. The ARDL model involves simultaneous estimation of short run and long run parameters and all variables are assumed to be endogenous. The ARDL specification of equation (10) is provided in equation (11) and the variables are in log form.

$$\begin{aligned}\Delta\ \pi_t\ =\ \varphi_0 + \sum_{i=1}^{m}\varphi_{1i}\,\Delta\,\pi_{t-i} + \sum_{i=0}^{m}\varphi_{2i}\,\Delta\ ss_{t-i} + \sum_{i=0}^{m}\varphi_{3i}\,\Delta\,sei_{t-i} + \sum_{i=0}^{m}\varphi_{4i}\,\Delta\,def_{t-i} + \sum_{i=0}^{m}\varphi_{5i}\,\Delta i_{t-i}\\ + \sum_{i=0}^{m}\varphi_{6i}\,\Delta\,k_{t-i} + \sum_{i=0}^{m}\varphi_{7i}\,\Delta\,og_{t-i}\\ + \sigma_1\ \pi_{t-1} + \ \sigma_2\,ss_{t-1} + \sigma_3\,sei_{t-1} + \ \sigma_4 def_{t-1} + \sigma_5 i_{t-1} + \ \sigma_6 k_{t-1} + \sigma_7 og_{t-_1} + u_t\end{aligned} \tag{11}$$

The presence of a long-run relationship between the variables of equation (11) is tested by means of bounds-testing procedure. The bounds test is a joint significance test, where H_0 implies no co-integration. The bounds procedure is conducted for equation (11). If the computed F-statistic exceeds the upper critical bounds value, then the $\sigma_1=\sigma_2=\sigma_3=\sigma_4=\sigma_5=\sigma_6=\sigma_7=0$ is rejected. If the bounds procedure suggests that co-integration exists, then we estimate the ARDL representation of the error correction model. The ecm model is estimated as in equation (12), where λ is the speed of adjustment to long-run equilibrium and ecm is the residuals obtained from equation (11).

$$\begin{aligned}\Delta\ \pi_t\ =\ \varphi_0 + \sum_{i=1}^{m}\varphi_{1i}\,\Delta\,\pi_{t-i} + \sum_{i=0}^{m}\varphi_{2i}\,\Delta\ ss_{t-i} + \sum_{i=0}^{m}\varphi_{3i}\,\Delta\,sei_{t-i} + \sum_{i=0}^{m}\varphi_{4i}\,\Delta\,def_{t-i} + \sum_{i=0}^{m}\varphi_{5i}\,\Delta i_{t-i}\\ + \sum_{i=0}^{m}\varphi_{6i}\,\Delta\,k_{t-i} + \sum_{i=0}^{m}\varphi_{7i}\,\Delta\,og_{t-i} + \lambda ecm_{t-1} + u_t\end{aligned} \tag{12}$$

The stationarity test has been done with the help of the unit root tests as proposed by the Augmented Dickey Fuller and Phillips-Perron method (*Table 2* and *3*). As would be seen from unit root tests, the variables considered in this paper are a mix of I(0) and I(1) series.

Table 2: Augmented Dickey Fuller Unit Root Tests

Variable	t-statistic	Constant, Trend	Lags	Decision
wpi	-5.035269 (0.0003)	Constant	0	I(0)
cpi	-3.578314 (0.0120)	Constant	0	I(0)
def	-3.195264 (0.0025)	None	3	I(1)
og	-2.851424 (0.0063)	None	8	I(0)
k	-12.29955 (0.0000)	None	0	I(1)
sei	-4.549623 (0.0010)	Constant	0	I(0)
i	-4.695767 (0.0000)	None	0	I(0)
ss	-5.952853 (0.0000)	Constant	0	I(0)

Source: *(Basic data): Handbook of Indian Statistics, Reserve Bank of India (various years) and CSO, Ministry of Statistics and Policy Implementation, Govt. of India(various years)*

The variables wpi, og, ss, sei, i, are I(0) series having significant 't'-statistic values for 1% level of significance, while cpi is I(0) series having significant 't'-statistic values for 5% level of significance. The variables def and k are I(1) series having significant 't'-statistic values for 1% level of significance.

Table 3: Phillips-Perron Unit Root Tests

Variable	Adj. t-statistic	Constant, Trend	Bandwidth	Decision
wpi	-2.235403 (0.0266)	None	3	I(0)
cpi	-3.952141 (0.0116)	Constant	3	I(0)
def	-5.128850 (0.0000)	None	4	I(1)
og	-4.481433 (0.0001)	None	4	I(0)
k	-3.377431 (0.0724)	Constant, Linear	4	I(0)
sei	-4.549623 (0.0010)	Constant	0	I(0)
i	-4.632080 (0.0000)	None	3	I(0)
ss	-6.053910 (0.0000)	Constant	6	I(0)

Source: *(Basic data): Handbook of Indian Statistics, Reserve Bank of India (various years) and CSO, Ministry of Statistics and Policy Implementation, Govt. of India (various years)*

The Phillips-Perron tests also reveals that the variables wpi, cpi, og, ss, sei, k and i are I(0) and the variable def is an I(1) series (*Table 3*).

Table 4: Optimal Lag Structure: ARDL Procedure

Model	ARDL Procedure
I	2,2,2,2,1,2,2
Ii	1,2,2,1,2,0,2
Iii	0,2,2,1,1,2,0,1
Iv	2,2,1,2,1,2,1,1

Source: *(Basic data), RBI and Govt. of India(various years)*

The second step is to determine the appropriate lag. The optimal lag of each variable is estimated through the minimum Akaike Information Criteria (AIC) (*Table 4).* The optimal parameterization is crucial in ARDL models to eliminate any endogeneity problems. After getting the desired lag structure of ARDL model, we go for bounds procedure to decide whether there is co-integration or not. The bounds procedure shows that the F statistic is higher than the upper bound at 95 % or 90% so we reject the null hypothesis of no co-integration and incorporated the error correction mechanism in the model.

Table 5: ARDL Estimates from ECM Structure

REGRESSOR	(i) (WPI)	(ii) (CPI)	(iii) (WPI with DEREGUL DUMMY)	(iv) (CPI with DEREGUL DUMMY)
$\Delta\, Log\, \pi_{t-1}$	-0.82642*			0.47937**
	(-4.3632)			(2.8099)
$\Delta\, Log\, ss_t$	0.83805**	-0.75664***	-0.023416	-0.38651
	(3.1813)	(-2.0024)	(-0.080860)	(-1.2576)
$\Delta\, Log\, ss_{t-1}$	0.80423*	-1.2116*	0.35470	-0.60125**
	(3.5427)	(-4.5906)	(1.2704)	(-2.4068)
$\Delta\, Log\, sei_t$	0.35166*	0.078527	0.36860**	0.082171
	(3.3853)	(0.67025)	(2.7466)	(0.76680
$\Delta\, Log\, sei_{t-1}$	-0.29880**	-0.15444	-0.19342	
	(-2.4262)	(-1.2185)	(-1.6827)	
$\Delta\, Log\, def_t$	0.48539	0.68291*	-0.68538**	0.16400
	(1.1365)	(4.0536)	(-2.8436)	(0.58341)
$\Delta\, Log\, def_{t-1}$	-1.6414**			1.0012*
	(-3.1640)			(3.3977)
Δi_t	-0.12424*	-0.061632*	-0.13013*	-0.068582**
	(-4.0795)	(-4.8260)	(-6.3415)	(-2.8427)
Δi_{t-1}		-0.013124		
		(-0.93525)		
$\Delta\, k_t$	0.8171E-4	0.7253E-4	-0.4458E-3**	-0.5040E-4
	(0.64712)	(0.47164)	(-2.7513)	(-0.28152)
$\Delta\, k_{t-1}$	-0.1811E-3		-04811E-3**	-0.3859E-3***
	(-0.88835)		(-2.6743)	(-1.7811)
$\Delta\, og_t$	0.029417	0.21802*	0.041839*	0.16214*
	(0.86872)	(6.0145)	(3.4475)	(6.0849)
$\Delta\, og_{t-1}$	-0.068613***	-0.085551**		
	(-2.1333)	(-2.9115)		
c	-5.2098	-4.1316	3.4039	4.1672
	(-0.88183)	(-0.98498)	(1.0131)	(1.3050)
ecm	-0.66831**	-1.4284*		-1.9427*
	(-2.6738)	(-7.9555)		(-7.7370)
deregul dummy			1.2878*	1.3082**
			(3.9921)	(2.7810)
R-squared	0.99	0.97	0.93	0.93
DW statistic	1.81	2.43	2.13	2.61

Note: *(*) denotes 1% significant values, (**) denotes 5% significant values and (***) denotes only 10% significant values*

Source*: (Basic data): Handbook of Indian Statistics, Reserve Bank of India (various years) and CSO, Ministry of Statistics and Policy Implementation, Govt of India (various years)*

The models (i) and (ii) are for the financially deregulated period. The ARDL estimates from model (i) suggest that seigniorage and supply-side variables along with output gap, deficit and rate of interest are crucial in determining inflation in India during the deregulated regime (*Table 5*). Similarly, for model (ii) we have supply side, deficit, rate of interest and output gap as significant variables for the same deregulated period. Also, the results from model (iii) and model (iv) for a wider period 1980-81 to 2013-14, after having incorporated the dummy for financial deregulation (1991 dummy) have broadly remained the same.

VI. Conclusion

This paper empirically examines the inflation function for India using the time-series data for the financially deregulated period. Using ADRL methodology, the paper estimated the determinants of inflation and found that the supply side factors indeed have a significant effect on the level of inflation in India. This result has policy implications in the light of new monetary framework in India where there is an agreement between the Central Bank and Government of India to decide that the sole monetary policy decision should be price stability with growth as backup. However, as inflation is determined by both monetary and supply side variables, the inflation targeting might not be an ideal way of inflation management.

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