Inflation and Economic Growth in India –An Empirical Analysis

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Abstract

This paper seeks to examine the relationship between inflation and GDP growth in India. An empirical evidence is obtained from the cointegration and error correction models using annual data collected from the Reserve Bank of India. The result shows that there is a long-run negative relationship between inflation and GDP growth rate in India. Inflation is harmful rather than helpful to growth. These results have important policy implications.

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I. INTRODUCTION

The relationship between inflation and growth remains a controversial one in both theory and empirical findings. Originating in the Latin American context in the 1950s, the issue has generated an enduring debate between *structuralists* and *monetarists*. The structuralists believe that inflation is essential for economic growth, whereas the monetarists see inflation as detrimental to economic progress. There are two aspects to this debate: (a) the nature of the relationship if one exists and (b) the direction of causality. Friedman (1973: 41) succinctly summarized the inconclusive nature of the relationship between inflation and economic growth as follows: "historically, all possible combinations have occurred: inflation with and without development, no inflation with and without development".

The impact of inflation on growth, output and productivity has been one of the main issues examined in macroeconomics. Theoretical models in the money and growth literature analyze the impact of inflation on growth focusing on the effects of inflation on the steady state equilibrium of capital per capita and output (e.g., Orphanides and Solow, 1990). There are three possible results regarding the impact of inflation on output and growth: i) none; ii) positive; and iii) negative. Sidrauski (1967) established the first result, showing that money is neutral and superneutral1 in an optimal control framework considering real money balances (M/P) in the utility function. Tobin (1965), who assumed money as substitute to capital, established the positive impact of inflation on growth, his result being known as the Tobin effect. The negative impact of inflation on growth, also known as the anti-Tobin effect, is associated mainly with cash in advance models (e.g., Stockman, 1981) which consider money as complementary to capital.

Following Friedman's (1977) Nobel Lecture the theoretical and empirical research on the relationship between inflation and output growth has progresses along two distinct lines. The first line of research starting with Friedman's hypothesis that higher nominal inflation raises inflation uncertainty, has tended to investigate the relationships among inflation, inflation uncertainty, growth and growth uncertainty. The second line of research has tended to remain within the traditional macroeconomics and investigate the relation between inflation and growth without reference to inflation uncertainty and growth uncertainty.

This study follows the second line and examines the nature of the relation between inflation and growth in the Indian economy. Within the second line of research two distinct camps, with

opposite predictions on the relation between inflation and growth, have distinguished themselves. Researchers of the first camp base their arguments on the Phillips curve and output gap, defined as the difference between actual and potential output and assert a positive relation between inflation and growth. The underlying reasoning is that if actual output rises above potential output, this will create an upward pressure on wages in the labor market. Higher wages, in turn, will lead to higher production costs and hence higher prices. This conclusion has been supported by empirical findings. Gerloch and Smets (1999), for instance, show that 1% increase over potential output raises inflation by 0.2% in the subsequent quarter in the EMU-5 countries. Moreover, since inflation is serially correlated, future inflation rate will also rise. Another interesting study has been undertaken by Paul *et al*. (1997) who work with data pertaining to 70 countries and the 1960-1989 periods. They report that the relation between inflation and growth is positive only in some countries. Mallik and Chowdhury (2001) analyse inflation-growth dynamics in four South Asian countries (Bangladesh, India, Pakistan and Sri Lanka) and find statistically significant evidence of a positive relation between these two variables.

Researchers belonging to the second camp base their arguments on the Real Business Cycle theories and assert that inflation negatively affects growth. One of the main studies investigating this negative relationship between inflation and growth has been carried out by Kydland and Prescott (1990). These authors argue that supply shocks, not demand shocks, are responsible for the inverse relationship. Supply shocks render the prices countercyclical, while demand shocks cause pro-cyclical moves in prices towards output. However, there is a condition to be taken into account: Price flexibility. In an environment with sticky prices, a demand shock will increase the output while prices move very little. As output is on the way towards its trend, prices may be rising. Hence, a negative correlation between these variables can also be observed even when a demand shock is responsible for these movements. Ball and Mankiw (1994) and Judd and Trehan (1995) study these effects. In addition, Den Haan and Wouter (2000), by using long forecast horizons within a VAR framework, argues that a negative correlation between inflation and growth exists.

Yet another study showing the divergence of output growth from inflation in developing countries is that of Agenor and Hoffmaister (1997), who employ generalized VAR analysis to examine the short run dynamics among inflation, output, nominal wages and exchange rate. They find that a fall in the depreciation of the exchange rate reduces inflation and stimulates output. But the expansion in output is short lived. Kirmanoglu (2001), by employing VAR models shows that high inflation rates in Turkey cause lower economic growth. Mendoza (2003) finds evidence of inflation-output trade off in

the Turkish economy using VAR and GARCH models. Beside VAR models, panel data studies also support this negative relationship, especially for countries that suffer from high inflation. Barro (1996), for instance, shows that a negative relation exists for a set of countries that had inflation rates above 15%. Judson and Orphanides (1996) use a 10% threshold. Bruno and Easterly (1998) argue in favor of a 40% inflation as the relevant threshold inflation rate. Ghosh and Philips (1998) find a positive effect for low inflation rates, but for those above 5% they find a non-linear negative effect.

Based on cross-country and panel regression, several studies have demonstrated in recent years, that there is negative correlation between inflation and growth in the long run due to the influence of the former on reducing investment and productivity growth. There is yet another set of studies (Bruno & Easterly, 1998, Sarel, 1996) which show that harmful effects of inflation are not universal, but appear only over the "threshold" level of inflation. Nevertheless, there is the growing concern in developed countries; particularly in the EMU area that excessively low inflation threshold may hurt economic growth. It is argued that the developed countries do have very well developed financial markets and less government interventions in goods markets. Such economies are mostly demand driven, in which case stimulus to demand results in rising prices and a clear trade off is observed at low level of inflation. On the other hand, the developing countries are more vulnerable to supply shocks causing high variability in inflation and disturb the consumption, investment and production behaviour. Further, the government interventions in financial and goods markets and macroeconomic rigidities such as rigidities in labour laws cause market failure and macroeconomic instability. Therefore, prices do not give correct signals about the policies and the course of actions of the economic agents.

It is in this context, it will be interesting to know the inflation-growth nexus in developing countries. The objective of this study is to examine the inflation-growth nexus in India using annual data for the period 1972–2007. We will examine the relationship between growth and inflation in India. In the short run, the relationship between growth and inflation is usually positive. Policies that raise output (for example, expansionary fiscal and monetary policies) also raise prices. Inflation is undesirable because it adversely affects some sections of the population (especially the poor and those whose earnings are not indexed to prices), distorts relative prices, leads to an appreciation of real exchange rates, erodes the value of the financial assets and creates instability. The ultimate policy objective is a higher level of well-being for the population, but a conflict arises in the means of achieving it—by higher growth or by lower inflation. There is a trade-off involved and both cannot be achieved together.

A tightening of fiscal and monetary policies may achieve lower inflation but only at the cost of growth. The government needs to find the right balance between contractionary and expansionary policies to maximise the well-being of its people.

Macroeconomics has, until recently, focused on the positive short-term relationship between the rate of increase in prices, and output. Recently there has been an exploration into the nature of the long-term relationship between inflation and long-term growth in output. Developments in growth theory have resulted in both a theoretical and an empirical analysis of the effect of inflation on long-term growth. Theoretically the relationship has been located in the effect of inflation on investment. If investment is assumed to be the engine of growth in a model of endogenous growth, an adverse impact of inflation on investment implies an inverse relationship between inflation and growth. Empirical evidence supports the hypothesis of an inverse relationship between inflation and long-term growth. This is in contrast to the short-term experience, where inflation and output growth occur together.

Growth and inflation in the Indian economy:

The growth rate of GDP in India increased from 3.5 % in the 1970s to 5.5 % in the 1980s. This increase in growth has been attributed to both demand and supply-side factors. But it has been suggested that 'Keynesian expansion', or the increase in aggregate demand due to higher government spending and larger fiscal deficits, was primarily responsible for pushing up growth rates (Joshi and Little 1994). In the early 1980s public investment was growing rapidly, but in the second half of the decade it slowed down and government consumption expenditure grew at a much faster pace. The revenue deficit grew, indicating that government consumption was being financed by borrowing, which entailed interest and repayment commitments.

The success of expansionary fiscal policies in raising output growth, at least in the short run, can partly be attributed to the under-utilisation of productive capacity in the preceding years. By the end of the 1980s, when output was above trend levels, fiscal policy continued to be expansionary creating excess demand in the system (Joshi and Little 1994).

The reform of the financial sector consists primarily of a reduction in the statutory liquidity ratio and a rationalisation of subsidised credit to priority sectors, relaxation of interest controls and restrictions on firms' access to capital markets, and more autonomy for public sector banks. The

major reform in the case of public sector enterprises consisted of eliminating privileges such as protection from external and domestic competition and preferential access to budget and bank resources. Though the condition relating to an effective 'exit policy' for the closure or restructuring of money-losing firms in the private and public sector has not been fulfilled, the reforms made have largely been in line with the program's objectives.

Monetary policy and growth:

A noteworthy feature of Indian growth process over the last one and a half decades has been its stability. This is evident from the substantially lower coefficient of variation of real GDP growth during the post-reform period as compared to that during the pre-reform period, that is, before the nineties. It is also important to note that India's growth is driven by domestic consumption, contributing on an average to almost two-thirds of the overall demand, while investment and export demand are also accelerating. As consumption is less volatile component of demand, this has also contributed to reducing the volatility of GDP.

The inflation rate accelerated steadily from an annual average of 1.7% during the 1950s to 6.4 % during the 1960s and further to 9.0 % in the 1970s before easing marginally to 8.0 % in the 1980s. India had generally not experienced runaway inflation. On the other hand, the volatility in the inflation rate, as measured by the coefficient of variation, which was fairly high in the 1950s at 4.4, moved in a narrow band of 0.4–1.0 in the subsequent decades, thus reducing the inflation-risk premium. The pick up in inflation rate from 1970s onwards reflected the impact of a sharp rise in money supply growth and also partly supply shocks from crude oil prices and crop failures. Demand pressures, emanating partly from the widening fiscal imbalances, also contributed to inflationary pressures in the 1980s. The second half of the 1990s was marked by a significant turnaround in the inflation outcome reflecting the improved monetary-fiscal interface.

The "Great Moderation":

One of the defining characteristics of global economic developments over the last three decades has been termed the "Great Moderation" –the sustained decline in the volatility of output and inflation. This development has been due to the structural changes that many economies have undergone. Some have attributed these changes to the implementation of better policy options and others to simply good luck. Professor Kenneth Rogoff of Harvard University has argued on many

occasions that improved competitiveness as a result of increased globalisation coupled with better policies has had a major positive impact on inflationary trends in many countries. The declining trend in inflation since 1990 is clearly evident in India and South Africa. Inflation in India has declined steadily from an average of 10.3 % between 1990–1994, to 8.9 % during 1995–1999 and to 4.3 % in this decade. Similarly in South Africa, inflation has declined from an average of 12.5 %, to 7.3 % and to 5.1 % over the same time periods. The economic growth performance of both countries has also been quite impressive. Since 1990, India has experienced average growth rates of around 6 % per annum.

Inflation could hamper economic growth mainly due to the following reasons

• Economies that are not fully adjusted to a given rate of inflation usually suffer from relative price distortions caused by inflation. Nominal interest rates are often controlled, and hence real interest rates become negative and volatile, discouraging savings. Depreciation of exchange rates lag behind inflation, resulting in variability in real appreciations and exchange rates.

• Real tax collections do not keep up with inflation, because collections are based on nominal incomes of an earlier year (the Tanzi effect) and public utility prices are not raised in line with inflation. For both reasons, the fiscal problem is intensified by inflation, and public savings may be reduced. This may adversely affect public investment.

• High inflation is unstable. There is uncertainty about future rates of inflation, which reduces the efficiency of investment and discourages potential investors.

II. LITERATURE REVIEW

Understanding the relationship between inflation and real growth has all along been a key concern in macro-economic research. According to Rangarajan (1998), the question, in essence, presupposes a possible trade-off between price stability and growth either in the long or short run. The new endogenous growth theories, for instance, surmised that inflation has an adverse impact on growth because of its harmful effects on productivity and efficiency. Others such as Choi, Smith and Boyd (1996) echoed a similar view and argued that inflation, in the presence of information asymmetry can harm growth by accentuating financial markets frictions and thereby adversely affecting the provision and allocation of investment. The rational expectations revolution inter alia, criticised the non-neutrality proposition of Keynesians by arguing that, under flexible markets,

repeated monetary shocks meant to facilitate growth could only lead to ever increasing levels of inflation in the long run [Rangarajan 1998].

Bruno and Easterly (1998) conclude that there was no evidence of a growth-inflation trade-off in a sample which excluded discrete high inflationary crisis. On the other hand, there was ample evidence to show that growth turned sharply negative when inflation crossed past a high threshold rate of 40 % per annum. They also argue that the failure of investigators in detecting a meaningful relationship between inflation and growth can be attributed to a stylised rapid recovery of output after inflation which, on an average, renders the overall statistical relationship insignificant. On the other hand, Sarel (1997) attempts an alternative empirical investigation of the problem and also concludes that inflation affects growth only if it breaches a specific 'threshold' rate of inflation but not otherwise. He concludes that an inflation threshold of about 8 % for a pooled sample of a large number of countries, including India, serves as a good common benchmark for the sample as a whole. Since the common threshold is an estimate from a pooled sample, it may not be exactly suitable for particular country if taken in isolation. There is, therefore, a need to have yet another empirical assessment of the problem of finding the level at which inflation actually begins to erode economic growth in given economy.

Earlier works (for example, Tun Wai, 1959) failed to establish any meaningful relationship between inflation and economic growth. A more recent work by Paul, Kearney and Chowdhury (1997) involving 70 countries (of which 48 are developing economies) for the period 1960-1989 found no causal relationship between inflation and economic growth in 40 % of the countries; they reported bidirectional causality in about 20 % of countries and a unidirectional (either inflation to growth or vice versa) relationship in the rest. More interestingly, the relationship was found to be positive in some cases, but negative in others. Recent cross-country studies, found that inflation affecting economic growth negatively, includes Fischer (1993), Barro (1996) and Bruno and Easterly (1998). Fischer (1993) and Barro (1996) found a very small negative impact of inflation on growth. Yet Fischer (1993: 281) concluded "however weak the evidence, one strong conclusion can be drawn: inflation is not good for longer-term growth". Barro (1996) also preferred price stability because he believed it to be good for economic growth.

Bruno and Easterly's (1998) work is interesting. They note that the ratio of people who believe inflation is harmful to economic growth to tangible evidence is unusually high. Their investigation confirms the observation of Dornbusch (1993), Dornbusch and Reynoso (1989), Levine

and Renelt (1992) and Levine and Zervos (1993) that the inflation-economic growth relationship is influenced by countries with extreme values (either very high or very low inflation). Thus, Bruno and Easterly (1998) examined only cases of discrete high-inflation (40 % and above) crises and found a robust empirical result that growth falls sharply during high-inflation crises, then recovers rapidly and strongly after inflation falls.

Cross-country evidence:

Some recent studies have found cross-country evidence supporting the view that long -term growth is adversely affected by inflation (Kormendi and Meguire 1985; Fischer 1983, 1991, 1993; De Gregorio 1993; Gylfason 1991; Roubini and Sala-i-Martin 1992; Grier and Tullock 1989; Levine and Zervos 1992). Countries (especially in Latin America) that have experienced high inflation rates, have also witnessed lower long-term growth (Cardoso and Fishlow 1989; De Gregorio 1992a, 1992b). This literature is part of the endogenous growth literature, which tries to determine the causes of differences in growth rates in different countries. There is now considerable evidence that investment is one of the most important determinants of long-term growth (Barro 1991; Levine and Renelt 1992). It has often been suggested that a stable macroeconomic environment promotes growth by providing a more conducive environment for private investment. This issue has been directly addressed in the growth literature in the work by Fischer 1991, 1993; Easterly and Rebelo 1993; Frenkel and Khan 1990; and Bleaney 1996.

The effect of macroeconomic instability on growth comes largely from the effect of uncertainty on private investment. Multi-country panel data studies on investment report that measures of macroeconomic instability, like the variability in the real exchange rate or the rate of inflation, have an adverse impact on investment (Serven and Solimano 1992). In a study of 17 countries, Cordon (1990) finds that although there are outliers, evidence generally supports the view that high growth is associated with low inflation.

This is suggested both by cross-country evidence and comparison over time for countries where the rate of growth has fallen in relation to an increased as the rate of inflation. Fischer (1993) examines the role of macroeconomic factors in growth. He found evidence that growth is negatively associated with inflation and positively associated with good fiscal performance and undistorted foreign exchange markets. Growth may be linked to uncertainty and macroeconomic instability where temporary uncertainty about the macro economy causes potential investors to wait for its resolution, thereby reducing the investment rate (Pindyck and Solimano 1993). Uncertainty and

macroeconomic stability are, however, difficult to quantify. Fischer suggests that, since there are no good arguments for very high rates of inflation, a government that is producing high inflation is a government that has lost control. The inflation rate thus serves as an indicator of macroeconomic stability and the overall ability of the government to manage the economy.

Fischer finds support for the view that a stable macroeconomic environment, meaning a reasonably low rate of inflation, a small budget deficit and an undistorted foreign exchange market, is conducive to sustained economic growth. He presents a growth accounting framework in which he identifies the main channels through which inflation reduces growth. He suggests that the variability of inflation might serve as a more direct indicator of the uncertainty of the macroeconomic environment. However, he finds it difficult to separate the level of inflation from the uncertainty about inflation, in terms of their effect on growth. This is because the inflation rate and its variance are highly correlated in cross-country data. Evidence is in favour of the view that macroeconomic stability, as measured by the inverse of the inflation rate and the indicators of macroeconomic trends, is associated with higher growth.

To examine the mechanism through which macroeconomic variables affect growth, Fischer regresses the rate of capital accumulation on these variables. The coefficient of the rate of inflation is found to be negative, suggesting that an important route through which inflation affects growth is the reduction of capital accumulation. Fischer further finds that the inflation rate is negatively correlated with the rate of productivity growth measured by the Solow residual. He also examines the possibility that the above results are due to the inclusion in the sample of countries with very high inflation rates. When the inflation rate is broken into three categories—low (up to 15 %), medium (15 to 40 %) and high (above 40 %)—results show that, contrary to what might have been expected, the association between inflation and growth and its determinants on average weakens as inflation rises. This supports the results obtained by Levine and Zervos (1992). Thus it is not the case that high inflation outliers are responsible for the overall negative correlations between inflation and growth, capital accumulation and productivity growth. Rather, Fischer's results suggest that the association between growth, inflation and capital accumulation is stronger at the low and moderate levels than at high inflation.

De Gregorio (1993) presents evidence from 12 Latin American countries over the period 1950–85. He finds a significant negative correlation between inflation and growth. Though both inflation and its variance have negative effects on growth, since they are highly correlated in cross-

country evidence, the results cannot discriminate whether it is the level or the variability that negatively affects growth. Even when high inflation countries were eliminated from the regression, the impact of inflation was both negative and significant. However, though results suggest a negative relation between inflation and investment in physical capital and foreign investment, the relationship is not significantly different from zero. Though Fischer's results suggest that inflation affects the level of investment, De Gregorio finds that it is the efficiency of investment that is affected and that is what leads to the effect of inflation on growth. This result is supported by cross-country evidence presented in Levine and Renelt (1992). Bleaney (1996) finds that poor macroeconomic policy, measured by fiscal balance and real exchange rate volatility, appears to be negatively correlated with growth. In his sample, inflation is positively correlated with the real exchange rate and when included in the same regression inflation does not appear to have a negative influence on growth. Since the two are correlated, this suggests that the choice of one of the two variables may depend on the degree of openness and the relative influence of the domestic and foreign prices for investment decisions.

High inflation rates also tend to be volatile and the associated negative and unpredictable real interest rates discourage domestic financial savings. Unanticipated high inflation erodes the real value of financial assets and the volatility of inflation increases the risk associated with holding them. Conversely, low-to-moderate inflation, particularly at stable rates, encourages financial savings. Fry (1988) and Gleb (1989) find, from pooled cross-economy time series data, a consistently positive and significant relationship between economic growth and the real rate of interest. To separate the effects of inflation in a financially repressed regime from those of real interest rates, a World Bank study re-estimates the equations (World Bank 1993). Evidence from a sample of twenty countries, for the impact of the real interest rate and the inflation rate on the GNP growth rate is reported. The real interest rate has a statistically significant and positive impact on growth. But when inflation is included, the coefficient for the real interest rate is no longer statistically significant, while the negative coefficient on the rate of inflation is. This suggests that the positive relation between real rate of interest and growth was actually reflecting a negative relation between inflation and growth in financially repressed regimes, where nominal interest rates are kept fixed. Perhaps that is why, for a sub sample of economies for which real interest rates are positive, the coefficients of both the real interest rate and inflation are negative, indicating that lower real interest rates may have had a positive impact on growth. The study also suggests that another condition that was particularly important to investment was public investment in infrastructure. If inflation reduces public saving, public investment is likely to fall.

The Asian experience:

Cross-country evidence appears to support a cross-country negative relationship. In general, countries with higher growth are those with lower inflation rates. A World Bank study finds that the high-performing East Asian countries, that have had sustained high growth for the last three decades, have each had a stable macroeconomic environment that fostered high rates of investment and economic growth (World Bank 1993). Macroeconomic stability has been defined as inflation being kept under control, internal and external debt remaining manageable, and resolving the macroeconomic crisis that emerged within a year or two.

Though the cross-country evidence suggests a negative correlation between inflation and growth, a distinction is not made between open and closed economies among these countries. It may be that the negative correlation is strong in the case of open market economies which rely on private foreign and domestic investment that is encouraged by low inflation and where maintaining export competitiveness and preventing capital flight have a larger role to play. In a closed planned economy, where the reliance on public investment is substantial and financed by inflationary means, the relationship between growth and inflation may even be positive for long periods of time. As India moves from a closed planned economy to an open one, where private domestic and foreign investment is expected to be the engine of growth, it is relevant to examine the impact of inflation on investment.

The empirical evidence also underwent similar changes in views. The evidence of an inverse relationship between inflation and growth was vociferously advocated mainly since the beginning of the 1980s in contradiction to the earlier stands taken by several researchers including Johnson (1967) who indicated that "there was no conclusive empirical evidence one way or the other". However, especially, since the arrival of the new evidence of a negative relationship, a large body of empirical research has explored various paradigms in inflation analysis. Incidentally, much of the empirical literature on the important subject of inflation-growth trade-off is devoted to developing countries as their economies happen to provide rich information with interesting variations in macro-economic activity. Notable among the recent papers that address this relationship are by De Gregorio (1993), Fisher (1993), Barro (1995), Sbordone and Kuttner (1994) and Smyth (1994), all of whom technically confirm that inflation has a negative effect on economic growth. Alternative, recent empirical, exercises by investigators such as Sarel (1997), Bruno and Easterly (1998), however, have questioned this sweeping generalization. They argued that harmful effects of inflation on growth are

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not universal but appear only over the spectrum exceeding a given 'threshold'. These authors also believe that an inflation rate below the threshold may even have positive influences on economic growth.

The quantity theory can be traced to Richard Cantillon and David Hume. As Lucas (1996, p. 662) puts it, "These are two of Hume's statements of what we now call the Quantity Theory of Money: the doctrine that changes in the number of units of money in circulation will have proportional effects on all prices that are stated in money terms, and no effect at all on anything real, on how much people work or on the goods they produce or consume."

The quantity theory thus contains two testable propositions. The first is that long-run inflation rates are equal to money growth rates. The second is the long-run super neutrality of money: A country's long-run rate of real economic growth is independent of its money growth rate. Long-run super neutrality is of course not short-run super neutrality. Bruno and Easterly (1998) showed that countries experiencing short periods of high inflation also experienced decreases in growth of real GDP per capita. But following the episodes of high inflation, their per capita growth rates increased to rates above the world average (1998, tables 2 and 3). Money growth is far from neutral in the short run "The central predictions of the quantity theory are that, in the long run, money growth should be neutral in its effects on the growth rate of production and should affect the inflation rate on a one-for-one basis." (Lucas 1996, p. 665)

Literature on inflation in India: an analytical review:

Existing literature on inflation in India includes papers in a Phillips-curve framework, papers in a Lucas-supply-function framework, and papers that treat inflation as a variable in a larger system of equations or in a vector autoregressive (VAR) model.

Papers in a Phillips-curve framework examine the relation between inflation and the output gap. Out of them, the only paper that explicitly attempts to estimate the Phillips curve for India is, Dholakia (1990).Studying a sample from 1950 to 1985, Dholakia asserts that the Indian economy does not seem to face any appreciable tradeoffs between unemployment and inflation even in the short run. He argues that the least-developed countries having underutilized potential would not experience inflationary pressures if the pace of growth is high. Referring to India, Dholakia concludes, ''an imaginary serious tradeoff between inflation and unemployment, in all probability, is

not likely to exist.''Bhalla (1981) fails to find any evidence of a significantly positive relationship between inflation and excess demand in the Indian economy. Bhalla comments, ''Aggregate changes in real output apparently have no effect on the inflation rate.'' Studying India's manufacturing sector over the period from 1961 to 1977, Rangarajan (1983) asserts a negative correlation coefficient between price change and real-output change. Based on Indian yearly data from 1950 to 1988, Bhattacharya and Lodh (1990) find a weak and negative relationship between inflation and output growth. They also refer to Bhattacharya (1984) who argues that the Keynesian Phillips curve does not work in developing countries like India. Ghani (1991) estimates a price equation for India on a sample from 1967 to 1982. The equation shows a negative sign on output. Balakrishnan (1991) works on a sample from 1950 to 1980 in the Indian manufacturing sector. By regressing inflation on the output gap or the 'activity' variable, Balakrishnan finds a significantly negative relation, which clearly contradicts the Phillips curve for India. In another study on a sample from 1951 to 1990, Nachane and Laxmi (2002) find a negative relation between inflation and the output gap. Brahmananda and Nagaraj (2002) in their claims that the correlation between inflation and growth, if any, is often negative in Indian data from 1970 to 1999. Using the quarterly data from 1983Q1 to 2001Q4 on output series constructed by Virmani and Kapoor (2002) and Virmani (2004) finds a negative relation between the output gap and inflation.

Papers in a Lucas-supply-function framework attempt to see the output gap in response to inflation in India. Following Lucas (1973), Arak (1977) and Makin (1982) one study by Samanta (1986) finds a negative relation between the price level and real output in India. Samanta (1986 attempts to estimate an expectations adjusted supply function (EASF) for India using yearly data from 1952 to 1983. The EASF hypothesis states that price change affects real output or supply only when such price change is purely unanticipated Lucas (1973), Samanta's estimation, which does not justify the EASF for India finds a significantly negative relationship between price surprises and output.

Papers in a VAR model examine the interrelationship of output growth, inflation, and money growth in India. Rangarajan and Arif (1990) using annual data over the period from 1961 to 1985 conclude that the price level has no response to the changes in real output. Das (2003) working with money, price, and output of India over the period from April 1992 to March 2000 shows a negative relationship between price and output. Overall most papers, especially papers that clearly focused on the Phillips curve, do not show that a Phillips curve exists for India. A few papers discuss supply shocks faced by India without adequately incorporating them in estimating inflation. Thus,

three lines of arguments in explaining inflation dynamics in India can be observed. First, supply shocks are held responsible as a vital factor in determining Indian inflation Balakrishnan 1991;Dholakia 1990; Goyal and Pujari 2004;Ramachandran 2004; Second, one group believes that countercyclical money wage is the answer to the negative relation between inflation and the output gap(Ahluwalia 1979;Balakrishnan 1991; Roy and Darbha 2002) Third, another group believes that real marginal cost is not positively correlated with output in India (Chatterji 1989).The first reasoning would imply that the Phillips-curve theory actually fits India, if supply shocks are properly accounted for. The second reasoning implies that firms in India generally do not set prices to maximize profit. The second and the third reasoning, if true, would imply that conventional macroeconomics, as applies to the US, cannot fit India. If the first reasoning is true, which means we can estimate the Phillips curve for India by controlling supply shocks, the second and the third reasoning become contradictory or redundant. To examine the first reasoning, it is imperative at this point to see the major supply shocks to the Indian economy.

Some studies claim that India's economic reform brought a significant change in the nature of the Phillips curve Bhattacharya and Mitra 1997;Paul and Bhanumurthy 1999; Rao 2002) claims that the Phillips curve emerges only in the post-reform era.

In the first group of models (Romer (1993) and Lane (1997)), increased openness to trade lowers inflation by making the Phillips curve *steeper*, i.e. the output-inflation tradeoff smaller; underlying this mechanism is the negative terms of trade effect of a real depreciation, which is triggered by a monetary expansion. Roomer's model applies mainly to countries that are large enough to affect international prices. Lane (1997) shows that this is not a necessary assumption; using a model with imperfectly competitive goods markets and sticky prices in the non-tradeables sector he shows that the output gains from unexpected inflation are smaller in more open economies. Again, one would expect openness to be associated with lower inflation and a smaller output-inflation tradeoff. A further implication of Lane (1997) is that – for a given level of openness – the larger a country, the more reduces the terms of trade effect the benefits from surprise inflation. A negative effect of country size on inflation would point to the relevance of this effect.

The second class of models is provided by Daniels and VanHoose (2006) and Razin and Loungani (2007). In the model by Daniel and VanHoose (2006), characterized by economy wide monopolistic competition, increased openness reduces the pricing power of domestic firms. As a consequence the output-inflation tradeoff becomes larger. At the same time, the reduced pricing

power lowers the output effects, induced by unexpected price increases through a monetary expansion. Hence, one would expect openness to trade to be associated with lower inflation and a larger output-inflation tradeoff. Also note that the model predicts that a higher sensitivity of domestic spending with respect to a real depreciation reduces the output-inflation tradeoff but increases the inflation bias. In larger countries, where trade is a smaller share of domestic spending, terms of trade changes have lower output effects ceteris paribus. Hence, country size should reduce the inflation bias and *increase* the sacrifice ratio.

Many papers have estimated directly the impact of inflation on growth, output, investment and productivity. In this literature, the growth rate of the economy is considered as the dependent variable and the inflation rate as the explanatory variable. The empirical results have a clear policy implication: if inflation affects growth negatively, then monetary policy ought to stress price stability based on vigorous anti-inflationary policies targeting zero inflation.5 Examples of papers that have attempted to follow this line of research are Smyth (1992, 1994, and 1995), De Gregorio (1993), and Barro (1995). Smyth (1992) has estimated a negative relationship between inflation and growth: for each one percentage point increase in the USA inflation the annual growth rate is reduced by 0.223%. Smyth (1994) has also shown that inflation acceleration impacts growth negatively in the USA, each one percentage point increase in acceleration causing a reduction of 0.158% in growth. For Germany, Smyth (1995) has estimated that a 10% increase in the rate of inflation reduces the rate of growth of total factor productivity by 0.025%. Cameron et al. (1996) test the robustness of this kind of estimation and their results are suggestive that there is no connection between inflation and the level of productivity.

Threshold Inflation:

With price stability as the dominant objective of monetary policy, the choice of an appropriate rate of inflation consistent with maximising growth attains importance. Friedman (1969) argued that anticipated inflation should, on average, be negative. Steady deflation - at a rate equal to the real rate of interest - is optimal because only at a nominal zero rate of interest is the marginal opportunity cost of holding cash equal to its marginal production cost (close to zero in practice). If shocks are only nominal and rigidities are symmetrical (of equal size both downward and upward) then near zero inflation may be optimal. However, the real world is marked by existence of nominal rigidities and zero inflation is not an optimal target (Akerlof et al., 1996). Zero inflation is also not

favoured because of the upward bias in measured inflation. Moreover, a target of zero inflation rate increases the level of sustainable unemployment and hence, reduces output. In other words, a long-run output-inflation trade-off may exist at very low levels of inflation. The output effects of this trade-off may be large; for instance, the median increase in the equilibrium unemployment rate associated with zero rather than 3 % inflation is more than 2 percentage points. For Europe, even higher increases in unemployment are indicated (Holden 2002). For all these reasons, a low but positive rate of inflation is favoured as a target for 'greasing the wheels' of the economy (Krugman, 1998).

International evidence shows a wide range for estimates of threshold inflation. While for industrial countries' threshold is placed between 1 to 3 %, for developing countries, it ranges from eight % to 40 % (Bruno and Easterly, 1995; Khan and Senhadji, 2002; Sarel, 1996). The results suggest that threshold is not fixed over time across countries - it is time varying and country specific in nature.

For India, since the second half of the 1990s, a number of studies have attempted to estimate threshold inflation. The Chakravarty Committee (RBI, 1985) referred to an inflation rate of four % as an acceptable rise in prices. This can be regarded as the first influential fix on the threshold rate of inflation in India. More recent studies have made estimates of threshold inflation using Sarel methodology and these estimates place threshold inflation for India in the range of 4-7 % (Kannan and Joshi, 2002; Rangarajan, 1997; RBI, 2003a; Samantaraya and Prasad, 2001; Vasudevan, Bhoi and Dhal, 1998). The estimate of threshold inflation has, however, a shifting perspective (RBI, 2003b). With structural changes in the economy, prolonged price stability at the global level as well as in India and the credible anchoring of inflationary expectations at a lower level, the threshold inflation could also move downwards.

III. COINTEGRATION AND ERROR CORRECTION MODEL

To examine the extent to which economic growth is related to inflation and vice versa, the theory of cointegration and Error Correction Models (ECM) is applied. With the help of this procedure it is possible to examine the short-run and long-run relationships between two variables. The Engle-Granger (1987) two-step cointegration procedure is used to test the presence of

cointegration between the two variables. If both time series are integrated of the same order then it is possible to proceed with the estimation of the following cointegration regression:

$$Y_t = a_{11} + b_{11} P_t + \mu_t \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(ia)}$$

$$P_t = a_{21} + b_{21} Y_t + \eta_t \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{(ib)}$$

where Y_t = economic growth rate, P_t = inflation rate at time t, and μ_t and η_t are random error terms (residuals). Residuals μ_t and η_t measure the extent to which Y_t and P_t are out of equilibrium. If μ_t and ηt are integrated of order zero, I (0), then it can be said that both Y_t and P_t are cointegrated and not expected to remain apart in the long run. If cointegration exists, then information on one variable can be used to predict the other.

In principle, there can be a long-run or equilibrium relationship between two series in a bivariate relationship only if they are stationary or if each series is at least integrated of the same order (Campbell and Perron, 1991). That is, if two series are integrated of the same order, I (d) for d = 0, 1, 2,… then the two series are said to be cointegrated and the regression on the same levels of the two variables is meaningful (not spurious) and on long-run information is lost. Therefore, the first task is to check for the existence of stationarity property in the series for growth rate (Y) and inflation rate (Y).

First, the DF test is used (Dickey and Fuller, 1979) and then the ADF test (Dickey and Fuller, 1981) with and without a time trend. The latter allows for higher autocorrelation in residuals.

$$\Delta X_t = \beta_1 + \pi_1 X_{t-1} + \sum_{i=1}^{n} \rho_1 X_{t-i} + e_{1t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\textit{(ii)}$$

The ADF tests are unable to discriminate well between non-stationary and stationary series with a high degree of autoregression. It is therefore possible that inflation, which is likely to be highly autocorrelated, is in fact stationary although the ADF tests show that it is non-stationary. The ADF tests may also incorrectly indicate that the inflation series contain a unit root when there is a structural break in the series (Culver and Papell, 1997). In consequence, the Phillips-Perron (PP) test (Phillips and Perron, 1988) is applied. The PP test has an advantage over the ADF test as it gives

robust estimates when the series has serial correlation and time-dependent heteroscedasticity, and there is a structural break. For the PP test we have to estimate equation (iii).

$$\Delta X_t = \alpha + \pi_2 X_{t-1} + \Phi_{(t-T/2)} + \sum_{i-1}^{m} \Phi_i \Delta X_{t-I} + e_{2t} \quad \ldots\ldots\ldots\ldots\ldots.(iii)$$

In equations (ii) and (iii), $\Delta \square$ is the first difference operator and e_t and e_{2t} are covariance stationary random error terms. The lag length n is determined by Akaike's information Criteria (AIC) (Akaike, 1973) to ensure serially uncorrelated residuals and m (for PP test) is decided according to Newley-West's (Newley and West, 1987) suggestions.

The null hypothesis of non-stationarity is tested using the t-statistic with critical values calculated by MacKinnon (1991). The null hypothesis that Yt and Pt are non-stationary time series is rejected if π_1 and π_2 are less than zero and statistically significant for each. Given the inherent weakness of the unit root test to distinguish between the null and the alternative hypotheses, both DF-ADF tests are applied following Engle and Granger (1987) and Granger (1986), and subsequently supplemented by the PP test following West (1988) and Culver and Papell (1997). These tests are carried out for both variables by replacing Xt with Yt and Pt in equations (ii) (for the DF-ADF tests) and (iii) (for the PP test).

DF-ADF-PP unit root tests are also applied for residuals μ_t and η_t (from equations (ia) and (ib)) by respecifying equations (ii) and (iii) in terms of μt and ηt instead of Xt. When μt and ηt are found to be integrated of order zero then it can be concluded that these two series are cointegrated. If the hypothesis of no integration is rejected, a stable long-run relationship exists between economic growth and inflation.

According to Engle and Granger (1987), when Yt and Pt are found to be cointegrated then there must exists an associated error correction mechanism (ECM) that may take the following form:

$$\Delta Y_t = \Phi_{10} + \sum_{j=0}^{s} \Phi_{11} \Delta P_{t-j} + \sum_{i=1}^{q} \Phi_{12} \Delta Y_{t-i} + \rho_1 \mu_{t-1} + e_{3t} \quad \ldots\ldots\ldots.(iva)$$

$$\Delta P_t = \Phi_{20} + \sum_{j=0}^{s} \Phi_{21} \Delta Y_{t-j} + \sum_{i=1}^{q} \Phi_{22} \Delta P_{t-i} + \rho_2 \eta_{t-1} + e_{4t} \quad \ldots\ldots\ldots(ivb)$$

Where Δ denotes the first difference operator, μ_{t-1} and η_{t-1} are error correction terms, s and q are the number of lag lengths (determined by AIC) and e_{3t} and e_{4t} are random disturbance terms. Here i begins at one and j begins at zero in order for the series to be related within a structural ECM (Engle and Yoo, 1991). The error correction terms μ_{t-1} and η_{t-1} (which are the residual series of the cointegrating vector normalized for Yt and Pt) measure deviations of the series from the long-run equilibrium relations. For the series to converge to the long-run equilibrium relation, $\mathbf{0 \leq \rho_1, \rho_2 \leq 1}$ should hold. However, cointegration implies that not all ρ_1, ρ_2 should be zero.

IV. DATA AND EMPIRICAL EVIDENCE

Equations are estimated over the period 1972-73 to 2007-08 using annual data collected from RBI and CSO. Inflation (P) is measured from the average wholesale price index (WPI) and growth (Y) rates of gross domestic product are calculated at 1993-94 prices.

Results of unit root tests are reported in tables 2A and 2B. They show that both growth rate (Y) and inflation (P) are integrated of order zero for India.

Table 1. Average inflation and growth rates

	Inflation	Growth
Mean	7.38	5.47
Standard Deviation	4.93	3.10

Period of study: 1972-2008

Table 2A. Unit root test with DF and ADF

Variables	DF		ADF	
	c	c & t	c	c & t
Y	-6.14	-7.51	-2.08	-4.40 (3)
P	-4.13	-4.47	-3.84	-4.89 (3)

Table 2B. Phillips Perron test for unit root

Variables	Phillips Perron	
	c	c & t
Y	-6.12 (3)	-7.77 (3)
P	-4.01 (3)	-4.37 (3)

Notes for tables 2A and 2B:

DF, ADF and PP tests were performed using Econometric Views Package.

Figures within parentheses indicate lag lengths.

All the variables are significant at 1%, 5% and 10% levels of significance

comparing critical t statistics as computed by MacKinnon (1991).

c = intercept and c & t = intercept and the time trend.

Next, we examine the cointegrating relationship between economic growth and inflation. First, cointegrating equations (ia) and (ib) are estimated.

Results of cointegration tests and estimates of the cointegrating parameters are reported in tables 3A and 3B. They show that growth rates and inflation rates are cointegrated. The empirical evidence also implies that there is a long-run relationship between growth rates and inflation rates and the interesting finding, is that the relationship between inflation and growth rates is negative.

Table 3A. Unit root test for the residuals and the coefficient of the dependent variables from equation (ia)

	Unit Root Test for μ_t		
Coefficient of Pt	DF	ADF	PP
-0.2547	-6.53	-3.98(1)	-6.49 (3)

Table 3B. Unit root test for the residuals and the coefficient of the dependent variables from equation (ib)

	Unit Root Test for η_t		
Coefficient of Yt	DF	ADF	PP
-0.6423	-4.42	-5.48 (1)	-4.34 (3)

Notes for table 3A and 3B:

DF, ADF and PP tests were performed using Econometric Views Package.

Figures within parentheses indicate lag lengths.

All the variables are significant at 1%, 5% and 10% levels of significance

comparing critical t statistics as computed by MacKinnon (1991).

These findings have important policy implications – inflation is harmful rather than helpful to growth. Caution is needed since higher inflation may trigger inflationary spirals beyond a safe level as implied by larger inflation elasticities. As Bruno (1995: 38) puts it, "chronic inflation tends to resemble smoking; once you get the habit; it is very difficult to escape a worsening addiction".

Table 4A. Error correction model for GDP on WPI

Dependent Variable: D(GDP)

Method: Least Squares

Sample(adjusted): 1976 2007

Included observations: 32 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-0.017468	0.197264	-0.088551	0.9301
D(WPI)	-0.493730	0.123933	-3.983861	0.0005
D(WPI(-2))	-0.112561	0.093949	-1.198109	0.2421
D(WPI(-1))	0.258670	0.106145	2.436956	0.0223
D(WPI(-3))	0.102868	0.092051	1.117511	0.2744
RES1(-1)	**-0.789190**	**0.251433**	**-3.138765**	**0.0043**
C	0.214559	0.426064	0.503583	0.6190
R-squared	0.747959	Mean dependent var		5.55E-17
Adjusted R-squared	0.687470	S.D. dependent var		4.236858
S.E. of regression	2.368590	Akaike info criterion		4.753107
Sum squared resid	140.2555	Schwarz criterion		5.073737
Log likelihood	-69.04971	F-statistic		12.36507
Durbin-Watson stat	2.175395	Prob(F-statistic)		0.000002

Table 4B. Error correction model for WPI on GDP

Dependent Variable: D(WPI)

Method: Least Squares

Sample(adjusted): 1976 2007

Included observations: 32 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP)	-0.413392	0.168835	-2.448503	0.0214
D(WPI(-1))	0.202438	0.125679	1.610757	0.1193
D(GDP(-2))	0.178362	0.164809	1.082234	0.2891
D(GDP(-3))	0.048458	0.156218	0.310196	0.7589
RESWPI(-1)	**-0.714363**	**0.166727**	**-4.284619**	**0.0002**
C	-0.214485	0.529800	-0.404841	0.6889
R-squared	0.555595	Mean dependent var		0.179375
Adjusted R-squared	0.470132	S.D. dependent var		4.043216
S.E. of regression	2.943139	Akaike info criterion		5.164191
Sum squared resid	225.2138	Schwarz criterion		5.439017
Log likelihood	-76.62706	F-statistic		6.501030
Durbin-Watson stat	1.908869	Prob(F-statistic)		0.000481

Tables 4A and 4B present estimated coefficients of the error correction term (long-run effects) and the lagged values of the two series (short-run effects). The estimated coefficients of the error correction term ρ_1, and ρ_2 are significant at the 5 % level from growth rates to inflation and vice versa with appropriate (negative) signs. This means that if the two series are out of equilibrium, as specified in the cointegrating regression (ia) and (ib), growth rates will adjust to reduce the equilibrium error and vice versa.

V. CONCLUSION

This study has been motivated by the recent developments in the literature on the relationship between inflation and growth and the apparent contradictory evidence provided for the developed and developing economies. In this paper, the cointegration and error correction models have used to

empirically examine long-run and short-run dynamics of the inflation-economic growth relationship in India using annual data. The main objective was to examine whether a relationship exists between economic growth and inflation and, if so, its nature. The interesting results found in this exercise is that the, inflation and economic growth are negatively related. Second, the sensitivity of inflation to changes in growth rates is larger than that of growth to changes in inflation rates. These findings have important policy implications.

In this study, the inflation-growth nexus in India has been systematically analyzed. The important conclusion is that any increase in inflation from the previous period negatively affects growth. Therefore, unlike in the case of the EMU area, the most desired policy for India is the one in which there is always a downward pressure on inflation, without having to worry about what is the threshold level. Further, the policymakers should note that any increase in inflation from the previous period at any level has negative effect on economic growth. However, the fact that the common people and the decision makers do not like inflation has enormous effects on the consumption pattern, which in turn affects the output demanded.

Macroeconomic stability and the necessary infrastructure are among the preconditions for sustained growth. Among the ways inflation can affect growth, an important avenue is the effect of inflation on investment. Low or moderate inflation is an indicator of macroeconomic stability and creates an environment conducive for investment. A review of the existing cross-country international evidence, as well as evidence from Asia, indicates a negative relationship between inflation and long-term growth. Countries with low or moderate rates of inflation have higher growth rates over the long-term compared with countries with high inflation rates. However, low inflation does not constitute a sufficient condition for growth. The Indian experience appears to support the above view. In India inflation has generally been kept under control. There have been two episodes of high inflation since 1980 but price rise has been controlled by various fiscal, monetary and administrative measures. Also, evidence from investment behaviour in private manufacturing suggests that an increase in the rate of inflation has a negative impact on private investment in manufacturing. The regression for private investment in agriculture points towards complementarities between public and private investment. Taking economy-wide linkages into account, the analysis suggests that higher growth can be achieved by controlling inflation and raising public investment. To promote growth and keep inflation low, the government needs to control budget deficits. While simulations indicate that this can be achieved by switching public expenditure from consumption to investment, this may be a difficult policy to pursue, especially in a developing

country with a multiparty democracy. It may be more realistic to choose 'tolerable' levels of inflation rate and achieve the maximum possible growth given that rate, by deficit-financed public investment. The model allows the policy maker to see the various trade-offs involved. The overall message is clear—the government should curtail unproductive expenditure, which is bad for both growth and inflation, in favour of investment. Providing stability and the necessary infrastructure can set the stage for the use of other more direct policy measures aimed at promoting growth.

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