The role of asset prices in Indian inflation in recent years: some conjectures

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Consequent upon the external payments crisis of 1990-91, a process of structural reforms has been set in motion in India, encompassing inter alia the financial, fiscal and external sectors. Against this backdrop, we made an attempt to analyse the impact of stock prices on commodity price inflation in India in the recent period (1994-2000). We constructed a vector autoregression (VAR) model comprising the call money rate, broad money growth, output gap, stock price inflation and commodity price inflation. We found that while stock price inflation did not Granger cause an output gap, it seemed to have Granger caused commodity price inflation. The results remained unaltered even if the output gap was replaced by output growth in the model. In other words, this implies that while stock prices may not have much significance for the growth of output, they contain important information about commodity prices and may thus serve as a leading indicator of inflation. We also considered gold as an alternative asset in the household portfolio. Gold price inflation, however, failed to emerge as a leading indicator of inflation. Similar results followed even after the introduction of the exchange rate as an additional variable in our basic VAR model.

1. Introduction

The relationship between asset price inflation and commodity price inflation, and more generally the significance of asset prices for monetary policy formulation, has been the subject of intense debate amongst academics and policymakers, particularly in the context of industrialised economies. While the asymmetric impact of asset price movements on the real economy as well as their implications for financial stability have been well recognised, a clear consensus on the precise extent to which monetary policy needs to take cognisance of their "leading indicator properties" for the inflation process, enigmatic as they usually are, has yet to emerge. The financial crises in Japan during the early 1990s and, more recently, in Southeast Asia have only served to reinforce the concerns relating to asset prices, an upsurge in which had coexisted with low levels of commodity price inflation in those economies, apparently masking their impending and virulent collapse. More recently, the concerns relating to the sharp downturn in technology, media and telecommunications (TMT) stocks across the globe after their spectacular run-up, as well as evidence of the existence of *strong* links between asset (stock) prices and the real economy even in emerging market countries, have fuelled the ongoing debate.

Such developments evoked some curiosity about the role of asset price inflation in the general inflation process in a country like India that is undergoing financial liberalisation and rapid structural transformation and is being increasingly integrated with the global economy, abetted by wide-ranging market-oriented reforms initiated in the previous decade.

Asset prices have until recently, and quite understandably given the nascency of the reform process, been somewhat ignored in the traditional explanations of the inflation process in India, viz the monetarist and structuralist schools. Consequent upon the external payments crisis of 1990-91, a process of structural reforms was set in motion in India. With the advent of reforms, financial markets, including capital markets, have undergone significant liberalisation, mainly reflected in the deregulation of interest rates, the progressive latitude accorded to private sector entities, including foreign players,

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institutional changes and the development of new products. These changes have not only resulted in the rapid growth of financial markets but have also strengthened their interlinkages. At the same time, a distinct moderation in the commodity price inflation rate was witnessed during the second half of the 1990s, from its relatively high average level of 8 to 9% in the past, reflecting to some extent the salutary impact of the reform process. What is the role of asset prices in Indian inflation in this changing scenario? Do we need to incorporate their information content in order to gauge the inflation process in India? More specifically, are asset prices indicative of future inflationary trends? These are some of the questions that we attempt to address in this paper.

The paper is organised as follows: Section 2 presents a select resumé of the relevant issues that are raised in the literature. In addition to a survey of studies on Indian inflation, trends in select macro variables are discussed in Section 3. Sections 4 and 5 are devoted to the methodology and empirical results on the relationship between stock prices and inflation, respectively. Some robustness tests are looked into in Section 6. Section 7 concludes the paper.

2. Role of asset prices in inflation: an overview of the literature[2]

Broadly speaking, the transmission from asset price inflation to commodity price inflation could be gauged in terms of the impact of asset prices on aggregate demand as well as on the expectations of the future trends in output and inflation - given that the current price of an asset is the discounted value of the future income stream generated by it - that are implicit in them. The nature and speed of the transmission would not only depend upon the share of assets in private sector wealth but also the level of development of the economy, particularly its financial markets. In general, with increasing market integration, imbalances in one asset market could be easily transmitted to other markets. For instance, excess liquidity would tend to reduce short-term interest rates (the opportunity cost of holding money), which could show up in an excess demand for stocks and a consequent increase in their prices and so on. As the range of assets (stocks, money, government bonds, gold, real estate, foreign exchange and the like) increases, their interactions, amongst themselves as well as with real variables, could, however, render the transmission process more nebulous. It is also recognised that asset prices are inherently volatile and are highly susceptible to changes in investor sentiments, quite independent of any change in the "fundamentals". Consequently, extracting the "right" information from any observed movement in asset prices is near impossible [Bernanke and Gertler (2000)]. Against this backdrop, let us turn to two specific issues that have been raised in the literature on asset price inflation.

2.1 Transmission channels from asset prices to real activity and inflation

While stock prices and property prices are found to have significant predictive power for the real GDP growth rate and the output gap, respectively, of many industrialised countries, views have differed on the causal relationships between the changes in the prices of these assets and output growth (and, in turn, inflation).[3] One view relegates stock markets to mere "sideshows" since they do not cause real output, but the information implicitly contained in their prices is indicative of the future rate of growth of dividends/income/output. Another view underscores the causal impact of asset prices on private consumption and investment. Rising asset prices affect private consumption by raising lifetime wealth, signalling higher expected wage incomes (as a result of growth of real incomes) and increasing the value of collateral, which influences the borrowing capacity of private agents. Vickers (2000), however, points out that higher housing prices may cause people who do not own houses or those whose housing needs are not fully satiated to reduce their non-housing expenditures, and therefore the impact of housing prices on consumption expenditure could be equivocal.

An increase in asset prices affects investment by lowering the cost of new capital relative to existing capital (Tobin's q theory), providing an impetus to current investment based on expected future growth

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2 See Gertler et al (1998) for an overview of the various issues relating to asset prices and monetary policy.

3 See International Monetary Fund (2000) for a discussion and survey of various views on this.

of output (the "flexible accelerator" model) and improving the banks' balance sheet and thus inducing them to lower interest charges on loans. Second round effects of these changes in aggregate demand on asset prices are also evident.

Empirical evidence confirms the impact of stock and property prices on private consumption and investment in industrialised countries, although the magnitude of the effect varies, depending upon, inter alia, the share of the assets in national wealth and the nature of corporate and banking laws. Kent and Lowe (1997) particularly highlight the asymmetric impact of changes in asset prices on (output and) commodity prices in that the indirect effect of falling asset prices on consumer prices via banking and financial system instability is significantly larger than the direct effect. This occurs mainly because the erosion of the value of certain assets used as collateral for loans, following a sharp dip in their prices, results in large losses to banks and financial institutions, discouraging, if not coercing, them to reverse their liberal lending policies and leading to a protracted slowdown in economic activity and a deflationary environment. On the other hand, against the backdrop of the low (consumer price) inflation environment that coincided with the run-up in asset prices in Japan and Southeast Asian economies in the 1990s, Browne et al (1998) have highlighted the importance of taking cognisance of rising asset prices and the surge in investment spending in policy formulation. In Japan for instance, while rising asset prices were facilitated by financial deregulation and liberalisation, consumer price inflation remained low partly because the appreciation of the domestic currency lowered the cost of imported products. Moreover, it may be recognised in this context that the transmission of asset prices to consumer prices may be incomplete and may occur with a lag. Similarly, Christoffersen and Slok (2000) show that, in the case of six transition economies (the Czech Republic, Russia, Poland, Hungary, Slovenia and Slovakia) over the period 1994-99, lagged values of asset prices (real stock returns, real three-month money market interest rates and changes in the real exchange rate) contain significant signals of changes in real economic activity, particularly industrial production.

The composition of the assets is also found to be an important factor determining the magnitude and nature of the impact on the real economy.[4] It has also been highlighted that the ultimate impact of stock price movements on the real economy may have to be gauged not only in terms of their "wealth effects" but also in terms of their effects on consumer and business confidence in the economic environment.

2.2 Information content of asset prices with respect to expected inflation

A conventional starting point for assessing the information content of financial asset prices as embodied in nominal interest rates is the Fisher equation: $i = r + \pi^e$, where i, r and π^e denote the nominal interest rate, the real interest rate and the expected inflation rate, respectively. In the absence of risk premia and money illusion and assuming r to be a constant, the equation portrays a one-to-one relationship between nominal interest and expected inflation. In other words, since the "returns" from the financial asset would be obtained over a time period in the future, according to the Fisher equation, the investors would like to be fully compensated for the likely/expected inflation rate that would prevail during that period, so as to earn a specified constant real rate of return. Given a real rate of return, nominal interest rates or the current price of a financial asset, therefore, reflect the inflation rate expected to prevail in the future. Assuming a relationship can be drawn between the expected future inflation rate and the actual future inflation rate, the current financial asset price, conceptually, contains information about the future inflation rate.[5] Smets (1997), in fact, argues that even if the

4 It has been observed that the relatively high share of telecommunications in Asia, Latin America and Europe makes these regions less susceptible to changes in perceptions regarding the new economy, and that, given the small size of the TMT sectors in Asia and Latin America, the impact on aggregate consumption and investment would be relatively smaller. Empirical analyses showed that both TMT and non-TMT stocks have a significant impact on consumption and investment in North America and the United Kindom, while non-TMT stocks were not found to have a large impact in continental Europe. Furthermore, TMT stocks were found to be a leading indicator of economic activity in the major regions of the world; see IMF (2001) for details.

5 An important issue in this context is the appropriateness of the conventional price indices. Attempts have been made to reconstruct these price indices so as to account for the full impact of changes in asset prices. The central argument in such endeavours is that since conventional consumer price indices focus on changes in the price level of consumption goods in the current period, they fail to capture the import of lifetime utility, which basically reflects a choice between present and future consumption. Drawing upon the Inter-temporal Cost of Living Index (ICLI) developed by Alchian and Klein (1973), Shibuya (1992), for example, constructed a Dynamic Equilibrium Price Index (DEPI) as a weighted geometric mean of the

impact of asset prices on aggregate demand is limited, they may contain useful information about the current and future economic environment, which could be utilised to improve the efficacy of monetary policy.

Some empirical studies have generally confirmed that current asset prices/nominal interest rates provide reliable forecasts of future inflation up to a certain period, to some (but not a great) extent.[6] For instance, Mishkin (1990) reports that the yield spread, an asset price based indicator, provides a reliable forecast of inflation up to three years in the future but explains only 3 to 7% of the total variation in inflation.[7] Goodhart and Hoffmann (2000) in their study of 16 industrialised countries over the period 1973-98, however, did not find the yield spread to be a very useful predictor, in general, for future changes in the inflation rate (four, eight and 12 quarters ahead) although it turned out to be a significant predictor for future real GDP growth in the case of a greater number of countries.[8] It has further been pointed out that the nature of the association between the expected inflation rate and nominal asset prices depends on the correlation between inflation and the income from the asset and, in turn, on the relationship between inflation, real output and interest rates. This suggests that the predictive power of asset prices would be contingent upon the macroeconomic environment: for instance, asset prices would be more likely to predict inflation if such an inflationary situation was brought about by accommodative monetary policy that facilitated output growth and a decline in interest rates, rather than an inflationary environment created by negative shocks to the productive potential of the economy [Borio et al (1994)].

The broad messages that emerge from the foregoing discussion are that (certain) asset prices have information regarding the future course of real output and inflation, though with different degrees of success; the outcome has been largely shaped by the prevailing macroeconomic environment, household portfolio preferences and the nature of institutional arrangements. Moreover, asset prices such as interest rates and property/land and stock prices have predominantly figured in the empirical exercises to gauge the impact of asset price inflation.

3. Nature of Indian inflation and role of asset prices

3.1 Indian inflation: a select resumé

There has been a plethora of studies on inflation in the Indian economy.[9] Broadly speaking, the aggregate price or inflation behaviour in India followed two distinct, but not necessarily mutually

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current price index (P: GDP deflator) and asset price (AP) changes (changes in the value of the national wealth), $DEPI = 1[P^1/P^0]^{\alpha} [AP^1/AP^0]^{(1-\alpha):}$, where $\alpha = \rho/(1+\rho)$ and ρ is time preference. Apart from the intractability of such an index, there is a contrary view too; see Kent and Lowe (1997), who aver that central banks target the future expected (path of) inflation and not the current rate of inflation. Moreover, asset price increases resulting from say, productivity growth and improved corporate outlook are likely to be associated with a decline in future expected inflation. For both these reasons, they argue that it is not necessary to include asset prices in an index of prices for central banks to target. Vickers (2000) points out that the retail price index includes prices of durable goods (such as refrigerators) whose services may be reaped over the future and that, therefore, to say that the retail price index is the money cost of a basket of goods and services for current consumption is not exactly true; see also Filardo (2000). Recently, however, Cecchetti et al (2000) extracted the core component from equity, housing and consumer prices and suggested bestowing a higher weight on housing prices in the index of consumer prices.

6 See, for example, Fama (1977) and Mishkin (1990).

7 The yield spread is the difference between long-term and short-term nominal interest rates. According to the expectations theory of term structure, long-term nominal interest rates reflect expected future short-term interest rates. Assuming constant real interest rate risk premia, the yield spread, therefore, is indicative of the expected future inflation rate.

8 Notwithstanding the Fisher hypothesis, a number of studies have documented an inverse relationship between the rates of return on assets and the expected rate of inflation. This “puzzling” result has usually been attributed to “proxy effects” (ie a positive association between asset returns and real activity and a negative association between real activity and inflation imply a negative relation between stock returns and inflation) or to irrationality/money illusion and market inefficiency; see, for example, Fama and Schwert (1977), Marshall (1992), Boudoukh and Richardson (1993) and Santoni and Moehring (1994).

9 See Bhattacharya and Lodh (1990) for a survey of studies on Indian inflation.

exclusive, paths, viz monetarist and structuralist. Typically, monetarist models attempted to explain inflation primarily in terms of excess money growth and, given the fact that in India excessive monetary growth reflected profligacy on the part of the Union Government, particularly during the 1980s, held it responsible for Indian inflation.[10] In specific terms, most of these studies attempted to estimate a long-run relationship between money, output and prices. The major determinants of Indian inflation to emerge from the recent studies are M3, output and the call money rate [see, for example, Callen and Chang (1999)]. In the case of the manufacturing sector, the exchange rate and import prices are also found to be useful.

Conversely, in the structuralist approach, sectoral prices are determined first and then the overall aggregate level is seen as a weighted average of the sectoral prices. In the structuralist tradition, Balakrishnan (1991) modelled Indian inflation in terms of a mark-up, raw material cost and wage cost, along with an index for capacity utilisation. Agricultural prices, on the other hand, had been modelled in terms of per capita output, per capita income of the non-agricultural sector and the government procurement of food grains. Results from his non-nested tests revealed that the structuralist model of Indian inflation outperformed the monetarist model.

As alluded to earlier, the impact of the stock market on commodity prices and real activity has not attracted much attention in the Indian context. There have been some attempts, nevertheless. Mukherjee (1988), using annual data for the period 1949 to 1981, found that while consumption Granger causes stock prices, in the case of investment the causality is from stock prices to investment. He found that stock prices Granger caused GDP during this period. For a shorter period using monthly data from 1970 to 1981, however, he found unidirectional causality from the index of industrial production (IIP) to stock prices. Recently, Pethe and Karnik (2000) examined the relationship between stock prices and IIP. Using monthly data over the period April 1992 to December 1997, they found no evidence of cointegration between stock prices and IIP on the basis of the Engle-Granger two-step procedure; they inferred that "… there is no evidence to suggest that a revival of the stock market, in the sense of rising share price, could be a leading indicator of the economy" (p 355). We felt that Mukherjee's (1988) finding could be critically specific to the time period he had chosen, when the stock market was not really sufficiently developed in India. Moreover, as the relationship between stock prices and output does not exist in isolation, one may question the selection of just two variables, viz IIP and stock prices in Pethe and Karnik (2000). In addition, we found that Pethe and Karnik's result is sensitive to the choice of methodology. In fact, when we ran the Johansen cointegration routine between IIP (manufacturing) and stock prices over the same period (ie April 1992 to December 1997), we found the variables to be cointegrated.[11] However, we felt that any attempt to obtain a cointegrating relationship between stock prices and IIP over such a short period could be inappropriate. Besides, irrespective of the technique, existence of any cointegrating relationship between these variables in such a bivariate setup may not have much exploratory content because of the combined effect of the omitted variables.

3.2 Recent trends in select Indian macro variables

The Indian economy has witnessed significant changes over the past decade. Unsustainable macroeconomic policies in the 1980s coupled with the adverse impact of the Gulf war culminated in an external payments crisis in 1990-91. Structural reforms launched in the wake of the crisis,

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10 See Chand (1996) for a discussion on the fiscal determinants of Indian inflation.

11 Assuming unrestricted intercepts and no trends, the results from the Johansen cointegration procedure are as follows (where r is the number of cointegrating vectors):

Test	Null hypothesis	Alternative hypothesis	Statistics in the model		95% critical value
			Without seasonal dummies	With seasonal dummies	
Eigenvalue	$r = 0$	$r = 1$	22.90	23.85	14.88
	$r \leq 1$	$r = 2$	0.05	0.00	8.07
Trace	$r = 0$	$r \geq 1$	23.00	23.76	17.86
	$r \leq 1$	$r = 2$	0.05	0.00	8.07

encompassing the fiscal, monetary, banking, financial and external sectors and essentially aimed at liberalising the economy, inducing competition and instilling macroeconomic discipline, have been the hallmark of developments in the 1990s. In the present paper, our concern is the second half of the 1990s, when the reform process began to get firmly entrenched. What happened on the output and inflation fronts during these years? How did the money and equity markets behave? As a prelude to our understanding of the relationship between stock price inflation and commodity price inflation in India, we present a rundown of the trends in select macro variables (Appendix Table 1).

The inflation rate in India, as measured by the wholesale price index (WPI), has been lower and relatively less volatile than in most developing countries, particularly during the last two decades.[12] After remaining at around 8 to 9%, on average, during the 1970s and 1980s, the inflation rate increased sharply during the first half of the 1990s, reflecting a myriad of factors, including intermittent domestic agricultural supply shocks and exogenous shocks such as the oil price increase and the Gulf war as well as passive monetary accommodation of past fiscal excesses. There was a distinct moderation in the average rate of inflation during the second half of the 1990s, with the inflation rate declining to below 4% in 1999-2000. Such a deceleration in the price level was facilitated by reforms gaining momentum, particularly the institutional arrangements that have greatly improved the implementation of monetary policy and liberalisation-led internal restructuring, technological innovation and the environment of price competitiveness. Moreover, the rate of increase in prices of manufactured products (which are most affected by price competitiveness and which constitute around 60% of the WPI) has not only been more stable but has also generally remained below that of the overall rate of inflation; part of the decline, at least in recent years, has, however, been on account of the industrial slowdown. Notwithstanding the general improvement in the price situation, the inflation rate has continued to reflect occasional pressures from supply shocks and increases in administered fuel prices.

The ongoing process of economic reforms and liberalisation has invigorated the capital market as well. The Indian capital market ranks as one of the largest in the world in terms of the number of investors and the number of listed companies [Patil (1999)]. The market capitalisation of the Bombay Stock Exchange (BSE) (the focus of our empirical analysis), for instance, was placed at 47% of GDP in 1999-2000.[13]

The year-on-year growth rate of the monthly 30-scrip index at the BSE, called the SENSEX, over the period 1994-95 to 1999-2000 shows a rough W-shaped movement, reflecting marked volatility (coefficient of variation of 253%).[14] The uptrends have been attributed to a combination of factors such as an improvement in corporate earnings, foreign institutional investment (FII) inflows, favourable legislative changes and, more recently, the global upsurge in infotech stocks. The downward movements have coincided with the prevalence of high domestic interest rates resulting from intervention to even out high volatility in the foreign exchange market (1995-96), uncertainties related to the financial crises in Southeast Asia, the imposition of economic sanctions, downgrading by international rating agencies and the industrial slowdown (1998-99).

Monetary policy in India has been guided by the twin objectives of price stability and the provision of adequate credit to the productive sectors of the economy, with the emphasis between the two objectives being dictated by year-specific considerations. The rate of growth of money supply was placed significantly above the long-run rate of growth of 17% during 1994-95 and 1998-99. The increase in money supply during 1994-95 reflected partly the substantial increase in credit to the commercial sector and partly a sustained rise in capital inflows, both facilitating the initial upsurge in industrial production and the increase in stock prices. The large monetary expansion during 1998-99 reflected surges in non-resident inflows. The deceleration in money supply during 1995-96 was partly attributable to the drying-up of liquidity following exchange market intervention to stem speculative

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[12] The WPI is the main measure of the rate of inflation used in India. The basic advantage of the WPI is that it is class-independent and available at high frequency (ie weekly) in a timely manner. This index, however, does not cover the non-commodity producing sector, eg services and non-tradables; see Reddy (1999) for details on issues related to various measures of price indices in India.

[13] The Indian securities market consists of 22 stock exchanges. Currently, there are about 9,000 listed companies, of which, however, only about 1,500 company stocks, on average, are traded on a daily basis.

[14] The trends in the rates of change in the SENSEX and the broader BSE national index are more or less similar.

pressures. Reflecting this development, the average call money rate jumped sharply to over 17% from its usual range of 7 to 9%. It is often expected that a developing country like India will be marked by market segmentation. Interestingly, trends in call rates and the SENSEX since the mid-1990s are symptomatic of increasing market integration.[15]

So far we have only looked into financial variables and prices. What happened on the output front during these years? By the mid-1990s it had become clear that the Indian economy was out of the shackles of low growth rates and had started operating on a higher growth trajectory. After a high growth phase of above 7% per annum from 1994-95 to 1996-97, the pace of real GDP growth in India has, however, slackened somewhat to around 6 to 6.5% more recently. The trend in the overall rate of growth has been affected by the increasing share of the services sector and occasional agricultural supply shocks (during 1995-96, 1997-98 and 1999-2000). Following an initial surge, industrial (manufacturing) production generally remained subdued up to 1998-99 but recovered substantially during 1999-2000. The output gap, as measured by the deviation of the index of industrial production (manufacturing) and its Hodrick-Prescott filtered value, showed wide fluctuations.[16] After an initial downturn during 1995-96, it was on an upswing during the next year and a half, followed by further downward movement. It is apparent that this fluctuating movement of the output gap was not in tune with the downward movement of commodity price inflation.

4. Asset price and Indian inflation: methodology and data

4.1 Methodology

The importance of asset prices for commodity price inflation is explored by means of an unrestricted reduced form vector autoregression (VAR) model, in the tradition of Sims (1980). Accordingly, we construct a VAR model of the form:

$$X_t = B_0 + C(L)\, X_{t-1} \qquad (1)$$

where X is the vector of variables, and C(L) is a lagged polynomial operator of order N, ie $C(L) = 1+L+L^2+ \ldots + L^N$, with $L^k X_t = X_{t-k}$.

We preferred the reduced form non-cointegrated VAR technique to its two standard rivals: (a) cointegrated VAR and (b) structural VAR.

As far as cointegrated VARs are concerned, as we see below, our choice of period is extremely short, viz six years. Over such a short period, we felt that any pre-testing of a long-run relationship may not be very meaningful. Thus, we took the variables in the form in which we expect them to be stationary.[17]

Our preference over structural VAR also needs some justification. As far as the theoretical literature is concerned, we did not find an unambiguous stance that gave an idea about the underlying structural relationship between asset prices, inflation, money, output and, perhaps, interest rates. Therefore, we preferred the Sims-type (1992) reduced form VAR, and tried to discern the impulse responses through a Choleski-type identification scheme. A major critique against such reduced form VARs is that structural inferences from the impulse responses of such VAR models are sensitive to the ordering of the variables. Often the solution is offered in the form of theoretically meaningful restrictions on the

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[15] It is often found that there is a tendency for the peaks of the call rate to coincide with the troughs of the SENSEX. There seems to be a similar tendency between stock price *inflation* and the call rate, *albeit* with some lags. There are exceptions to these trends too.

[16] As we have monthly data, we have taken λ = 14,400.

[17] This is contrary to the works of Sims and his associates [eg Sims (1992)], whereby a reduced form VAR is run in terms of the level variables. The justification came from Sims et al (1990), who, in developing Fuller's (1977) results, showed that coefficients were consistently estimated independent of the order of integration of the variables. Furthermore, as Hamilton (1994) has pointed out, even if the true model is a VAR in differences, certain functions of the parameters and hypothesis tests based on VAR in levels have the same asymptotic distribution based on differentiated data.

innovations of the VAR process. While such structural VARs have been quite popular in recent years, unless they have proper theoretical foundations there could be a tendency to adopt “incredible identifying restrictions”. Besides, we have reasons to believe that the ordering has some justification a priori. However, to take care of the sensitivity of the impulse responses to the ordering of the variables, we employed Pesaran et al-type (1997) generalised impulse response functions.[18] In the context of the above N-ordered VAR, the notion of a generalised impulse response function (GIR) is as follows.

The VAR can be written in the infinite moving average form as $X_t = A + \sum_{i=0}^{\infty} B_i e_{t-i}$, where A is a vector of constants, and e_ts are unobserved vectors of shocks, which are jointly normally distributed with zero mean and a constant variance-covariance matrix Ω with a typical element ρ_{ij}. Following Pesaran et al (1997), the conditional expectation of e_t can be written as $E[e_t \mid e_{jt} = k] = (\rho_{ij})^{-1} k \, \Omega \, e_j$, where e_j is a selection vector with element j equal to unity and zero elsewhere. Then, the GIRs of the jth disturbance term on X_{t+M} are $B_M \, \Omega \, e_j \, (\sqrt{\rho_{ij}})^{-1}$, and the GIRs of X_{t+M} are, following a unit shock to the jth variables, $(\Sigma_p \, B_p) \, \Omega \, e_j \, (\sqrt{\rho_{ij}})^{-1}$.

4.2 Data

The choice of variables in our empirical investigation is quite eclectic, and follows from the basic idea of Hoffmaister and Schinasi (1995) that asset price inflation can affect commodity price inflation via its interaction with the nominal interest rate, real output (or the output gap) and monetary growth. Thus, in estimating (1), X, the vector of variables, includes a proxy for commodity price inflation (π), a proxy for asset price inflation (π^A), the real output gap (ie Y - Y*), a nominal interest rate (i), and a variable capturing monetary growth (m). We have taken equity as the chosen asset. While it could be argued that a meaningful analysis of recent trends of the Indian economy should have been extended to the beginning of the reform period (ie 1991-92), because of the irregularities in the stock market the numbers for 1992-93 are to a fair extent outliers. Besides, screen-based trading in the stock exchanges started much later. Hence we opt for the six-year period, April 1994 to March 2000, as our sample (the financial year of the Indian economy being April-March).

Because of the small sample, we take all the data at a monthly frequency. It may be mentioned that we have incorporated all the basic level data in deseasonalised form, using the census X-11 method. While the literature is quite ambiguous as regards the use of seasonal filters in taking the variables of the VAR, it is quite a normal practice to use the data in deseasonalised form in the case of a reduced form VAR, as against a cointegrated VAR, where centred seasonal dummies are introduced.[19] The theoretical justification for using seasonally adjusted data comes from Sims (1993), who showed that seasonally unadjusted data tended to overemphasise the fit at the seasonal frequencies; conversely, use of seasonally adjusted data would produce a small bias.[20]

Thus, the following variables have been taken into consideration.

– Output gap (Y - Y*): GDP numbers in India have been available at a quarterly frequency only in the recent period. Hence, we use the monthly index of industrial production (IIP) as the proxy for the activity variable. Since we have confined our analysis to the stock market, a much narrower notion of industrial activity has been adopted, namely IIP on account of manufacturing (Y). In order to construct an index of potential output, we have taken Hodrick-

[18] Pesaran et al’s (1997) generalised impulse response analysis builds on the earlier work by Koop et al (1996). It has been shown that generalised impulse responses are unique and fully take account of the historical pattern of correlations observed among the different shocks. Furthermore, the generalised and Choleski-type impulses coincide when the variance-covariance matrix of error process of the underlying VAR is a diagonal one. However, we are unable to construct the standard error bounds for these generalised impulse responses.

[19] For example, Sims (1980) and Sims (1992) both use seasonally adjusted data for a large number of variables. Lütkepohl (1993) too uses deseasonalised data.

[20] To quote from Sims (1993), “Use of (seasonally) unadjusted data and a correctly specified model of seasonal variation is always the best option. But treating seasonality casually, as a “nuisance” component of the model, can lead to worse errors than those produced by use of adjusted data” (p 19).

Prescott filtered values of Y (denoted by Y^*), and taken the deviation of Y from Y^* as a measure of the output gap [Hodrick and Prescott (1997)].

– Inflation (π): Corresponding to the measure of output, we take the wholesale price index (WPI) for manufactured products as the relevant price index and its rate of change as the measure of inflation.

– Stock price inflation (π^S): This is taken as the rate of change in the BSE sensitive index (SENSEX).

– Interest rate (i): The call money rate in the Bombay market is taken as the interest rate.

– Monetary growth rate (m): The growth rate of broad money, or M3, is taken as the monetary growth rate.

Thus, we estimate a VAR of the following form (with $a_{ij}(L)$ as the lag operator):[21]

$$\begin{bmatrix} i_t \\ m_t \\ (Y_t - Y^*) \\ \pi_t^S \\ \pi_t \end{bmatrix} = \begin{bmatrix} a_{11}(L) & a_{12}(L) & a_{13}(L) & a_{14}(L) & a_{15}(L) \\ . & . & . & . & . \\ . & . & . & . & . \\ . & . & . & . & . \\ a_{51}(L) & a_{52}(L) & a_{53}(L) & a_{54}(L) & a_{55}(L) \end{bmatrix} \begin{bmatrix} i_t \\ m_t \\ (Y_t - Y^*) \\ \pi_t^S \\ \pi_t \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \\ e_{5t} \end{bmatrix} \quad (1)$$

5. Asset price and Indian inflation: empirical results

5.1 Time series properties of the variables

Before we proceed to estimate the VAR, it is necessary to test for the time series properties of the variables. We employed the standard Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) test (Appendix Table 3). All the variables - interest rate, M3 growth, output gap, stock price inflation, gold price inflation, and manufacturing price inflation - appear to be stationary. This is in consonance with the relevant studies on the order of integration of related Indian macro variables.[22] Since we have taken the data in deseasonalised form, the power of the unit root tests could have been reduced [Ghysels and Perron (1993)]. Hence, we reworked the DF and ADF tests using non-deseasonalised data; the results on the order of integration of the variables were found to be invariant.

5.2 Relationship between the variables: correlation coefficients

To begin with, we looked at the simple correlations between the variables. As we have already shown that all the variables are I(0), one can expect the simple correlation coefficients to be indicative of some association and not the underlying spuriousness due to the presence of a time trend. It is interesting to note that stock price inflation is significantly negatively correlated with the interest rate. The correlation between stock price inflation and commodity price inflation is, however, insignificant.[23] Considering that these are contemporaneous correlations, one need not read too much into these findings. Nevertheless, the correlation coefficients between current values of commodity price inflation and lagged values of stock price inflation turned out to be significantly positive.[24] This gives us a

[21] All the rates of change or growth rates are taken as annualised, ie $(x_t - x_{t-12})/x_{t-12}$.

[22] For example, Parikh (1997) found IIP, M3 and WPI to be I(1) and the call rate to be I(0).

[23] The significance of the correlation coefficient (r) is tested through the t-statistic $[r \sqrt{(N-2)}] / [\sqrt{(1-r^2)}] \sim t_{N-2}$.

[24] For example, the coefficients between commodity price inflation and lagged values of stock price inflation, with lags 0 to 10, respectively, turned out to be –0.123, –0.038, 0.070, 0.182, 0.279, 0.360, 0.437, 0.493, 0.565, 0.613 and 0.634, respectively.

hunch about the appropriateness of considering stock price inflation as a leading indicator of commodity price inflation.

Table 1

Contemporaneous correlation coefficients between the variables

(period of estimation: April 1994 to March 2000)

Variables	Interest rate	M3 growth	Output gap	Stock price inflation	Commodity price inflation
Interest rate	1.000	– 0.303[1]	0.178[1]	– 0.259[1]	0.297[1]
M3 growth		1.000	– 0.623[1]	0.092	0.221
Output gap			1.000	0.042	– 0.084
Stock price inflation				1.000	– 0.123
Commodity price inflation					1.000

[1] Denotes significance at the 5% level.

5.3 Block exogeneity of asset price inflation in the VARs

After determining the lags for the respective VARs, we estimated the VAR described above.[25] To begin with, we tested for the block exogeneity pattern of various variables in order to determine the extent to which these variables selected for the VAR are significant (Table 2). All the variables in both the VARs appear to be block endogenous (as revealed by the respective χ^2 values), implying thereby that their exclusion from the system would lead to loss of information.

Table 2

Block exogeneity tests for the variables in the VAR

(period of estimation: April 1994 to March 2000)

Variables	χ^2
Interest rate	105.22 [1]
M3 growth	161.62 [1]
Output gap	108.09 [1]
Stock price inflation	168.53 [1]
Commodity price inflation	133.37 [1]

[1] Denotes significance at the 1% level. The χ^2 values for VAR have 40 degrees of freedom.

5.4 Granger causality patterns

Nevertheless, our primary concern is to see whether asset prices matter for inflation in India. In order to check that, we looked at the joint significance of various independent variables in the commodity price inflation equation using the standard F test. As can be seen from Table 3, all the variables, including stock price inflation, are significant in the commodity price inflation equation in the VAR.

[25] The lags are determined through Schwarz Information criteria, and through sequential testing using Sims' (1980) Modified LR tests. The optimal lags of the VAR turned out to be 10 months.

Table 3

Granger causality patterns in the VAR

(period of estimation: April 1994 to March 2000)

Independent variables	Dependent variable: commodity price inflation		Dependent variable: output gap	
	F-statistic	Significance	F-statistic	Significance
Interest rate	2.09	0.07	0.69	0.72
M3 growth	2.36	0.05	1.65	0.16
Output gap	2.16	0.07	2.13	0.07
Stock price inflation	3.52	0.01	1.17	0.36
Commodity price inflation	238.69	0.00	0.65	0.76

Thus, stock price inflation is seen to be Granger causing commodity price inflation. However, when it comes to the output gap, apart from its own past values, all the variables fail to Granger cause an output gap. There could be two possible explanations for this. First, this may be indicative of the lack of output effect on the part of stock price inflation and, from that standpoint, would be in line with earlier evidence such as Mukherjee (1988) and Pethe and Karnik (2000).[26] Alternatively, this could be due to the failure of the output gap to emerge as an important determinant of Indian inflation.[27] Thus, despite the failure of stock price inflation to influence the output gap, it is found to have an effect on inflation. Granger causality, however, refers to incremental predictability. Hence, what we can infer is that stock price inflation contains important information on future commodity price inflation. In other words, stock price inflation may turn out to be a leading indicator of inflation.

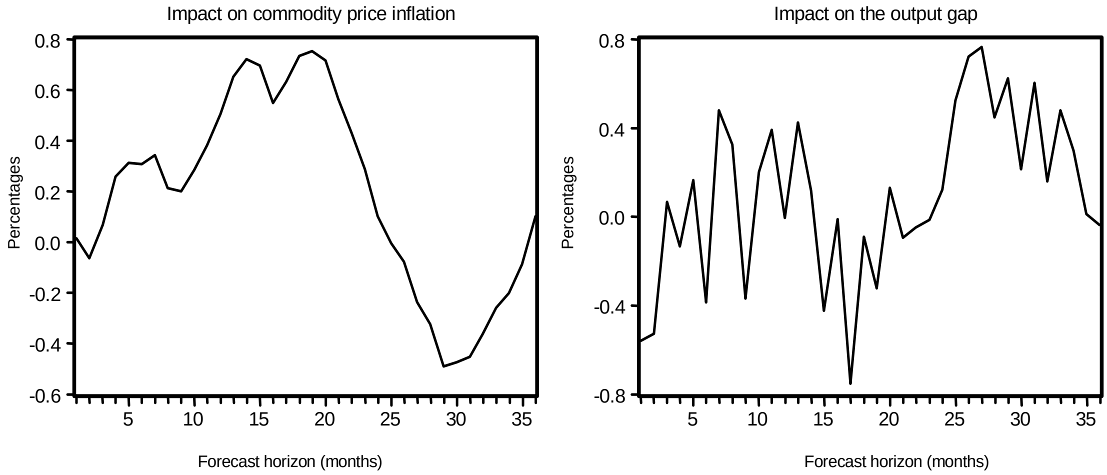
5.5 Impact of asset price inflation shock on commodity price inflation

How does stock price inflation influence commodity price inflation? We looked into the generalised impulse response of commodity price inflation to a unit standard deviation shock to stock price inflation (Chart 1). It appears that, in the initial 20 months, there is a general upward trend in commodity price inflation as a result of a unit standard deviation shock in stock price inflation (and not in the stock price level). This upward impact, however, does taper off and exhibits a downward tendency up to nearly 30 months. The impact on the output gap is more uncertain, reflecting perhaps the fluctuations in the index of industrial production. It needs to be noted in this connection that in the absence of any structural model it may not be at all appropriate to give a structural interpretation of these generalised impulses. Furthermore, since we are unable to construct the standard error bands, it would be difficult to gauge the reliability of the impulses [Runkle (1987)].

[26] This result occurs typically with respect to stock prices. The outcome with respect to market capitalisation could be quite different. In fact, in a preliminary bivariate exercise, we found that real market capitalisation Granger causes manufacturing output growth.

[27] Coe and McDermott (1997) found that for India the output gap model did not work.

Chart 1
Impulse responses of stock price inflation in a VAR with the output gap



5.6 Variance decomposition

How much of the forecast errors of commodity price inflation and the output gap is explained by stock price inflation? To this end, Table 4 reports the generalised forecast error variance decomposition of commodity price inflation and the output gap. It is evident that although, in the initial periods, stock price inflation explains only a small proportion of commodity price inflation, the ratio increases after six months and reaches as much as 60% after one and a half years. In fact, the contribution of stock price inflation in explaining the variance of commodity price inflation surpasses all other variables (including M3 growth) after a year. On the other hand, as expected, the contribution of stock price inflation in explaining the variance of the output gap seems to be limited.

Table 4
Variance decomposition of commodity price inflation and the output gap

Months	**Proportion of variance of commodity price inflation explained by**					**Proportion of variance of the output gap explained by**				
	interest rate	**M3 growth**	**output gap**	**stock price inflation**	**commodity price inflation**	**interest rate**	**M3 growth**	**output gap**	**stock price inflation**	**commodity price inflation**
1	2.5	8.3	1.0	0.3	100.0	11.5	17.1	100.0	8.4	0.9
6	20.9	31.8	3.3	23.4	22.8	13.9	37.3	53.1	10.6	7.0
12	19.3	24.5	3.8	44.3	17.2	18.5	33.1	37.2	12.1	7.0
18	9.2	12.0	11.7	64.0	7.5	27.0	28.0	29.7	14.8	8.4
24	17.8	11.3	12.6	60.7	5.8	33.0	26.7	26.1	12.2	8.7
30	16.7	18.3	9.4	49.8	4.6	29.6	23.9	22.8	18.2	9.1
36	22.1	16.2	8.4	41.8	6.3	31.6	21.7	20.7	17.9	8.9

These findings indicate that while stock prices fail to Granger cause the output gap, they seem to contain information on inflation. Granger causality, however, does not have any ontological connotation; hence, the above results would indicate that past knowledge of asset price inflation helps to predict commodity price inflation but fails to do so in the case of output growth. This is, however, not an unexpected outcome. Despite financial liberalisation and an increase in market capitalisation, equity is yet to emerge as the major repository of private sector wealth in India and hence a prime determinant of private consumption. In fact, the bulk of equity holdings in India are in the hands of various financial institutions, many of which are in the public sector. A restrictive policy on the part of the banks towards lending for stock market investment may have further attenuated the linkage between stock prices and output growth. Yet another reason could be that, due to their very nature, extant industrial output statistics failed to take cognisance of stock market developments, which occurred primarily in the services-related segments in recent years. This apart, even in the case of output growth it is the services sector that has become the major source of activity in India in recent years.[28] Besides, as already pointed out, the insignificant impact of the stock market on the real economy could be due to our choice of stock price inflation as the asset price indicator; with indicators capturing stock market activities (such as market capitalisation), the outcome could be entirely different. It may be highlighted in this context that, even in the case of a number of developed countries, stock prices failed to emerge as a leading indicator of the output gap.[29] Nevertheless, given the information base and related market efficiency, stock price inflation seems to have information content as regards the inflationary expectations of economic agents. As a result, even if it fails to Granger cause growth, it seems to have predictive content about inflation. Similar findings have been arrived at for a number of developed economies such as Denmark, Finland, Norway and the United States [Borio et al (1994)].

6. Some robustness tests

How far are the results presented above robust? In this context, the present section will relax some of the assumptions of the above analysis. In particular, we will replace the output gap with output growth and use alternative definitions of asset prices.

6.1 Using output growth instead of the output gap

It may be noted that our measure of the output gap is somewhat crude in the absence of any structural model. Furthermore, Coe and McDermott (1997) have pointed out that the output gap model does not work for India. Hence, in the above VAR we replaced the output gap with growth of manufactured IIP. Even after this substitution, all the variables turned out to be block endogenous.[30] In this case too, stock price inflation is seen to be Granger causing commodity price inflation; the impact of stock price inflation on output growth seems to be insignificant (Table 5).

Table 5

Granger causality in the VAR with output growth

(period of estimation: April 1994 to March 2000)

Independent variables	Dependent variable: commodity price inflation	Dependent variable: output growth
Interest rate	1.10	1.16
M3 growth	2.31[1]	0.71
Output growth	1.61	1.73
Stock price inflation	3.45[2]	0.68
Commodity price inflation	79.12[2]	2.52[2]

[1] Denotes significance at the 5% level. [2] Denotes significance at the 1% level.

[28] A possible solution to this problem could be to run the whole exercise in terms of GDP growth. However, as already indicated, due to the low frequency of GDP statistics we are unable to do so.

[29] See, for example, IMF (2000), p 96.

[30] The $\chi 2$ values for the interest rate, M3 growth, output growth, stock price inflation and commodity price inflation turned out to be 82.89, 130.69, 109.13, 160.52 and 134.31, respectively. All of these are significant at the 1% level.

The generalised impulse response functions of a unit standard deviation shock to asset price inflation, as reported in Chart 2, indicate some positive impact on commodity price inflation for nearly a year and a half. The impact on output growth, however, is much more erratic - after the initial expansionary phase up to six months, there is a downturn up to nearly a year and a half. Thus, the impulses do not seem to be sensitive to definition of the output gap. Similar results are obtained from the forecast error variance decomposition (Table 6).

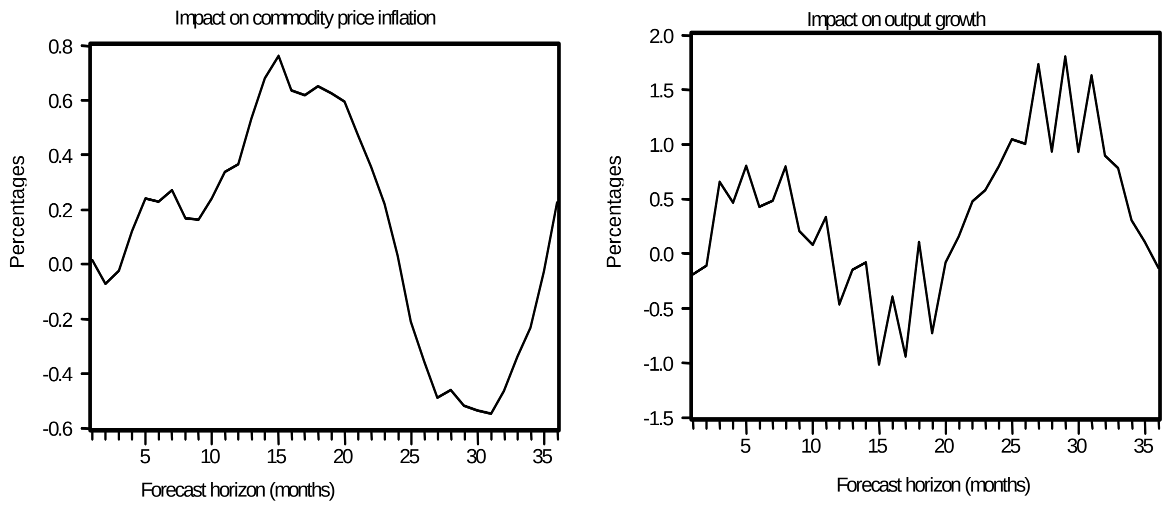
Table 6

Variance decomposition of the VAR with output growth

Months	Proportion of variance of commodity price inflation explained by					Proportion of variance of output growth explained by				
	interest rate	M3 growth	output growth	stock price inflation	commodity price inflation	interest rate	M3 growth	output growth	stock price inflation	commodity price inflation
1	0.7	1.4	1.2	0.2	100.0	1.2	29.9	100.0	0.8	1.2
6	6.7	51.8	25.3	11.7	25.7	4.9	23.1	55.2	15.5	12.6
12	7.7	42.0	26.7	29.8	17.6	11.8	20.5	46.8	16.7	10.2
18	3.3	17.9	22.9	61.7	6.8	16.2	27.8	35.7	19.0	7.1
24	9.1	15.8	34.7	53.0	4.4	23.4	25.1	27.5	19.6	6.9
30	9.6	16.3	30.8	52.2	3.7	19.0	21.7	19.3	33.4	5.2
36	8.5	15.5	34.0	49.2	5.1	17.7	17.6	25.8	30.8	4.7

Chart 2

Impulse responses of stock price inflation in a VAR with output growth



6.2 VAR with alternative asset prices

So far our analysis has been couched only in terms of one asset, viz equity. The menu of assets in the household portfolio could, however, be much larger. In fact, the choice set could be somewhat different for a developing country to enable it to take care of the rather special preferences of agents. For example, in the Indian case, apart from equity, land and gold could perhaps be important alternative assets in the household investment portfolio.[31] Despite the fact that in rural credit transactions land could be seen as an interlinked asset, in the Indian case there is an absence of systematic and reliable statistics on land price. This apart, due to urban land ceiling legislation, during the period covered by our study real estate prices in urban areas could have had a lot to do with scarcity rent rather than economic fundamentals. Thus, we did not consider land as an alternative asset in our analysis.

The story of gold in the Indian case is, however, different.[32] It is well known that Indians have an enormous propensity for holding the yellow metal. There could be several motives behind this. Apart from social demands, gold could also act as an important form of collateral in the case of an informal money market.[33] The movement in domestic gold prices (as proxied by the gold price in the Bombay market) reflects not only seasonal demand (with peaks occurring a number of times in the month of February) and exchange rate movements but also the impact of periodic liberalisation measures that have facilitated a closer alignment of domestic prices with international prices. During the period under review, gold price inflation showed an undulating trend, with a massive downturn witnessed during 1996-98, largely reflecting subdued international prices. When we reworked our basic model in terms of gold price inflation, all the variables, including gold price inflation, turned out to be block endogenous. Nevertheless, gold price inflation failed to Granger cause either commodity price inflation or the output gap (Table 7). Hence, we inferred that the gold price failed to have much information content about commodity price inflation.

Table 7

Granger causality pattern in the model with gold price inflation

(period of estimation: April 1994 to March 2000)

Independent variables	Dependent variable: commodity price inflation		Dependent variable: output gap	
	F-statistic	**Significance**	**F-statistic**	**Significance**
Interest rate	1.84	0.11	0.68	0.72
M3 growth	0.65	0.74	1.36	0.26
Output gap	0.73	0.68	1.53	0.19
Gold price inflation	1.26	0.31	0.97	0.49
Commodity price inflation	205.84	0.00	0.65	0.75

6.3 VAR with the exchange rate as an additional variable

As is well known, the VAR results could be sensitive to the choice of the variable vector. Is there a specification problem in our VAR? Several such variables could be cited in this context, such as credit availability, the exchange rate, capital flows, energy prices, foreign interest rates and foreign asset prices.[34] Since we do not have a structural model of inflation in the Indian economy, many of these variables could be quite unmanageable to incorporate in our rather simplified reduced form VAR model. Nevertheless, we thought there is at least one crucial variable that could have some bearing on this issue, namely the exchange rate. This is essentially because the progressive liberalisation measures initiated as part of the ongoing reform process have not only opened up the external sector

[31] In fact, in Hoffmaister and Schinasi's (1995) model, land price is taken to be the representative asset price. They note that " ... although stock prices are notoriously difficult to model empirically, real estate prices generally move in response to fundamental economic factors, including business cycles and monetary factors" (p 63).

[32] See Garner (1995) for a discussion on taking the gold price as a leading indicator of inflation.

[33] The National Accounts of India treat gold as a consumption good and do not include it under saving; see Central Statistical Organisation (1980) for details. This is, however, contrary to the popular perception of Indian people, who often see gold as an investment avenue. See Sarma et al (1992) for details on gold stock in India.

[34] We are indebted to Miguel Messmacher for drawing our attention to this issue.

but also resulted in a greater degree of integration between the various segments of financial markets, viz money, capital and forex.[35] In order to take cognisance of this issue, we introduced the rupee/dollar exchange rate as an additional variable in our basic VAR model (1).

At this point, a rundown on the Indian exchange rate might be useful. The Indian rupee has, since September 1975, been pegged to a basket of currencies of India's major trading partners. The external payments crisis in 1990-91 and the subsequent initiation of structural reforms brought about significant changes to exchange rate management. After two successive downward adjustments in the external value of the rupee in July 1991, there was a gradual transition to a system of EXIM scrips, then to a dual exchange rate system, and finally to a fully market-based exchange rate regime in March 1993. India's exchange rate policy focuses upon "…managing volatility with no fixed rate target while allowing the underlying demand and supply conditions to determine the exchange rate movements over a period in an orderly way…" [RBI (2001b)]. Reflecting this, occasional exchange market pressures (see Appendix Table 1 for broad trends in the exchange rate), such as those which emanated in the wake of the Southeast Asian financial crises, have been addressed with a combination of timely policy measures, including interventions and monetary policy actions.

Even after the introduction of the exchange rate in our VAR model, we found that stock price inflation continued Granger causing commodity price inflation. On the other hand, as earlier, the exchange rate failed to influence the output gap.

Table 8

The Granger causality pattern in the basic model with the exchange rate

(period of estimation: April 1994 to March 2000)

Independent variables	Dependent variable: commodity price inflation		Dependent variable: output gap	
	F-statistic	**Significance**	**F-statistic**	**Significance**
Interest rate	2.61	0.07	0.99	0.50
M3 growth	2.36	0.09	1.20	0.39
Output gap	2.91	0.05	1.03	0.48
Stock price inflation	2.69	0.06	0.98	0.51
Commodity price inflation	25.21	0.00	0.42	0.91
Exchange rate	1.39	0.30	1.11	0.43

7. Conclusions

We looked into the role of asset prices in Indian inflation in recent years. Taking equity as an asset variable, we found that although stock price inflation failed to have any impact on the output gap or output growth, it has predictive content regarding commodity price inflation. In other words, stock prices seem to have information about the inflationary expectations in the economy. Some other assets such as gold, notwithstanding its importance in the household portfolio, failed to emerge as a leading indicator of commodity price inflation. Similar results followed even after the introduction of the exchange rate as an additional variable in our basic VAR model. Due to the short period of our analysis and in the absence of any structural model that could have incorporated the behavioural relationships of agents, this finding, however, is in the nature of a conjecture and needs to be substantiated with further research. Despite these limitations, the result of the paper - that the information content of equity price inflation is indicative of the future expected path of commodity price inflation - has important implications for monetary policy formulation.

[35] See RBI (2001a), Chapter 6, on this issue.

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Appendix

Appendix Table 1
Select macro indicators of India
(in percentages)

		1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	Real GDP	7.8	7.3	7.5	5.0	6.8	6.4
2	Industrial growth	8.5	12.8	5.8	6.6	4.0	8.1
3	Manufacturing growth	9.1	13.8	7.0	6.7	4.3	9.1
4	Commodity price inflation	10.9	7.8	6.3	4.8	6.9	3.0
5	Commodity price inflation (manufacturing)	10.5	9.1	4.0	4.1	4.5	1.7
6	Stock price inflation (based on BSE national index)	47.7	– 19.2	1.4	7.0	– 10.7	58.3
7	Stock price inflation (based on BSE sensitive index)	45.5	– 16.7	5.1	10.7	– 12.7	43.5
8	Gold price Inflation	3.0	6.2	2.7	– 14.3	– 1.3	2.9
9	Growth of reserve money	22.4	16.5	6.4	10.3	12.2	11.9
10	Growth of M3	19.8	15.7	16.2	17.0	19.8	17.1
11	Call rate	9.4	17.1	7.4	8.0	7.8	9.1
12	Center's GFD/GDP	– 5.7	– 5.1	– 4.9	– 5.9	– 6.4	– 5.6
13	CAD/GDP	– 1.0	– 1.6	– 1.2	– 1.3	– 1.0	– 0.9
14	Exchange rate (INR/USD)	31.40	33.45	35.50	37.16	42.07	43.33

Note: The yearly rates of change are calculated as averages of annualised monthly rates of change.

Appendix Table 2
Select indicators of the Indian capital market

		1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
1	BSE SENSEX (1978-79 = 100)	3,974.91	3,288.68	3,469.24	3,812.86	3,294.78	4,658.63
2	P/E ratio	41.24	19.92	15.34	14.51	12.86	19.76
3	Yield (% per annum)	0.75	1.25	1.54	1.53	1.82	1.23
4	Turnover (INR billions)	677.49	500.64	1,242.84	2,078.45	3,119.99	6,850.28
5	Turnover/GDP (%)	6.7	4.2	9.1	13.7	17.7	35.1
6	Market capitalisation (INR billions)	4,688.37	5,637.48	4,639.15	5,603.25	5,429.42	9,128.42
7	Market capitalisation/GDP (%)	43.1	44.5	34.1	37.0	30.9	46.8
8	Capital raised through public and rights issues	276.32	208.03	148.76	45.7	55.86	72.89

Note: Excepting item 8, all data pertain to the Bombay Stock Exchange.

Sources: Annual Report, Reserve Bank of India, various issues; Survey of Indian Industries, SEBI-NCAER

Appendix Table 3

Time series properties of the variables: Dickey-Fuller and augmented Dickey-Fuller statistics without a trend

(period of estimation: April 1994 to March 2000)

	Interest rate	M3 growth	Output gap	Stock price inflation	Gold price inflation	Manufacturing price inflation
1. Without a time trend						
DF	–4.974	–2.381	–4.192	–2.030	–1.549	–0.925
ADF(1)	–3.740	–1.720	–2.241	–2.182	–1.771	–1.286
ADF(2)	–2.831	–1.624	–1.845	–3.120	–1.735	–1.335
ADF(3)	–2.055	–1.568	–1.721	–3.099	–1.885	–1.311
ADF(4)	–2.037	–1.317	–1.948	–3.212	–1.761	–1.022
ADF(5)	–1.802	–2.146	–2.481	–3.588	–1.876	–1.000
ADF(6)	–1.922	–3.462	–2.730	–3.495	–1.907	–1.597
ADF(7)	–2.129	–3.412	–2.506	–3.941	–1.907	–1.492
ADF(8)	–2.166	–2.920	–2.215	–3.128	–1.722	–2.302
ADF(9)	–2.046	–2.392	–2.246	–3.045	–2.039	–2.234
ADF(10)	–2.141	–2.241	–2.068	–2.530	–2.648	–2.246
ADF(11)	–2.078	–2.845	–2.183	– 2.872	–2.299	–1.694
ADF(12)	–2.018	–1.784	–1.597	–2.084	–1.499	–2.126
2. With a time trend						
DF	–5.198	–2.349	–4.157	–2.026	–1.391	–1.311
ADF(1)	–4.021	–1.688	–2.179	–2.170	–1.717	–1.979
ADF(2)	–3.154	–1.591	–1.747	–3.107	–1.674	–2.036
ADF(3)	–2.430	–1.543	–1.599	–3.158	–1.869	–1.902
ADF(4)	–2.434	–1.279	–1.864	–3.269	–1.696	–1.940
ADF(5)	–1.990	–2.168	–2.519	–3.664	–1.709	–2.118
ADF(6)	–2.220	–3.687	–2.814	–3.671	–1.768	–2.382
ADF(7)	–2.465	–3.798	–2.555	–3.999	–1.824	–2.338
ADF(8)	–2.567	–3.316	–2.244	–3.209	–1.685	–2.836
ADF(9)	–2.462	–2.644	–2.120	–3.064	–2.051	–2.690
ADF(10)	–2.589	–2.304	–2.041	–2.576	–2.781	–2.838
ADF(11)	–2.514	–3.444	–2.760	–2.939	–2.366	–2.002
ADF(12)	–2.558	–1.638	–1.805	–2.237	–1.029	–1.520

Note: 95% critical value for the ADF statistics without a time trend is –2.90 and with a time trend is –3.47.