Modelling Inflation in India: A Critique of the Structuralist Approach *

Naveen Srinivasan†
Indira Gandhi Institute of Development Research, Mumbai

Vidya Mahambare
CRISIL Centre for Economic Research, Mumbai

M. Ramachandran
Institute for Social and Economic Change, Bangalore

Abstract

We estimate an augmented Phillips curve to examine the effects of supply shocks on inflation in India. Our results suggest that supply shocks only have a transitory effect on both headline and core measures of inflation. The evidence is robust to a variety of re-specifications and core inflation measures. The potential explanation for this is that monetary policy has not provided the basis for a sustained change in the inflation process by accommodating supply shocks i.e., expanding money supply in response to negative supply shocks. Thus, monetary authorities have implicitly focused on a core measure of inflation by discounting price movements that are expected to be reversed in the short-run. In short, what is crucial in inflation determination is not supply shocks *per se* but how policymakers respond to these shocks.

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† Corresponding Author: Indira Gandhi Institute of Development Research, Gen. A.K. Vaidya Marg, Santosh Nagar, Goregaon (East), Mumbai 400065. Email: naveen@igidr.ac.in

1. Introduction

There has been a plethora of studies on inflation in the Indian economy. Most of these studies have generally followed either a monetarist or a structuralist approach to inflation determination. Recent examples in the monetarist tradition include Moosa (1997), Rao (1997), and Nachane and Lakshmi (2002). In contrast, Balakrishnan (1994) applying the structuralist approach views the phenomenon as essentially commodity prices-led.[1] According to this view, inflation is a purely non-monetary phenomenon: it is driven by "cost-push" factors, and these factors dominate the behaviour of inflation regardless of what course monetary policy takes.

The most obvious and immediate effect of a negative supply shock (an increase in oil or commodity prices) is that the headline wholesale price index (WPI) rises.[2] This is a result of the largely direct link between oil (or commodity) prices and certain sub-components of WPI. However, a sustained rise in inflation due to upward jumps in the prices of certain commodities was never convincing to those working in the monetarist tradition. As Milton Friedman (1975) said: "*The special conditions that drove up the price of oil and food required purchasers to spend more on them, leaving them less to spend on other items. Did that not force other prices to go down, or to rise less rapidly than otherwise? Why should the* average *level of prices be affected significantly by changes in the price of some things relative to others*?"

[1] Many studies have also highlighted the role of cost-push factors, without ruling out the importance of demand factors. Examples include Bhattacharya (1984), Pandit (1985), and Krishnamurty et al. (1995).
[2] The WPI is the main measure of the rate of inflation used in India. The basic advantage of the WPI is that it is broad based and is available in a timely manner. The WPI covers 447 commodities and is heavily weighted toward manufactured products which comprise 57% of the index. Primary articles, consisting mainly of food items, account for 32% of the index, and fuel and energy the remaining 11%.

In practice, however, movements in relative prices do affect the aggregate price level due to nominal rigidities.[3] As a result of these rigidities jumps in the price of oil for example might help explain transitory periods of sharp increases in the general price level. Nevertheless, it is not clear how they alone could explain persistently high inflation in the absence of policy accommodation i.e., expansionary monetary policy in response to a negative supply shock. At least one strand of the conventional wisdom holds that over accommodation in response to higher oil prices was responsible for a good deal of the rise in US inflation during the 1970s. Policies that expanded the money supply to avoid a still deeper oil shock-driven recession succeeded in transforming what was a temporary burst of inflation into a permanent jump in the level of inflation (see Taylor, 1999 and Clarida et al., 2000).

Moreover, the key question is whether these shocks affect core inflation since it is this that policymakers can strictly speaking aim to control.[4] This in turn depends on how expectations are formed. These expectations, in turn, affect the *current* state of the economy because they are incorporated into wages via forward-looking labor contracts. In a rational expectations model expectations are consistent with the anticipated actions of the policymaker. When agents expect policymakers to accommodate unfavourable shocks, expected inflation is likely to rise. This characterization implies that price level shocks can shift current inflation even without

[3] Fundamentally, supply shocks are changes in certain relative prices. In a world with fully flexible prices a shock to a particular sector would lead to instantaneous changes in relative prices, which would, other things being equal, leave the aggregate price level unchanged. However, if there are costs associated with adjusting nominal prices (menu costs), relative price changes may not cancel out in terms of their effect on the aggregate price level (see Ball and Mankiw, 1995).

[4] There are effectively two transmission channels from a rise in headline to a rise in core inflation. Firms may pass on their increased costs of production in the form of higher product prices. Alternatively, workers respond to the increase in the cost of living by demanding higher wages.

monetary accommodation, but cannot become entrenched in the expected inflation rate in the absence of policy accommodation.

In this paper we estimate the effects of supply shocks on inflation in India, using an augmented Phillips curve framework. We supplement the traditional Phillips curve approach by taking into account the growing body of evidence suggesting a role for supply shocks (see Fuhrer (1995), Roberts (1995), Gordon (1997), and Hooker (2002)). We find that supply shocks have not contributed to a permanent increase in either the WPI or core inflation measure during 1995-2005 period. The potential explanation for this is that monetary policy has not provided the basis for a sustained change in the inflation process by accommodating negative supply shocks. The results of this study strengthen the case for modelling inflation in India along the monetarist approach.

The rest of the paper is organized as follows. In Section 2 we use an augmented Phillips curve framework to examine whether supply shocks have permanent or transitory effect on inflation. We also assess the robustness of these results in a number of dimensions. Section 3 addresses the interplay between supply shocks and monetary policy. Section 4 concludes.

2. Model of Inflation determination

As a statistical model of inflation, we use a standard version of the Phillips curve. Accordingly, in this section we consider regression estimates of

$$\pi_t = \alpha(L)\pi_t + \beta(L)\tilde{y}_t + \gamma(L)u_t + \varepsilon_t, \tag{2.1}$$

where π_t is the rate of inflation, $\tilde{y}_t$ is the output gap, u_t is a vector of supply shocks thought to shift the Phillips curve, ε_t is a normally distributed random error, and $\alpha(L)$, $\beta(L)$, and $\gamma(L)$ are polynomials in the lag operator. The lags of inflation are an autoregressive or adaptive representation of inflation expectations, which is consistent with the form of the Phillips curve in Staiger et al., (1997) and Rudebusch and Svensson (1999). However, the problem with this formulation is that its theoretical foundation is questionable. Yet, as Mankiw (2001) points out, the assumption of adaptive expectations is in essence what the data is crying out for.[5]

2.1 Data and Empirical Analysis

We use seasonally adjusted monthly data from 1995:4 to 2005:3. Inflation (π) is defined as a year-on-year percentage change in the wholesale price index (WPI- all items) with the base 1993-94=100. The output gap ($\tilde{y}$) is measured as the difference between the index of industrial production and its Hodrick-Prescott trend. In India, no measure of core inflation is publicly available. An obvious and immediately available proxy for core inflation is the percentage change in WPI for manufactured products (see Acharya, 2001). The main advantage of this measure is that it eliminates primary products (whose prices are most likely to be subject to temporary supply shocks) and fuel and energy (whose prices are often administered), from the WPI. Thus, core inflation ($\pi^{WPI(M)}$) is defined as a year-on-year percentage change in WPI for

[5] The rational expectations hypothesis has much appeal for reasons that were widely discussed in the 1970s. So, instead of (2.1) we estimated a New Keynesian version of the Phillips curve (where future inflation expectations appear as an explanatory variable) by taking into account the role of supply shocks. We followed the technique proposed by McCallum (1976) of using the actual future value of inflation as a proxy and then restricting the information used in estimation by using instruments. We used the GMM as the basis for the estimation of the parameter vector with an optimal weighting matrix that accounts for possible serial correlation in the errors. But the estimates we obtained were not precise. They were generally not significant because the estimated standard errors were large both on the coefficient estimate and on the equation as a whole.

manufactured products. As a robustness check we also experimented with an alternative measure of core inflation, the 20% trimmed mean of headline WPI (π^{TM}). Finally, we consider two proxies for supply shocks (u): 1) the year-on-year percentage change in the WPI index for primary commodities (not seasonally adjusted) relative to the respective price index ($u(A)$) and 2) the year-on-year percentage change in the WPI index for fuel, power, light and lubricants (not seasonally adjusted) relative to the respective price index ($u(O)$).[6]

2.2 Unit Root Tests

Following standard practice we begin by testing all these series for stationarity. We apply the standard ADF test and the Kwiatkowski, Phillips, Schmidt, and Shin (1992) test. The ADF test has a null hypothesis of non stationarity with critical values provided by MacKinnon (1996). An important practical issue for the implementation of the ADF test is the specification of lag length since the ADF test results are sensitive to the choice of lag length. Specifically, there are well documented problems with unit root tests when the chosen lag is too small. As shown by Hall (1994) and Ng and Perron (2001), the ADF test suffers from low power when the lag length is too small and leads to too few rejections of the null.[7] As an alternative to the ADF test we also use the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test which has a null of stationarity and the critical values are provided by KPSS. Table 1 reports the results from these unit root tests. All the variables are I(0) according to both the tests except

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[6] The main advantage of $u(A)$ is that unlike oil prices the administrative mechanism covers very limited number of agricultural commodities.

[7] If lag length is too small then the remaining serial correlation in the errors will bias the test. Monte Carlo experiments suggest it is better to error on the side of including too many lags. The BIC criterion selects a lag of only 1 for $u(A)_{\pi}$ and $u(A)_{\pi^{WPI(M)}}$. Here, the reported ADF test statistics are for autoregressive lag length chosen by the AIC criteria.

the year-on-year percentage change in WPI index for primary commodities relative to headline WPI ($u(A)_\pi$) which is not trend stationary according to the ADF test. Given these results we proceed with the estimation of the Phillips curve (2.1) assuming that all variables are stationary.

2.3 Estimation Results

Columns 1 and 2 in Table 2 summarise the regression results with π and $\pi^{WPI(M)}$ as dependant variables respectively. These results are for the set of preferred specification as measured by parameter parsimony, statistical fit, and plausibility of the estimated lag structure. The proxy for supply shock used here is the percentage change in the WPI index for primary commodities relative to the respective price index $u(A)$ i.e., headline WPI index in this case. Inflation persistence and expected inflation are captured by lags of the dependent variables with the coefficients constrained to 1. That is, a vertical long run Phillips curve is imposed in estimation.[8] Five lags were required in the model to remove autocorrelation. As for the diagnostics, the residuals do not exhibit evidence of heteroskedasticity, serial correlation or non-normality.[9]

In headline WPI (π) specification the sum of the output gap terms is not significant. In this regard Callen and Chang (1999) and Nachane and Lakshmi (2002) argue that unlike many other countries the output gap model does not perform well on Indian data. This is mainly because of a lack of a reliable data for potential GDP. The supply shock term in the current period is highly significant. The contemporaneous impact of

[8] As a robustness check, we carried out estimation without imposing the constraint. The sum of the coefficients of unconstrained equation is always close to 1 (0.88 in WPI) and imposing the constraint has little effect on the results.
[9] Note that standard Durbin-Watson test is invalid and is biased in the presence of lagged dependant variables. Hence, Breusch-Godfrey LM test results are reported.

agricultural supply shock on the headline WPI inflation is consistent with the fact that agricultural commodities have a substantial share in headline WPI. However, after a lag of three months the impact of these shocks on the headline measure dies down. Crucially, the Wald test for testing the null hypothesis that the coefficients on current and lagged supply shock terms are jointly zero cannot be rejected with a significance level of 0.79.

In the core inflation ($\pi^{WPI(M)}$) specification (column 2 in Table 2), the first lag of output gap is negative and significant. The negative sign of the coefficient is contrary to the theory, but is consistent with the other studies for India (see Callen and Chang, 1999). As for the coefficients of supply shock, there is a negative effect of supply shock on core inflation in the current period and a positive effect with a one period lag. This makes sense: since supply shocks are excluded from $\pi^{WPI(M)}$, they should affect it only with a lag. Once again the hypothesis that the supply shock terms sum to zero cannot be rejected, with a significance level of 0.65. As for the diagnostics, the residuals do not exhibit significant evidence of heteroskedasticity or serial correlation. However, there is evidence of non-normality in the residuals. This could arise as a result of a mis-specification of the model or due to the existence of a structural break in the series. The CUSUM and CUSUMQ tests do not show any evidence of a structural break.

Further, we investigate the possibility of mis-specification of the model. Many researchers have argued that the deleterious economic effects of supply shocks (rise in commodity prices) on inflation may be substantially stronger than its favourable effects (fall in commodity prices). We investigate this by allowing for asymmetry in the response of core inflation measure to supply shocks (see Mork, 1989). That is, we incorporate real supply shock increases $u(AI)$ and decreases $u(AD)$ as separate variables in the core inflation specification, where $u(AI)$ equals $u(A)$ when $u(A) > 0$ (i.e., when supply shocks are negative) and zero otherwise. Similarly, we define $u(AD)$ equals $u(A)$ when $u(A) < 0$ (i.e., when supply shocks are positive) and zero otherwise. These results are reported in column 3 in Table 2.

The errors turn out to be normal when we incorporate asymmetric inflation response to supply shocks. Moreover, the coefficients on supply shock increases are significantly different from zero, and similar to the coefficients on supply shock themselves. The coefficients on supply shock decreases, by contrast, are not statistically significant. Furthermore, there is no evidence of a permanent effect of supply shock (either positive or negative) on $\pi^{WPI(M)}$, since the hypothesis that the supply shock (increase and decrease) terms sum to zero cannot be rejected at conventional significance level.

We test for robustness of these results by replacing $u(A)$ with the WPI index for fuel, power, light and lubricants relative to the respective price index $u(O)$. Broadly speaking, the results reported in Table 3 are similar to the once reported in Table 2. Moreover, the results are also consistent with much of the broader macroeconomic literature on energy shocks, which finds that energy price shocks exert asymmetric effects on inflation. Once again, there is no evidence of a permanent effect of energy price shock on core inflation.

It is important to note that different methods used to estimate core inflation give different estimates (see Reddy, 1999 on this point). The $\pi^{WPI(M)}$ measure used in the preceding analysis has drawbacks of one kind or another. For example, the exclusion method on which it is based is not considered to be robust as past volatility of a certain sub-component of the index may not be a reliable guide to future volatility. In such circumstances, it is probably sensible for central banks, and perhaps also for those evaluating central bank behaviour, to pay attention to a variety of core inflation measures. As a result we re-estimate our Phillips curve using an alternative measure of core inflation- the 20% trimmed mean (π^{TM}) based on Bryan and Cecchetti (1994). The estimator is calculated by excluding a certain percentage of the largest and smallest (weighted) price changes among the components of headline WPI. Moreover, unlike $\pi^{WPI(M)}$ it does not require *a priori* judgement about which components to include or exclude permanently. Rather, components' price changes are included or excluded on the basis of their magnitudes.

Columns 1 and 2 in Table 4 summarise the regression results with π^{TM} as dependant variable. The first column reports estimates of (2.1) with $u(A)$ used as a proxy for supply shock while the second column reports results with $u(O)$. These results are similar to the once reported in Tables 2 and 3. However, unlike estimates with $\pi^{WPI(M)}$ we don't see any evidence of non-normality in the residuals with π^{TM}. As pointed out earlier different methods used to estimate core inflation give different estimates. Hence, it is not surprising that the evidence of mis-specification we obtain with $\pi^{WPI(M)}$ is not robust. Nevertheless, the hypothesis that supply shocks only have a transitory effect on core inflation cannot be rejected irrespective of the measure of core inflation used in the analysis.

Overall, our results suggest that supply shocks exerted a transitory effect on both measures of core inflation and influenced headline inflation primarily in accordance with their weights in the overall index. This suggests that irrespective of the price index used in the analysis the business cycle effects of supply shocks are fairly benign. An interesting question nevertheless is why do supply shocks only have a transitory effect on all these measures of inflation? Evaluating the Reserve Bank of India's (RBI) policy response to supply shocks may be the key to understanding this.

3. Supply shocks and monetary policy

This section evaluates the RBI's monetary policy stance in response to supply shocks. The model derived in this section follows to a great extent Svensson (1997). The model has three main elements: a multiperiod objective function for the central bank, an aggregate supply equation, and a rational expectations assumption.[10]

The central bank is assumed to minimise an intertemporal quadratic loss function:

$$L = \sum_{t=0}^{\infty} \beta^t \left[\lambda (\tilde{y}_t)^2 + (\pi_t)^2 \right], \qquad \lambda > 0 \qquad (3.1)$$

where the target inflation rate (π^*) is assumed to be zero. The central bank discounts future variability in the output gap ($\tilde{y}$) and inflation (π) by the factor β. The parameter 'λ' is the relative weight on output gap stabilization. Furthermore, we assume that the output gap is given by a traditional Lucas-style Phillips curve with persistence:

$$\tilde{y}_t = \rho \tilde{y}_{t-1} + \alpha_0 \left(\pi_t - \pi_t^e \right) + u_t, \qquad \rho, \alpha_0 > 0 \qquad (3.2)$$

where π_t^e is inflationary expectations formed rationally conditional on all available information, and u_t is a real supply shock. The autoregressive term in the Phillips curve acts as a proxy for market imperfections which prevents instantaneous

[10] Since monetary policy evaluation requires a realistic model of how policy impacts inflation and the real economy, we have assumed that expectations are rational.

adjustment of output/ inflation following a shock. This friction could arise as a result of wage contracts, menu costs, transactions costs, etc.

Finally, following Christensen (2001) we introduce a money demand relationship given by the quantity theory, where m_t is money growth rate

$$m_t = \pi_t + \tilde{y}_t, \tag{3.3}$$

where money velocity is set to zero for convenience and $y_{t-1} = y^*$ i.e., we assume that the economy in the previous period was at its natural rate level.

Minimizing the loss function (3.1) conditional on the Phillips curve yields the solution for inflation:[11]

$$\pi_t = -\left(\frac{\alpha_0 \lambda \rho}{1-\beta\rho^2}\right)\tilde{y}_{t-1} - \left(\frac{\alpha_0 \lambda}{1-\beta\rho^2 + \alpha_0{}^2 \lambda}\right)u_t, \tag{3.4}$$

where inflationary expectations can be shown to be given by $\pi_t^e = -\left(\frac{\alpha_0 \lambda \rho}{1-\beta\rho^2}\right)\tilde{y}_{t-1}$ i.e., there is state-dependent bias. The solution for optimal monetary policy can be obtained by substituting (3.2) and (3.4) in (3.3). This gives us:

$$m_t = \rho\left(\frac{1-\beta\rho^2 - \alpha_0 \lambda}{1-\beta\rho^2}\right)\tilde{y}_{t-1} + \left(\frac{1-\beta\rho^2 - \alpha_0 \lambda}{1-\beta\rho^2 + \alpha_0{}^2 \lambda}\right)u_t \tag{3.5}$$

Substracting (3.4) from (3.5) yields a model that can be estimated in order to analyze the influence of supply shocks on the money growth-inflation relationship. Thus, we have:

$$m_t - \pi_t = \rho\tilde{y}_{t-1} + \left(\frac{1-\beta\rho^2}{1-\beta\rho^2 + \alpha_0{}^2 \lambda}\right)u_t \tag{3.6}$$

[11] Details of the solution procedure are presented in Svensson (1997) and Dittmar et al., (1999).

Eq. (3.6) gives a potential explanation of the short run behaviour of the money growth-inflation relationship. That is, the model can explain why during periods of negative supply shock (higher prices of oil) the inflation rate can exceed the money growth rate. Alternatively, low inflation rates are indeed consistent with higher money growth in the short run.[12] However, note that in the long run $E(m) = E(\pi)$ i.e., money is neutral.

Finally, for empirical tractability we express (3.6) in error-correction form (see Christensen, 2001), that is:

$$m_t = \delta_0 m_{t-1} + \delta_1 \pi_t + \delta_2 \pi_{t-1} + \delta_3 \Delta\tilde{y}_{t-1} + \delta_4 \Delta u_t$$

or

$$\Delta m_t = \delta_1 \Delta\pi_t + \delta_3 \Delta\tilde{y}_{t-1} + \delta_4 \Delta u_t - (1-\delta_0)\left[m_{t-1} - \left(\frac{\delta_1 + \delta_2}{1-\delta_0}\right)\pi_{t-1}\right], \qquad (3.7)$$

where Δ is the first difference operator and δ_i's are constant parameters. The advantage of the error correction specification is that it is possible to incorporate and test a long-run one-to-one relationship between the inflation rate and the money growth rate, as well as allow for changes in money growth as a result of a supply shock depending on the actions of the policymaker. Imposing the long run restriction that $E(m) = E(\pi)$, which essentially means that $\delta_1 + \delta_2 = 1 - \delta_0$, we can determine our regression model as

$$\Delta m_t = \sum_{i=0}^{N} \delta_{1i} \Delta\pi_{t-i} + \sum_{i=0}^{N} \delta_{3i} \Delta\tilde{y}_{t-i-1} + \sum_{i=0}^{N} \delta_{4i} \Delta u_{t-i} - \lambda(m_{t-1} - \pi_{t-1}), \qquad (3.8)$$

where m is base money growth and π is headline inflation. Our initial estimation of (3.8) uses six lags of the explanatory variables. Insignificant lags were excluded until

[12] Note that we had assumed that money velocity is zero in this model for convenience. If we relax this assumption then velocity shocks provide an additional explanation for why the money growth-inflation relationship gets distorted in the short-run.

the lowest root-mean-squared-error (RMSE) was obtained. These results are reported in Table 5. The first column reports estimates of (3.8) with $u(A)$ used as a proxy for supply shock while the second column reports results with $u(O)$. First, the long run restriction ($\delta_1 + \delta_2 = 1 - \delta_0$) is not rejected in both these regressions since the error-correction term is negative and significantly different from zero. Second, policy has not reacted to supply shocks since the sum of supply shock coefficients is not significantly different from zero in either of these regressions. It appears therefore that during this period the RBI has implicitly focused on a core measure of inflation by discounting price movements that are expected to be reversed in the in the short-run.

Our results are also consistent with statements emanating from the RBI. Extracts of former Governor Bimal Jalan's *Monetary Policy Statement* of April 1999 in this regard reads: "……………. *A similar dilemma arises when inflation rate accelerates because of supply shocks, which are expected to be temporary. This, for example, was the situation last year when, until October, inflation was accelerating due to lower availability of a few primary commodities. The Reserve Bank at that time chose not to tighten monetary policy in the expectation that the price risk would reverse itself later in the year when agricultural supplies improve. In retrospect, this judgement turned out to be correct. However, if it had not, and inflation had accelerated further, monetary policy would have required much sharper tightening in the subsequent months of the year*."

Acharya (2001) notes: "*A very sharp increase in consumer prices and the modest rise in WPI posed a difficult conundrum for monetary policy in the autumn of 1998. While the price trend called for a further tightening of monetary policy, the continuing slack in industrial production and investment pointed towards easing of credit conditions.*

The RBI correctly diagnosed the supply shock driven price rise as temporary and largely self-correcting and therefore refrained from tightening monetary policy further. The deceleration of inflation for March 1999 vindicated this judgement."

Thus, by all accounts monetary policy has not provided the basis for a sustained change in the inflation process. Hence, negative supply shocks though they temporarily raise headline inflation, have tended to have a modest and transient effect. In this regard a recent survey by the Federation of Indian Chamber of Commerce and Industry (FICCI) on 'Emerging Oil Price Scenario and the Indian Industry' conducted during the month of October-November 2004 is quite revealing.[13] The survey (conducted at a time when oil prices shot up to $50 a barrel) revealed that as many as 77% of the 147 companies studied said their cost of production had risen by up to 20% due to rising oil prices. However, despite this increase in costs, a majority 60% reported that this incremental cost was being absorbed internally instead of increasing their product prices. 38% reported that they are taking in a part of the incremental cost internally and passing the rest to the consumer. Only 2% were found to pass it on fully to the consumers through increased prices.

The response of these firms suggests that strengthening of competition in the product market since liberalization has limited the extent to which oil prices and induced wage effects can be passed on to customers. This was of course feasible because monetary authorities did not allow inflationary impulses as a result of negative supply shocks to gain a permanent hold. That is, oil-induced wage-price spirals were not being validated by an accommodative policy stance.

[13] The survey covered companies with a wide geographical and sectoral spread. The turnover of the companies that participated in the survey ranged from Rs. 1 crore to Rs. 60, 000 crore.

4. Conclusion

Structuralist thinking has been, and still is, influential in India. In fact, many researchers felt that inflation was endemic in the process of economic growth and it was accordingly treated more as a consequence of structural imbalance than as a monetary phenomenon. In contrast, we argue that the crucial determinant of inflation is not supply shocks *per se* but how monetary policy responds to these shocks. This is not of course to deny that supply failure may almost inevitably give rise to a temporary bout of inflation. The statistical evidence presented here is consistent with the view that in the absence of monetary accommodation, the business cycle affects of negative supply shocks are fairly benign. Hence, we conclude that inflation is a phenomenon of policy.

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Table 1: Unit Root Tests

Variable	ADF		KPSS	
	level stationary	trend stationary	level stationary	trend stationary
π	-4.33***	-4.35***	0.14	0.16
$\pi^{WPI(M)}$	-3.03**	-3.13*	0.21	0.21
$\tilde{y}$	-3.31**	-3.42**	0.16	0.08
$u(A)_{\pi}$	-2.8*	-3.06	0.35	0.06
$u(A)_{\pi^{WPI(M)}}$	-3.03**	-3.13*	0.40	0.05
$u(O)_{\pi}$	-3.89* **	-3.88**	0.14	0.13
$u(O)_{\pi^{WPI(M)}}$	-3.82***	-3.87**	0.15	0.15
π^{TM}	-4.06***	-3.79**	0.47	0.19
$u(A)_{\pi^{TM}}$	-3.45***	-3.77**	0.27	0.05
$u(O)_{\pi^{TM}}$	-3.71**	-4.03***	0.15	0.14

Notes: ***, **, * denote significance of rejection at 1, 5 and 10% respectively. MacKinnon (1996) critical values are used for the ADF test and Kwiatkowski et al., (1992) for the KPSS test. The reported ADF test statistics are for autoregressive lag length chosen by the Akaike information criteria. The KPSS test uses the Barlett Kernel with Newey-West bandwidth selection.

Table 2: Phillips Curve Regressions (sample period 1995:4 to 2005:3)

	π	$\pi^{WPI(M)}$	$\pi^{WPI(M)}$ (asymmetry)
C	-0.011 (0.06)	-0.01 (0.06)	-0.019 (0.12)
$\tilde{y}_{t-1}$	0.02 (0.06)	-0.07* (0.04)	-0.09* (0.05)
$\tilde{y}_{t-2}$	-0.01 (0.06)	0.01 (0.05)	0.005 (0.05)
$\tilde{y}_{t-3}$	-0.04 (0.06)	-0.05 (0.05)	-0.04 (0.06)
$u(A)_t$	0.82*** (0.27)	-0.40*** (0.15)	
$u(A)_{t-1}$	-1.29*** (0.47)	0.58*** (0.19)	
$u(A)_{t-2}$	0.81** (0.35)	-0.22 (0.14)	
$u(A)_{t-3}$	-0.37 (0.23)	0.01 (0.09)	
p-value^{+}	0.79	0.65	
$u(AI)_t$			-0.49** (0.22)
$u(AI)_{t-1}$			0.59** (0.27)
$u(AI)_{t-2}$			-0.25 (0.21)
$u(AI)_{t-3}$			0.13 (0.10)
p-value^{+}			0.80
$u(AD)_t$			-0.20 (0.26)
$u(AD)_{t-1}$			0.51 (0.37)
$u(AD)_{t-2}$			-0.11 (0.22)
$u(AD)_{t-3}$			-0.28 (0.26)
p-value^{+}			0.77
Nobs	115	115	115
RMSE	0.67	0.54	0.54
Log likelihood	-111.38	-85.64	-84.3
Adj R^2	0.83	0.91	0.91
AIC criterion	2.14	1.69	1.74
BIC criterion	2.43	1.98	2.13
SE of regression	0.63	0.51	0.50
White Hetero test^{++}	0.56	0.79	0.45
Jarque-Bera Normality^{++}	0.35	0.08	0.11
B-G, lags(5)$^{++}$	0.62	0.13	0.36

Note: All equations include five lags of the dependant variable. Newey-West standard errors in the brackets. $^{+}$ *P*-value for the Wald test for the hypothesis that the sum of coefficients of supply shock terms is jointly zero. $^{++}$ *P*-values for diagnostics

Table 3: Robustness with Oil Shock (sample period 1995:4 to 2005:3)

	π		$\pi^{WPI(M)}$		$\pi^{WPI(M)}$ (asymmetry)	
C	-0.08	(0.08)	-0.08	(0.07)	-0.014	(0.07)
$\tilde{y}_{t-1}$	-0.07	(0.07)	-0.04	(0.04)	-0.036	(0.05)
$\tilde{y}_{t-2}$	-0.04	(0.06)	0.01	(0.04)	0.011	(0.05)
$\tilde{y}_{t-3}$	0.05	(0.07)	-0.12^{***}	(0.04)	-0.12^{*}	(0.04)
$u(O)_t$	0.60^{***}	(0.18)	-0.13	(0.09)		
$u(O)_{t-1}$	-0.64^{***}	(0.25)	0.43^{***}	(0.15)		
$u(O)_{t-2}$	0.12	(0.19)	-0.15	(0.11)		
$u(O)_{t-3}$	-0.01	(0.12)	-0.09	(0.10)		
p-value $^{+}$	0.13		0.08			
$u(OI)_t$					-0.11	(0.11)
$u(OI)_{t-1}$					0.37^{*}	(0.16)
$u(OI)_{t-2}$					-0.09^{**}	(0.11)
$u(OI)_{t-3}$					-0.141	(0.08)
p-value $^{+}$					0.42	
$u(OD)_t$					-0.19	(0.21)
$u(OD)_{t-1}$					0.79^{***}	(0.50)
$u(OD)_{t-2}$					-0.554	(0.43)
$u(OD)_{t-3}$					0.296	(0.66)
p-value $^{+}$					0.09	
Nobs	115		115		115	
RMSE	0.66		0.52		0.53	
Log likelihood	-109.92		-82.44		-80.7	
Adj R^2	0.84		0.92		0.92	
AIC criterion	2.12		1.64		1.68	
BIC criterion	2.40		1.92		2.06	
SE of regression	0.63		0.5		0.48	
White Hetero test $^{++}$	0.51		0.64		0.45	
Jarque-Bera Normality $^{++}$	0.84		0.04		0.11	
B-G, lags(5) $^{++}$	0.07		0.24		0.38	

Note: All equations include five lags of the dependant variable. Newey-West standard errors in the brackets. $^{+}$ *P*-value for the Wald test for the hypothesis that the sum of coefficients of supply shock terms is jointly zero. $^{++}$ *P*-values for diagnostics

Table 4: Robustness with 20% Trimmed Mean inflation (sample period 1995:4 to 2005:3)

	π^{TM}	π^{TM}
C	-0.00 (0.04)	-0.07 (0.06)
$\tilde{y}_{t-1}$	-0.04 (0.03)	-0.07** (0.03)
$\tilde{y}_{t-2}$	-0.02 (0.03)	-0.02 (0.03)
$\tilde{y}_{t-3}$	0.05 (0.04)	0.07*** (0.04)
$u(A)_t$	0.00 (0.03)	
$u(A)_{t-1}$	0.03 (0.05)	
$u(A)_{t-2}$	-0.02 (0.04)	
$u(A)_{t-3}$	0.02 (0.03)	
p-value+	0.27	
$u(O)_t$		0.08* (0.02)
$u(O)_{t-1}$		-0.09* (0.03)
$u(O)_{t-2}$		0.02 (0.04)
$u(O)_{t-3}$		0.00 (0.02)
p-value+		0.32
Nobs	115	115
RMSE	0.46	0.43
Log likelihood	-66.2	-59.7
Adj R^2	0.78	0.80
AIC criterion	1.36	1.25
BIC criterion	1.65	1.53
SE of regression	0.45	0.43
White Hetero test ++	0.80	0.75
Jarque-Bera Normality++	0.63	0.84
B-G, lags(5) ++	0.57	0.28

Note: All equations include five lags of the dependant variable. Newey-West standard errors in the brackets. + *P*-value for the Wald test for the hypothesis that the sum of coefficients of supply shock terms is jointly zero. ++ *P*-values for diagnostics

Table 5: RBI's Policy Reaction Function
(sample period 1995:4 to 2005:3)

	Δm_t		Δm_t	
$\Delta\pi_t + \Delta\pi_{t-1}$	0.61**	(0.05)	0.63*	(0.08)
$\Delta\tilde{y}_{t-1}$	-0.20	(0.20)	-0.27	(0.12)
$\Delta u(A)_t + \Delta u(A)_{t-1}$	-1.03	(0.28)		
$\Delta u(O)_t + \Delta u(O)_{t-1}$			-1.10	(0.12)
$m_{t-1} - \pi_{t-1}$	-0.08***	(0.00)	-0.07***	(0.01)
Nobs	118		118	
RMSE	2.26		2.35	
Log likelihood	-260.31		-265.11	
R^2	0.18		0.12	
Adj R^2	0.14		0.07	
White Hetero test^{++}	0.53		0.74	
Jarque-Bera Normality^{++}	0.83		0.94	
DW statistics	2.21		2.22	

Note: ***, **, * Significant at 1 and 5 and 10% respectively. *p*-values are reported in the brackets. $^{++}$ *p*-values for diagnostics