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Modeling and Forecasting Inflation in India

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Abstract

The Reserve Bank of India (RBI) has moved away from a broad money target toward a "multiple indicators" approach to the conduct of monetary policy. In adopting such a framework, it is necessary to know which of the many potential indicators provide the most reliable and timely information on future developments in the target variable(s). This paper assesses which indicators provide the most useful information about future inflationary trends. It concludes that while the broad money target has been de-emphasized, developments in the monetary aggregates remain an important indicator of future inflation. The exchange rate and import prices are also relevant, particularly for inflation in the manufacturing sector.

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Contents

I. Introduction and Motivation

Maintaining a reasonable degree of price stability while ensuring an adequate expansion of credit to assist economic growth have been the primary goals of monetary policy in India (Rangarajan, 1998). The concern with inflation emanates not only from the need to maintain overall macroeconomic stability, but also from the fact that inflation hits the poor particularly hard as they do not possess effective inflation hedges. Prime Minister Vajpayee recently stated that "inflation is the single biggest enemy of the poor." Consequently, maintaining low inflation is seen as a necessary part of an effective anti-poverty strategy.

By the standards of many developing countries, India has been reasonably successful in maintaining an acceptable rate of inflation. Since the early 1980s, inflation has not exceeded 17 percent (measured by the year-on-year change in the monthly wholesale price index (WPI)) and has averaged about 8 percent. While this is only on par with other countries in the Asian region, it compares well with an average inflation rate in all developing countries of around 35 percent.

During this period, the Reserve Bank of India (RBI) has largely conducted monetary policy through an intermediate target for credit or broad money growth. Prior to 1985/86, the implementation of monetary policy was based on an annual target for credit expansion (either a nominal target for total or non-food credit, or a targeted incremental credit-to-deposit ratio). In 1985/86, the RBI switched to an annual target for the growth of broad money. Initially this was fixed on the basis of actual monetary growth in the preceding year (or average of several years). In 1990/91, the target became more forward looking being based on projections for real GDP growth, inflation, and velocity. However, success in achieving the announced targets has been limited, with broad money growth being in line with the target in only four years between 1985/86 and 1997/98 (Mohanty and Mitra, 1999).[2]

In its April 1998 *Monetary and Credit Policy Statement* the RBI announced a move away from the broad money target toward a "multiple indicators" approach to the conduct of policy (although it still announced a projected range for M3 growth, which continues to be an integral part of the policy framework). However, as Kannan (1999) points out, this change was not really a discrete shift in the way policy is conducted, but rather the formal recognition of changes that have gradually taken place in the policy framework over several years. The appropriateness of using broad money as the intermediate target for monetary policy had increasingly become an issue. While the majority of empirical studies still point to a stable money demand function in India despite the ongoing process of financial deregulation

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[2]While broad money growth was the main policy target, other indicators were also emphasized at different times depending on the prevailing conditions. This may explain the lack of success in meeting the announced monetary target.

(Arif, 1996, and Reserve Bank of India, 1998),[3] the experiences with monetary targets in other countries following financial deregulation, and India's own limited success in meeting its announced targets, raised doubts about the continued usefulness of the monetary target.

In adopting a multiple indicators approach, it is necessary to know which of the many potential indicators provide the most reliable and timely indications of future developments in the target variable(s), and which should therefore be most closely monitored. In this paper, we assess which variables are the most useful indicators of future inflation developments. We approach this in two ways. First, we estimate two models of the inflation process in India (one based on a monetary approach, the other using an output gap) and then assess their ability to forecast recent inflation developments. Second, we use a series of vector autoregressions (VARs) to identify the indicators that contain predictive information about future inflation.

The remainder of the paper is organized as follows: Section II discusses the measures of inflation available in India; Section III describes recent inflation developments; Section IV discusses previous studies of inflation in India and outlines the models of the inflationary process used in the empirical work; Section V presents the estimation results, and discusses the results of the VAR analysis; and Section VI concludes with a discussion of the policy implications of the results.

II. Measures of Inflation in India

Three different price indices are published in India: the wholesale price index (WPI); the consumer price index (CPI), which is calculated for three different types of workers (those in the industrial, urban non-manual, and agricultural/rural sectors); and the GDP deflator. The WPI is available weekly, with a lag of two weeks for the provisional index and ten week lag for the final index. The CPI is available monthly, with a lag of about one month, and the GDP deflator is available only annually (and is not considered further in this paper).

In most countries, the main focus is placed on the CPI for assessing inflationary trends, both because it is usually the index where most statistical resources are placed and because it most closely represents the cost of living (and is therefore most appropriate in terms of the welfare of individuals in the economy). In India, however, the main focus is placed on the WPI because it has a broader coverage and is published on a more frequent and timely basis

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[3]Financial deregulation began in earnest in the early 1990s, although important changes in the structure of the financial sector had already started in the 1980s with the growth of the nonbank finance companies (NBFCs). The rapid growth of deposits into these institutions may already have begun to effect the interpretation of the monetary aggregates pre-1990.

than the CPI. However, the CPI remains important because it is used for indexation purposes for many wage and salary earners (including government employees).

The WPI covers 447 commodities and is heavily weighted toward manufactured products which comprise 57 percent of the index. Primary articles, consisting mainly of food items, account for 32 percent of the index, and fuel and energy the remaining 11 percent (the prices of many of these items are administered by the government, although they are being gradually deregulated). However, being a combination of primary and intermediate products, the WPI is not representative of the consumption basket of the average Indian household. The CPI is more relevant in measuring inflation as it impacts on households, but its coverage and quality are often questioned. The CPI for industrial workers, the most commonly quoted of the three CPI measures, covers 260 commodities, and is more heavily weighted toward food items which account for nearly 60 percent of the total index.

In recent years, a number of countries, particularly those who have adopted explicit inflation targets, have developed measures of "underlying" or "core" inflation which attempt to identify permanent trends in inflation by eliminating temporary price fluctuations from the index. Core inflation is generally associated with the demand pressure component of measured inflation and is often viewed as being important for the determination of inflation expectations. A further problem in many countries is that elements of the index are under government price control, and prices of these items generally adjust slowly, and not always completely, to changes in underlying market prices. Consequently, the measured price index may not fully reflect underlying inflationary trends.

In India, no measure of "core" inflation is publicly available. However, given the importance of supply shocks on primary prices (see discussion below) and the presence of price controls on a number of items in the measured indices, a notion of underlying inflation is important from a monetary policy perspective. An obvious and immediately available proxy for core inflation is the manufactured price sub-component of the WPI. This eliminates primary products (whose prices are most likely to be subject to temporary supply shocks) and fuel and energy (whose prices are often administered), from the WPI. However, this is far from a perfect proxy because the processing of agricultural produce is an important aspect of Indian manufacturing so agricultural supply still influences the manufacturing price index. Further, the mean of primary product inflation has exceeded that of the manufacturing inflation indicating that a focus on manufacturing inflation alone will likely underestimate "permanent" inflation.

III. Inflation During the 1980s and 1990s

WPI inflation was relatively stable between 1983 and 1990, averaging 6¾ percent, recording a low of 3 percent in early 1986, and a high of a little over 10 percent in early 1988 (Chart 1 and Table 1). In the 1990s, inflation has, on average, been higher at 8¾ percent, and considerably more variable. Inflation rose sharply in the early 1990s, reaching a peak of a little over 16 percent in late 1991, as primary product prices rose sharply and the balance of payments crisis resulted in a sharp depreciation of the rupee and upward pressure on the price of industrial inputs. However, as the agricultural sector rebounded, industrial activity slowed, and financial stability was restored, inflation declined to 7 percent by mid-1993, but then again accelerated to over 10 percent during 1994 and 1995 as economic activity recovered strongly. In response, the RBI moved to tighten monetary policy, and inflation was brought down gradually, reaching a low of 3¾ percent in mid-1997. However, more recently, inflation again accelerated in the second half of 1998 as adverse supply conditions in key commodity markets (although overall monsoon conditions were regarded as normal) put upward pressure on food prices. As these conditions have eased, inflation has again fallen sharply.

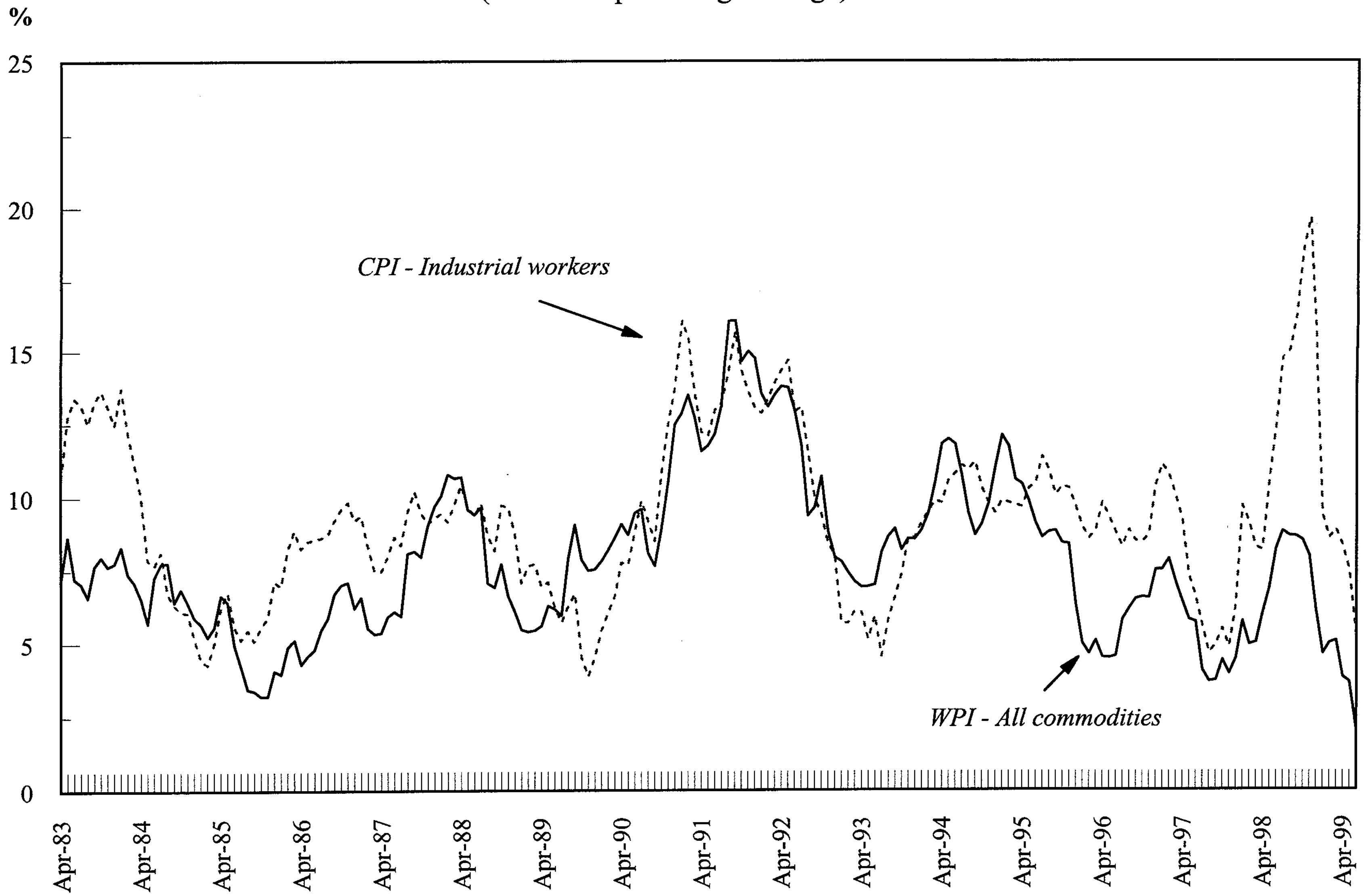
Table 1: Characteristics of Inflation: 1983–1999

	1983Q2-1999Q2	1983Q2-1990Q1	1990Q2-1999Q2
Mean inflation rate			
Overall WPI	7.84	6.75	8.65
Primary sector	8.33	6.39	9.80
Manufacturing sector	7.51	7.23	7.73
Fuel and energy	8.29	5.68	10.27
CPI (industrial workers)	9.19	8.31	9.86
Standard deviation			
Overall WPI	2.72	1.65	3.08
Primary sector	5.04	4.56	4.94
Manufacturing sector	2.85	2.53	3.08
Fuel and energy	5.24	2.50	5.91
CPI (industrial workers)	2.73	2.40	2.81

Within the three sub-components of the WPI, prices in the manufacturing sector have been lower and more stable, ranging from 2 to 13 percent (Chart 2). Inflation in both primary products and fuel and energy categories has been considerably higher in the 1990s than in the 1980s. Both indices have also been volatile. Within the fuel and energy category, the sharp rise in prices in recent years is partly due to the government moving more toward market based prices, although given the administered nature of these prices such adjustments have tended to occur at irregular intervals leading to sharp movements in the index.

Chart 1: CPI and WPI Inflation

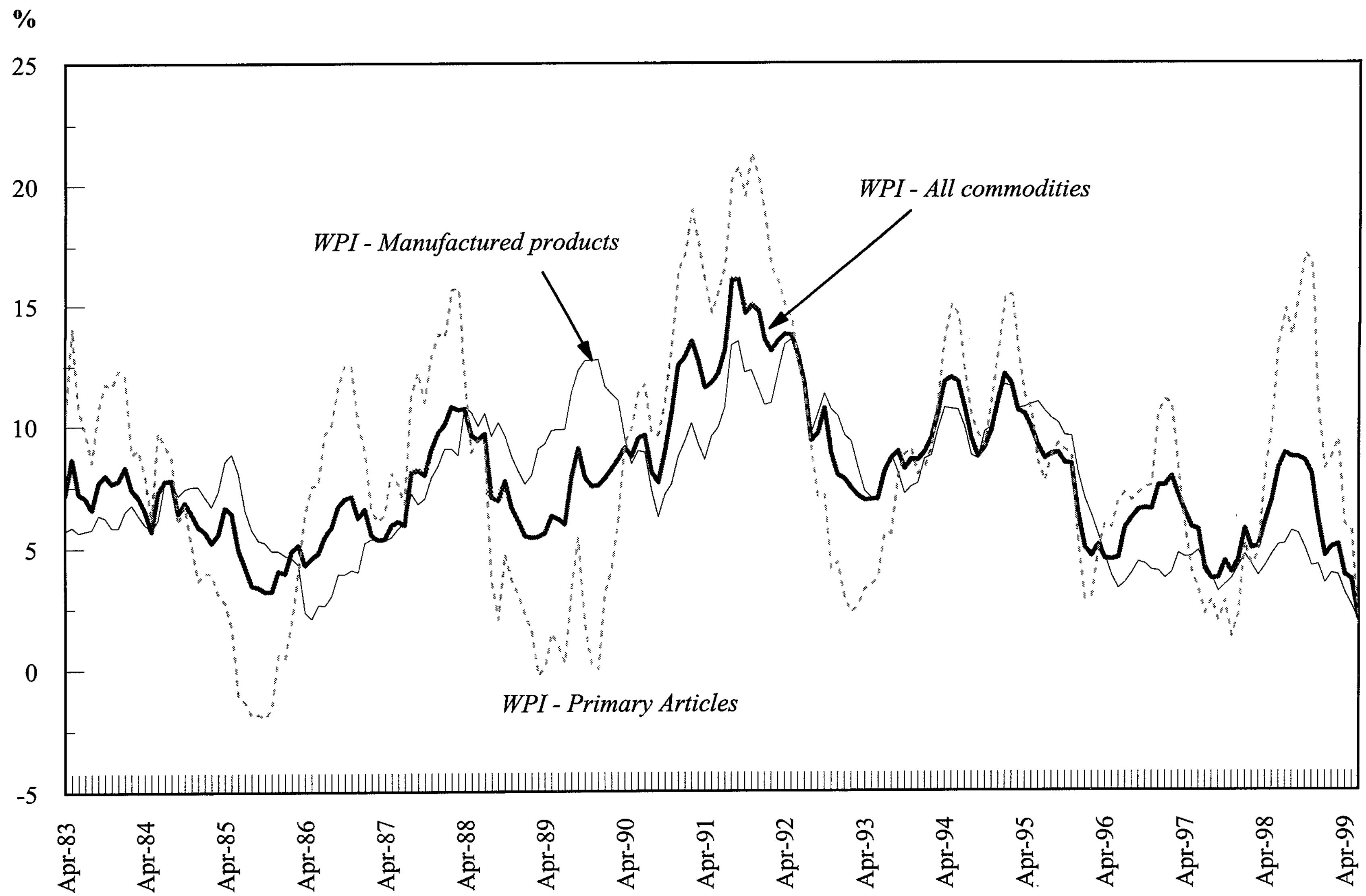
(12-month percentage change)



Source: Data provided by the Indian authorities.

Chart 2: Components of the WPI

(12-month percentage change)



Source: Data provided by the Indian authorities.

Inflation in the primary products category has ranged from a peak of over 21 percent in late 1991 to a low of negative 2 percent in 1985. While the government intervenes in the determination of the prices of essential food items by fixing procurement or minimum support prices for producers and issue prices for consumers, at the margin, agricultural prices are determined by market forces.[4] With around two-thirds of agricultural land in India still unirrigated, the monsoon remains the key factor for agricultural production and prices (imports of agricultural products are heavily restricted so that shortfalls in domestic production quickly translate into higher prices). Consequently, years of drought (1982/83, 1985/86, 1987/88, and 1990/91) have been associated with a sharp rise in inflation, while years following these droughts, or years with bumper harvests, have seen a decline in inflation.

Although the CPI has tended to give a higher estimate of inflation than the WPI or the manufacturing price index during this sample period,[5] the choice between the three indices as the main policy measure of inflation has been largely irrelevant for most of the 1980s and 1990s as there has been little sustained difference in their broad trends. However, there have been several periods where this has not been the case: (i) from mid-1983 to mid-1984 when CPI inflation increased to nearly 14 percent, but the WPI rate remained broadly unchanged at around 7 percent; (ii) from early 1995 to late 1996 when WPI inflation fell sharply from 12 percent to 4 percent, but CPI inflation remained around 8–10 percent; and (iii) during 1997 and 1998 when manufactured price inflation has remained broadly unchanged in the 4–5 percent range while the rates of overall WPI and CPI inflation have swung quite widely. Further, during 1998, CPI inflation accelerated much more rapidly than WPI inflation and a significant gap opened between the two measures. Samanta and Mitra (1998) find that the difference in the commodity basket and weighting patterns in the two indices explain part of this divergence, with the much higher weighting on food items in the CPI being important. However, other factors also appear to be at work, although their study does not identify these.

IV. Modeling Inflation in India

Recent studies of inflation in India have generally followed either a monetarist or "structuralist" approach. The monetarist approach is well known, and recent examples of its application to India include Kumar Das (1992) and Pradhan and Subramanian (1998). The structuralist approach sees inflation as the result of structural disequilibrium in the economy,

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[4]Major foodgrains such as rice and wheat and commodities such as sugar and edible oil are partly supplied through the public distribution system (PDS) which runs in parallel with the market system. Supplies for the PDS are purchased from producers at pre-announced procurement prices and are sold to consumers at a subsidized issue price (any individual with a registered residential address is eligible for a ration card that entitles them to buy a fixed quota of goods at the issue price). The Food Corporation of India (FCI) maintains a buffer stock of items sold through the PDS.

[5]However, this does not appear to be true over longer time periods (see Reserve Bank of India, *Annual Report, 1996/97*, page 64).

and examines inflation in a sector specific manner. In general, with agricultural output given in the short-run by the size of the crop (unless imports are freely allowed or significant stocks are held), agricultural prices are viewed as adjusting to clear excess demand. Within agricultural prices, the price of foodgrains (wheat and rice in particular) are considered to be the most important given their large share in family budgets (Buragohain (1997)). In the industrial sector, scope is seen for changes in output even with fixed capacity in the short-run, and industrial prices are not so much driven by demand as by cost factors. Price developments in the agricultural sector have implications for industrial costs and prices; excess demand for agricultural products leads to higher agricultural prices, and this, in turn, feeds into industrial prices because agricultural prices are a direct input into the production process and because wage pressures increase as the price of food items rise (as noted earlier, many wages and salaries are directly indexed to the CPI).

In applying the structuralist approach to India, Balakrishnan (1991, 1992) models manufactured prices through an error-correction specification based on a mark-up pricing rule using annual data for 1952–80. Labor and raw material costs are both found to be significant determinants of inflation in the industrial sector. Agricultural (foodgrain) prices are modeled as a function of per capita output, per capita income of the nonagricultural sector, and government procurement of foodgrains through the public distribution system (PDS). Balakrishnan (1994) finds the structuralist model outperforms the monetarist model on the basis of F-tests and the Cox test when estimated on annual data over the period 1952–80. This view of the superiority of the structuralist model over the monetarist model in the case of India is supported by Bhattacharya and Lodh (1990).

Demand pull models of inflation have been less commonly applied to India. An exception is Chand (1996) who modeled the GDP deflator over the period 1972–91 using an output gap approach. His results indicated that excess demand is an important determinant of inflation, and that there is some weak evidence of asymmetry in the effect of periods of excess demand and excess supply, with periods of excess demand exerting greater upward pressure on inflation than periods of excess supply exert in a downward direction.[6] However, Coe and McDermott (1997), in a study of the output gap model in Asia, found that India was one of the few countries where the output gap model did not work (to derive a satisfactory model of the Indian inflation process they had to add a "money gap" term into the equation).

Indeed, while considerable empirical support is provided for the output gap model in studies of industrial countries, and by Coe and McDermott for a number of Asian countries, it is not clear how applicable such a specification is for India, which has a large (and protected) agricultural sector and is subject to numerous supply shocks. The usual interpretation of the output gap model is that (say) a positive demand shock causes output to rise above its potential level (i.e., a positive output gap develops) and this leads to an increase in inflationary pressures. However, if instead, output rises above its potential level because of a positive

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[6]Several studies on industrial countries have argued that a non-linear Phillips curve provides a better representation of the data than the linear curve (see Debelle and Laxton (1997)).

supply shock (a favorable monsoon that leads to a large increase in agricultural production), this is likely to result in lower inflation in the agricultural sector and a decline in general inflation, at least in the first round.[7] The appropriateness of the output gap model is likely to depend on whether demand or supply shocks dominate in the economy.[8] For India, this suggests two possible lines could be considered for estimating an output gap model: (i) the estimation could be confined to manufactured prices where the output gap specification is likely to be relevant; or (ii) separate output gap terms reflecting the state of the industrial and agricultural sectors could be used with the expectation that a move in industrial output above potential will, other things being equal, result in an increase in inflationary pressures, but that a move in agricultural production above trend will result in a decline in inflation.

Most of the studies discussed above used annual data in the estimation. However, as the primary interest here is to develop a model that could be used to derive inflation forecasts as an input into the formulation of monetary policy a major consideration is to use variables for which data are published on a regular and timely basis. This places a constraint on adopting some of the approaches discussed above; the lack of information on the cost side, particularly on wages and productivity, means that the cost-push models of industrial prices estimated by Balakrishnan could not be considered.[9]

Our empirical work focuses on modeling and forecasting both the overall WPI and the manufacturing price subcomponent of the index. We follow two approaches. First, we derive a simple monetarist equation for the price level, apply co-integration techniques to model the long-run behavior of prices, and then derive a dynamic equation for inflation based on these results. Second, we model inflation through an output gap equation. We start from a simple model of price determination in which the price level, P_t, is a weighted average of tradable prices, P_t^T, and nontradable prices, P_t^N:

$$P_t = \theta P_t^N + (1-\theta)P_t^T \qquad (1)$$

and θ is the weight on nontradable prices in the price index. The price of tradable goods is determined in the world market, with their price in the domestic economy being a function of the foreign currency price, P_t^f, and the exchange rate, E_t (with an increase representing a

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[7]Of course, second round effects from the rise in incomes in the agricultural sector may lead to higher demand for manufactured products and a rise in inflation.

[8]On similar lines, De Masi (1997) argues that "the concept of potential output is less meaningful for countries in which a large proportion of output is accounted for by primary commodities whose production is supply determined, or which are experiencing large inflows or outflows of labor."

[9]While annual data on wages and productivity were published in the *Labour Bulletin* until the early 1980s, no data current appears to be published. Presumably this is why Balakrishnan's studies, which were published in the early 1990s, only used data up until 1980.

depreciation of the rupee). The price of nontradables is determined in the domestic money market:

$$\text{Log}P_t^N = \alpha\,(\text{Log}M_t - \text{Log}M_t^d) \tag{2}$$

where M_t is the outstanding stock of money, M_t^d is the demand for real money balances, and α is a scale factor representing the relationship between economy wide demand and demand for nontradable goods. The demand for real money balances is assumed to be determined by the level of real income, Y_t, and the opportunity cost of holding money vis-a-vis other assets (real or financial), i_t. Consequently, the price of nontradables can be rewritten as:

$$\text{Log}P_t^N = \alpha\,(\text{Log}M_t - a_1\,\text{Log}Y_t + a_2 i_t) \tag{3}$$

An increase in the outstanding money stock is expected to result in higher prices, an increase in real income is expected to expand the demand for money for transactions and, in turn, lead to a decline in prices, and an increase in the opportunity cost of holding money, by reducing the demand for money balances, will result in an increase in prices.

So, with uncapitalized letters representing logs, prices, p_t, can be written as:

$$p_t = \alpha\theta(m_t - a_1 y_t + a_2 i_t) + (1-\theta)(e_t + p_t^f) \tag{4}$$

and a dynamic specification of this long-run relationship can be written for inflation, π_t, as:

$$\pi_t = b_0 + b_1(L)\pi_t + b_2(L)\Delta m_t - b_3(L)\Delta y_t + b_4(L)\Delta i_t + b_5(L)\Delta e_t + b_6(L)\Delta p_t^f - b_7 ECM_{t-1} + u_t \tag{5}$$

where $\pi_t = \Delta p_t$, Δ is the first difference operator, L is the lag operator, and ECM is the deviation of actual prices from their estimated long-run equilibrium level obtained from (4).

To derive the output gap model, we start from equation (1), but specified in inflation rates (rather than price levels). Again, with the price of imported goods determined in the world market, imported inflation is a function of the change in foreign prices and the exchange rate. Inflation in the nontradables sector is assumed to be determined by an expectations augmented Phillips curve of the form:

$$\pi_t^N = \pi_t^e + \beta\,(y_t - y_t^*)/y_t^* \tag{6}$$

so that,

$$\pi_t = c_0 + c_1(L)\pi_t + c_2(L)(y_t - y_t^*)/y_t^* + c_3(L)\Delta e_t + c_4(L)\pi_t^f + w_t \tag{7}$$

where the lags of actual inflation are used as a proxy for inflation expectations in the absence of any survey measures of inflation expectations.

V. Estimation Methodology and Results

A. Data

An extended time series for quarterly GDP data is not available in India.[10] Consequently, industrial production is used as a proxy for activity in the estimation work. On an annual basis, GDP growth and growth in the industrial sector have a correlation of around 75 percent. No timely data is available on agricultural production on a quarterly basis.

The sample period used in the estimation work was 1982Q2 to 1998Q2. The data used are as follows (all data except interest rates and rainfall are in logs; exact definitions are contained in Appendix I): the overall WPI (LWPI); the manufacturing subcomponent of the WPI (LWPIM); the primary product subcomponent of the WPI (LWPIP); the CPI for industrial workers (LCPI); the industrial production index (LIP) as a proxy for real output/incomes; the output gap (OGAP), with trend industrial production, y*, derived from the Hodrick-Prescott filter (the industrial output gap and manufactured inflation are shown in Chart 3); narrow money (LM1); broad money (LM3); overnight interest rates (CALL)[11]; the deviation of rainfall from average (RAIND), which is used as a proxy for changes in agricultural production; foreign prices, approximated by US producer prices (LUSPPI); the rupee/dollar exchange rate (LERATE); and oil prices (LOIL). All data were non-seasonally adjusted, and seasonal dummies were included in the estimation (these are not reported in the results tables).

Based on the Augmented Dickey-Fuller and Phillips-Perron procedures, the hypothesis of a unit root in the levels of all variables except rainfall, the output gap, and the call rate could not be rejected (Appendix II, Table 1).

B. Empirical Results

While our main focus was on modeling LWPI and LWPIM, and the results for these are discussed in detail below, the equations were also run with LCPI as the dependent variable. The results obtained were very similar. Our modeling procedure was as follows: given the closed nature of the Indian economy (over the sample period, imports averaged less than 10 percent of GDP) we began with only the domestic variables in the analysis with the intention of adding further variables if cointegration relationships could not be found among this initial group. Even though the call rate was borderline I(1), it was included in the cointegrating regressions to be consistent with the model outlined above. As a first step we tested for cointegration between prices, money, output, and interest rates. Tests of

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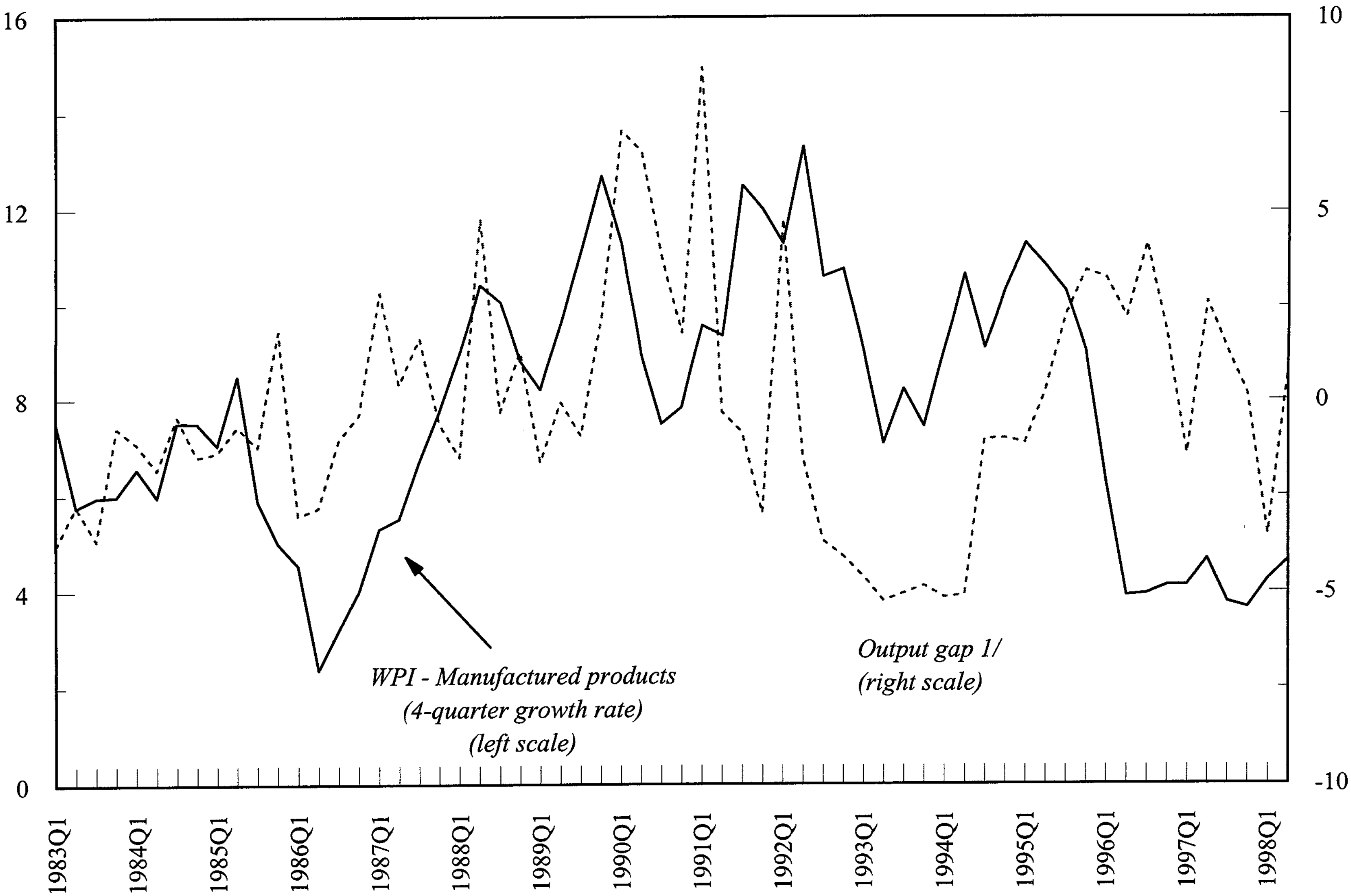
[10]The Central Statistical organization has recently published quarterly GDP data, but only from 1996 onward.

[11]Given the repressed state of the financial sector in India during the 1980s, interest rates show little movement for much of this period.

Chart 3: Manufactured Inflation and the Output Gap



Source: Data provided by the Indian authorities; staff calculations.

1/ Calculated from the industrial production index.

cointegration were carried out both via the Johansen procedure and a residuals-based approach (see Appendix II Tables 2 and 3 for the results). The results from the two procedures were generally consistent, with a couple of exceptions. Results for LWPI from the Johansen procedure indicate the presence of one cointegrating vector when either LM3 or LM1 is used (the maximum eigen value statistic suggests there may be two cointegrating vectors when LM3 is included). The residuals based approach, however, indicated cointegration only when LM1 was used. For LWPIM, cointegration is rejected in all cases. The search was therefore widened to include LUSPPI and LERATE. The inclusion of LUSPPI was found to yield a cointegrating vector under the Johansen procedure, but only with LM1 under the residuals-based approach. Inclusion of LERATE on its own did not yield a cointegrating relationship, and the inclusion of LUSPPI and LERATE together resulted in incorrect signs on the variables in the vector.

The cointegrating vectors for LWPI and LWPIM from the Johansen procedure with each of the two measures of money are set out in Table 2. The parameters in the equations are correctly signed, except the interest rate term in equations I and II.[12] The coefficient values are generally similar to those from the OLS regressions (Appendix II, Table 3). These stationary cointegrating relationship can be interpreted as representing the long-run or equilibrium relationship between prices, money, interest rates, and output (and foreign prices).

Table 2: Cointegrating Vectors for LWPI and LWPIM

I.	LWPI	=	0.68*LM3 - 0.42*LIP - 0.031*CALL
II.	LWPI	=	0.78*LM1 - 0.56*LIP - 0.006*CALL
III.	LWPIM	=	0.94*LM3 - 1.10*LIP + 0.01*CALL + 0.42*LUSPPI
IV.	LWPIM	=	0.76*LM1 - 0.64*LIP + 0.002*CALL + 0.48*LUSPPI

We interpreted the above results as indicating the presence of a single cointegrating relationship in all cases. Dynamic equations were then estimated for both DLWPI (where D signifies the first difference of a variable) and DLWPIM using ordinary least squares, and a general-to-specific modeling strategy was employed starting with four lags of each variable in the system. The final preferred specifications are presented in Table 3 (reported results are using LM3). The error-correction terms (ECM) of the deviation of actual prices from their

[12]The nominal call money rate used in these regressions is probably a poor proxy for the opportunity cost of holding broad money balances given that about 70 percent of broad money is held in interest bearing time deposits. Unfortunately, data on the return on these time deposits is not available to calculate a more realistic opportunity cost.

Table 3: Inflation Equations

Dependent variable	(1) DLWPI	(2) DLWPI	(3) DLWPIM	(4) DLWPIM
Constant	0.013 (2.78)	0.015 (4.22)	0.004 (0.94)	0.007 (3.19)
DLWPI (-1)	0.306 (2.72)	0.308 (2.76)	...	...
DLWPI (-2)	-0.024 (0.21)	-0.030 (0.26)	...	...
DLWPI (-3)	-0.368 (3.03)	0.363 (3.03)	...	...
DLWPI(-4)	-0.320 (2.66)	0.309 (2.63)	...	...
DLM3 (-1)	0.161 (2.18)	...	0.174 (2.63)	...
DLIP (-1)	-0.122 (4.19)	...	-0.098 (3.66)	...
MONG3 (-1)	...	0.126 (4.56)	...	0.107 (4.22)
DLERATE (-3)	...	...	0.063 (2.73)	0.066 (2.86)
DLUSPPI (-1)	...	...	0.230 (2.53)	0.229 (2.53)
DLUSPPI (-3)	...	...	0.322 (3.38)	0.312 (3.29)
DLWPIP (-3)	...	...	0.207 (4.49)	0.202 (4.39)
ECM (-4)	-0.083 (2.59)	-0.084 (2.61)	-0.116 (3.24)	-0.118 (3.29)
R^2	0.505	0.502	0.722	0.716
$\bar{R}^2$	0.404	0.412	0.666	0.666
LM (1)	7.49	8.21	4.54	4.88
White	20.03	19.39	18.75	16.58
Jarque-bera	0.9	0.91	2.97	1.53

Note: Sample: 1982Q2-1998Q2. t-statistics in parentheses.

long-run equilibrium level were found to be significant and correctly signed with a lag of four quarters. However, the speed of adjustment to the equilibrium is slow, while sum of the coefficients on lagged inflation in the DLWPI regression, at around 0.3, also suggests inertia in the inflation process. The first lags of money and output growth were found to be significant in both equations, and imposing equal and opposite coefficients on these terms was accepted. The term (DLM3-DLIP) can be interpreted as a "money gap" (MONG3) with monetary growth in excess of output leading to an increase in inflationary pressures. However, its short-run elasticity is quite low in both cases (0.13 and 0.11 respectively) indicating that excess monetary growth feeds slowly into inflation. The inclusion of RAIND as a proxy for agricultural production was not successful, entering the equation with a positive sign and being significant in its first and second lags.[13] The fit of the equation for DLCPI was actually slightly better than for DLWPI, but of the same basic structure.

For manufactured price inflation (DLWPIM), the first and third lags of imported inflation and the third lags of the exchange rate and primary product inflation (DLWPIP) were also found to be significant and correctly signed. The significance of imported inflation for manufactured inflation, but not overall inflation, reflects the greater import propensity of the manufacturing sector. Indeed, one important factor behind the relatively subdued inflation in the manufacturing sector in recent years is likely to have been the opening up of domestic industry to greater external competition. Indeed, this equation specification will not capture the full impact of trade liberalization on industrial price inflation given it uses U.S. producer prices rather than actual Indian import prices. The significance of primary product inflation is consistent with the feed through from the agricultural sector to the industrial sector emphasized by the structuralist models. As would be expected given the difficulties in modeling the variability of primary prices, the fit of the equation for DLWPIM is superior to that for DLWPI.

Tests on the equation residuals showed no signs of serial correlation or heteroskedasticity and also appeared normal at the 5 percent confidence level. The actual and fitted values of equations (1) and (3) are plotted in Chart 4. The dynamic forecasts over the period 1997Q2 to 1998Q2 indicate that while the equations predict inflation developments moderately well, there is considerable uncertainty around the forecasts (Chart 5). As expected, the results are better for LWPIM than LWPI. To see whether any structural breaks could be detected in the estimated relationships due to the effects of financial deregulation, Chow tests were conducted with the sample being split in 1992Q2. These tests did not indicate the presence of a break in either equation.[14] The choice of this quarter as the start of the period of financial deregulation is somewhat arbitrary, but the results did not appear to be sensitive to

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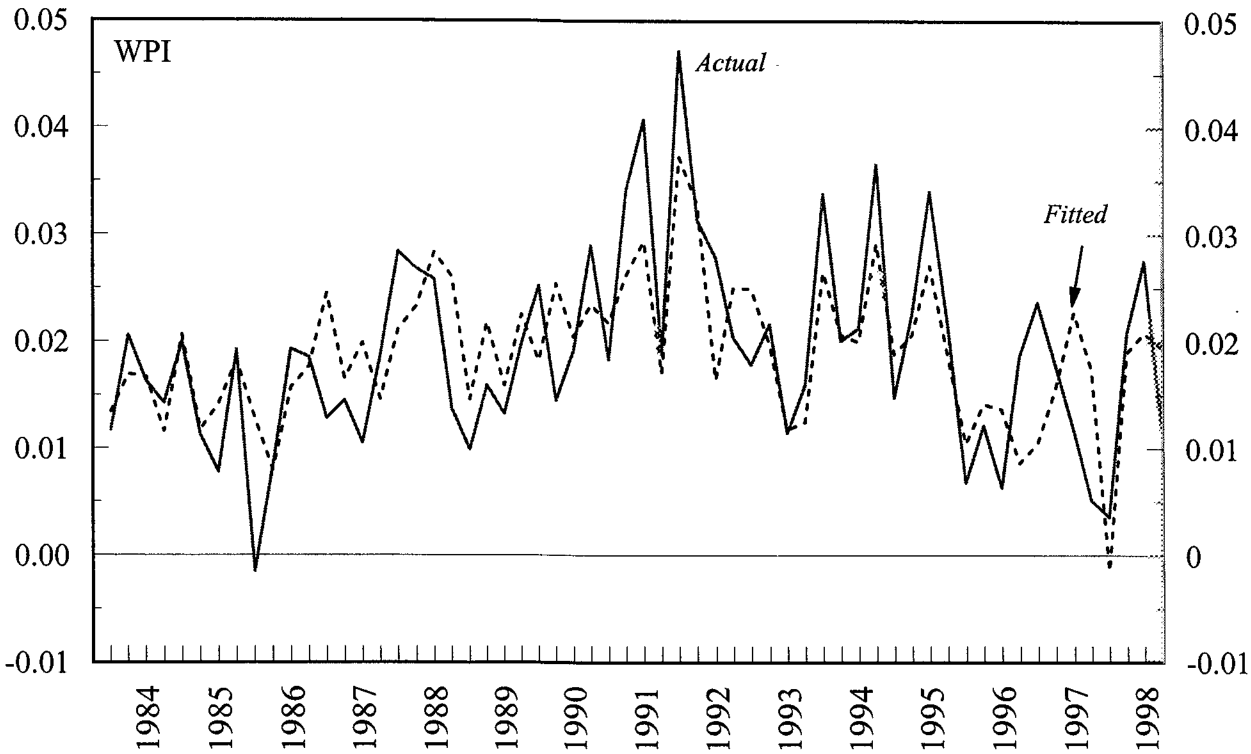
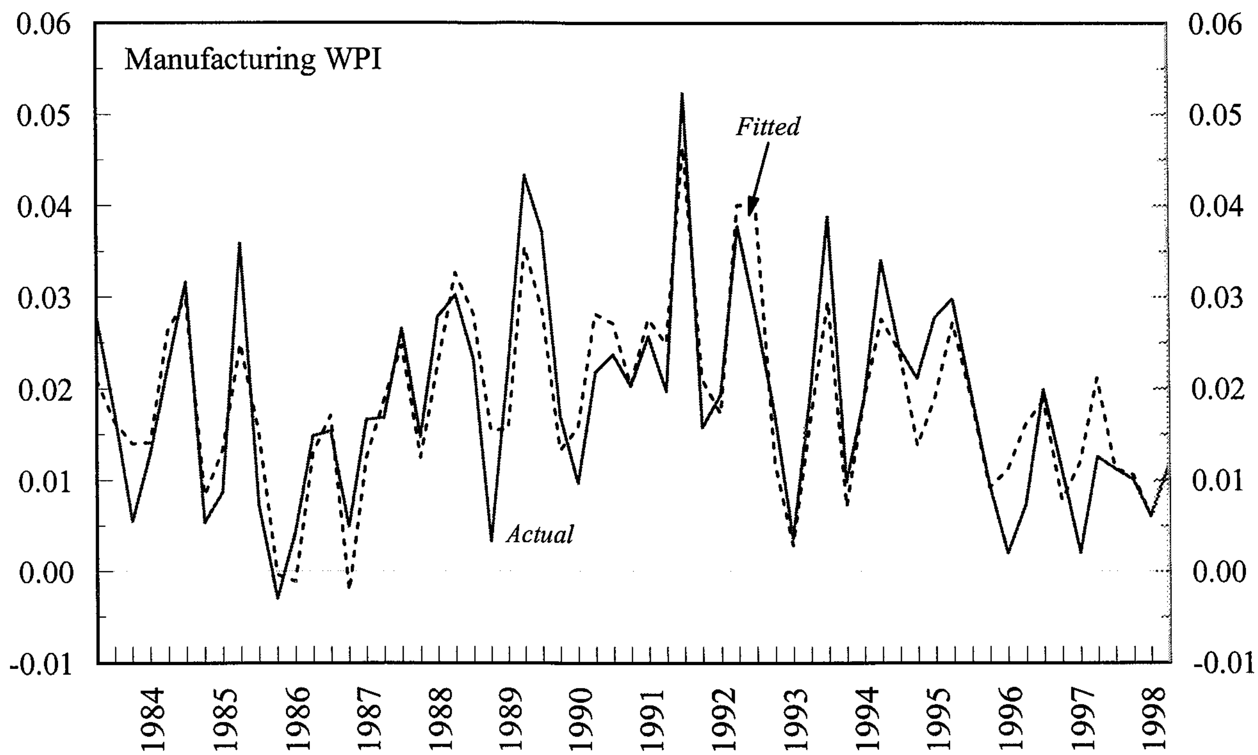
[13]Most studies of inflation in developing countries find a negative relationship between rainfall and inflation. However, excessive deviations from "normal" rainfall in either direction, ie. droughts or floods will hurt agricultural production and result in higher inflation.

[14]On a larger sample, Jadhev (1994), finds structural breaks in a quarterly money demand function in 1975 and in 1992/83.

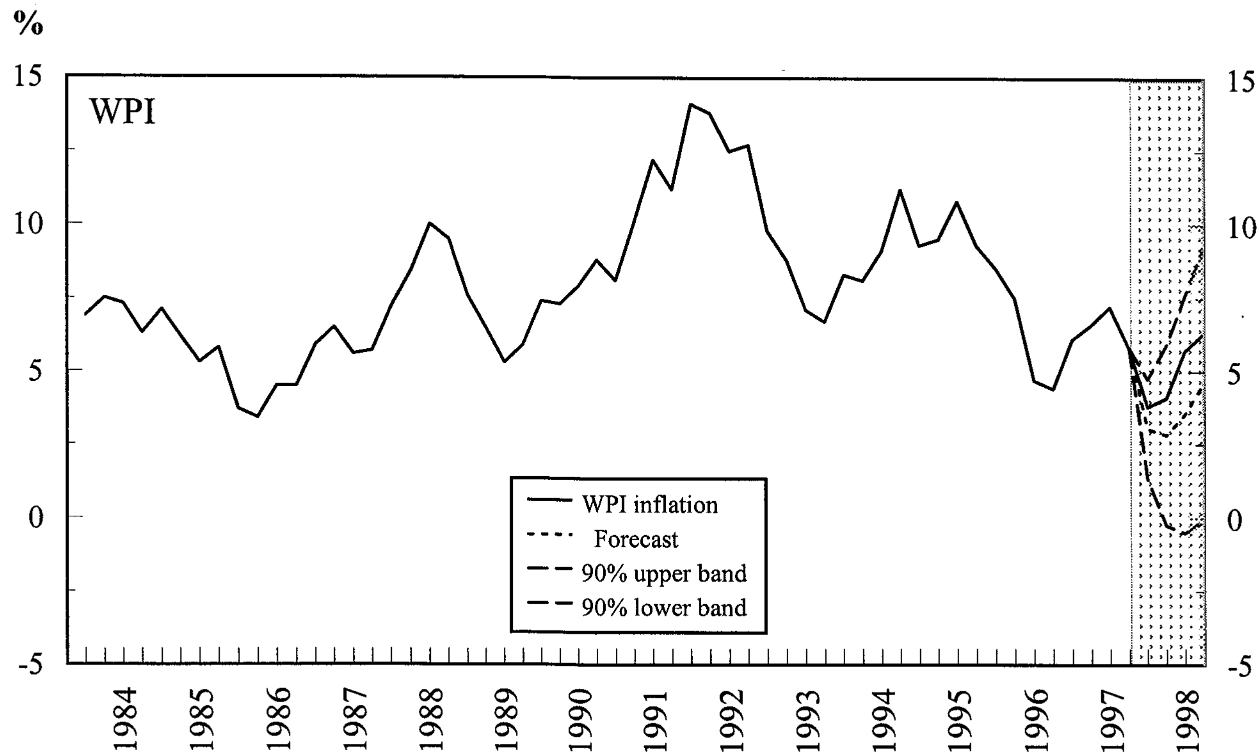
Chart 4: Actual and Fitted Values of the Equations
(Quarterly Log Change in the Dependent Variables)

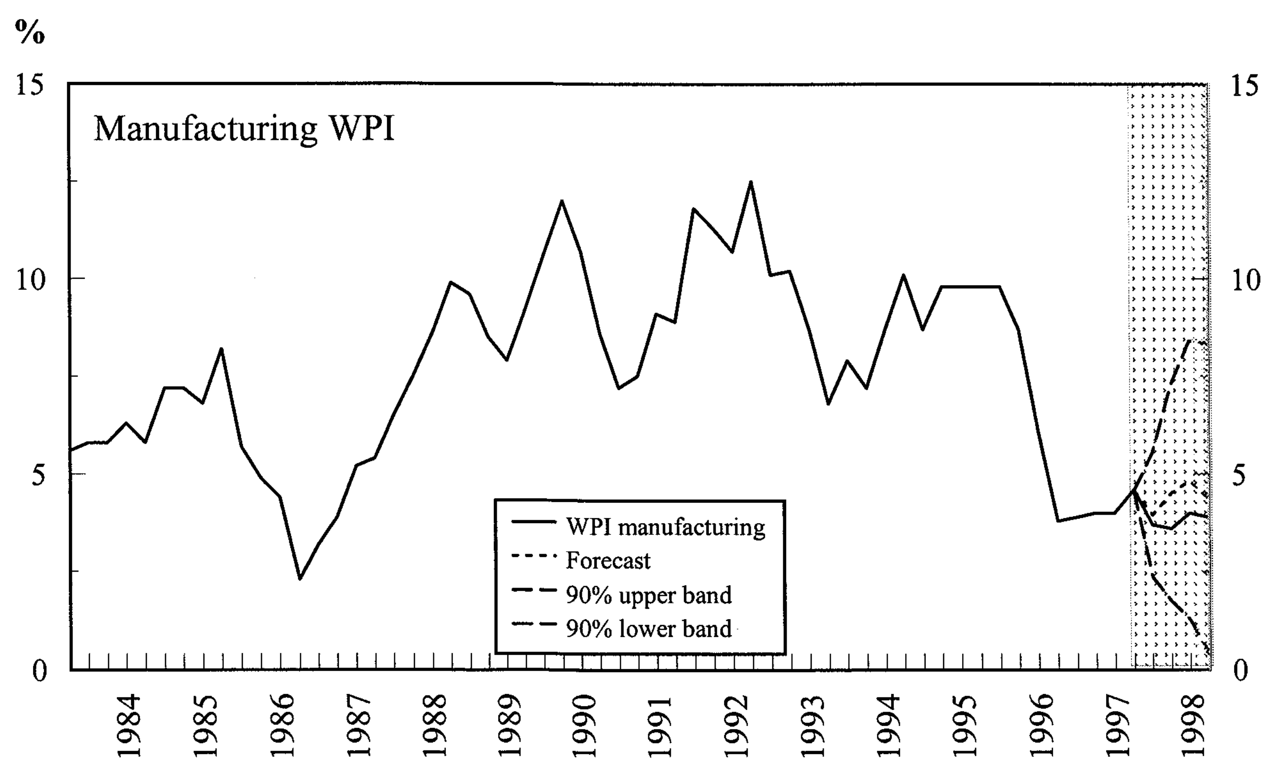




Source: Staff calculations.

Chart 5: Out of Sample Forecast of Inflation
(Year-on-year percentage change)





Source: Staff calculations.

the exact breakpoint chosen. However, while these statistical tests did not detect a structural break, re-estimation of the equations over the more recent time period suggested some interesting changes (although caution should be attached to these results given the short sample period). First, the fit of both equations improved. Second, the importance of the monetary terms and imported inflation increased significantly. Third, for manufactured inflation, the importance of primary product inflation declined, possibly suggesting that as the domestic economy has been opened to foreign competition the links between domestic agriculture and industry have weakened.

Estimates of the output gap model for overall and manufactured price inflation are presented in Appendix II, Table 4. While the sum of the output gap terms is correctly signed and significant for overall WPI inflation, it is incorrectly signed and significant for manufactured prices. Given the output gap is based on industrial production, rather than overall GDP, these results are counter intuitive.[14] The output gap was also insignificant and/or incorrectly signed when included in the preferred monetary equation.

To further explore the properties of the output gap model, and to check the robustness of the other results derived from the quarterly data, the equations reported above were re-estimated for LWPI using annual data (1957/58–1997/98) with real GDP as the activity variable instead of industrial production (results reported in Appendix II, Table 5). The results were broadly similar to those obtained from the quarterly data, again showing a relatively slow pace of adjustment to the long-run equilibrium. In these regressions, LOIL was found to outperform LUSPPI being highly significant in all the regressions. Again the output gap model was not supported by the data, with the coefficient on the output gap term being incorrectly signed and insignificant.[15]

The earlier discussion suggested that for the Indian economy it is likely to be important to distinguish between the agricultural and industrial sectors when estimating an output gap model. Using annual data, it is possible to split the output gap into separate industrial and agricultural components (again using the Hodrick-Prescott filter to derive estimates of trend output). Both the agricultural (OGAPA) and industrial (OGAPI) output gaps were correctly signed when entered individually (i.e., agricultural output above trend results in lower inflation, while industrial output above trend leads to higher inflation), although only the agricultural gap was significant. This highlights the importance of sectoral aspects of the Indian inflation process, and indicates the importance of accounting for supply shocks in explaining inflation.

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[15]Of course, this does not necessarily imply that the output gap model does not work for India. It may be that the Hodrick-Prescott filter does not provide a good characterization of potential output in India.

C. Leading Indicators of Inflation

In this section we assess the leading indicator properties of a number of variables for future inflation through the estimation of bivariate vector autoregressions (VARs) and a series of Granger causality tests and variance decompositions. The variables used in the bivariate tests are those used in the model estimation above together with stock prices.

The results of the bivariate Granger-causality tests are presented in Appendix II, Table 6. Likelihood ratio tests were carried out for the null hypothesis that the variable under consideration does not Granger-cause inflation. The results indicate that the money gap (MONG1 and MONG3 using M1 and M3 respectively) has the highest degree of predictive content for inflation, although this comes mainly from industrial production rather than the monetary aggregates over the whole sample period. However, during the more recent period (1992Q2 to 1998Q2), the predictive content of the monetary aggregates, particularly M1, increases, especially at short time horizons. Foreign inflation also has some predictive content over short time horizons. While the output gap also appears to have predictive content after one-quarter, the terms are incorrectly signed and the results are only included for completeness. For manufactured price inflation, the money gap again has significant predictive power, although in this case M1 on its own is significant. Foreign inflation and stock prices also have strong predictive content, while primary product inflation has some predictive content. However, in contrast to the results for the aggregate WPI, the predictive content of the money gap terms weaken substantially, particularly over short time horizons, during the more recent period.

The variance decomposition results broadly support the Granger-causality tests (Appendix II, Table 7). The variance decompositions measure the proportion of the variance of inflation that can be explained by the variance of the indicator variable. Variances of the money gap terms, industrial production on its own, and stock prices explain a significant proportion of the variance in inflation. Again the monetary terms become more important in explaining the variance of inflation in the more recent sample, as does imported inflation. Narrow money, the two money gap terms, primary product inflation, and stock prices appear to contain the most information about LWPIM.

VI. Conclusions and Policy Implications

In its recent policy statements, the Reserve Bank of India has indicated that it is moving away from a broad money target toward a "multiple indicators" approach to the conduct of monetary policy. In this paper we have attempted to assess which of the potential indicators available give the most reliable and timely indications of future inflationary developments. This has been carried out both by developing a model of inflation, and by estimating a series of bivariate VARs. The results indicate a number of important issues in modeling and forecasting inflation in India.

- Developing an adequate model of inflation is complicated by swings in the prices of primary products, which, year-to-year, are largely driven by climatic conditions, and by changes in administered prices. A model of manufacturing prices fits better than one for the overall WPI.

- Developments in the monetary aggregates (both M1 and M3) appear to contain the best information about future inflation, particularly when judged against developments in activity. If anything, the information content of the monetary aggregates appears to have increased since financial deregulation. An output gap specification, unlike in many other countries, does not perform well on Indian data.

- With regard to prices in the manufacturing sector, import prices, the exchange rate, stock prices, and the prices of primary products also provide useful information about future price developments.

In turn, the results have a number of policy implications and also raise a number of issues for the monetary authorities:

- While the RBI is moving away from announcing an explicit monetary target, developments in the monetary aggregates continue to provide important information about future inflationary developments and will need to continue to be closely monitored.

- The development of a wider measure of liquidity which includes public deposits held with financial institutions and NBFCs, as set out in the report of the Working Group on "Money Supply: Analytics and Methodology of Compilation," would provide important additional information given the growing importance of nonbank institutions.

- In this paper, the manufacturing subcomponent of the WPI has been used as a measure of core inflation. However, the Reserve Bank should develop a proper measure of core inflation which excludes volatile items and those items whose prices are not determined in the short-run by market forces. This index would give a better idea of underlying inflation developments in the economy than is available in the currently published indices, and would aid the conduct of monetary policy. Of course, in its current conduct of policy, the Reserve Bank at times implicitly focuses on a core measure of inflation by discounting price movements that are expected to be reversed in the short-run (for example, the recent sharp rise and subsequent decline in primary product prices). But the publication of an explicit core inflation index would improve the transparency of policy. However, this does not mean that developments in the headline price index can be totally discounted. The results presented here indicate that there are important links between developments in the primary sector and other areas of the economy, and the RBI needs to take this into account in its policy actions.

- It should also be noted that the change in the RBI's policy approach entails some risks. The broad money target has formed the backbone of monetary policy for a number of years and is well understood by the general public and provides an anchor for inflation expectations (Rangarajan, 1998). During the transition period, the RBI will need to be particularly vigilant and quickly respond to any pick-up in inflation pressures to ensure there is no suggestion of a weakening of its commitment to maintain a reasonable degree of price stability.

- An important question, and one that has not been addressed in this paper, is whether the swings in the prices of primary products are accentuated by remaining restrictions on the imports of many of these products and by poor distribution mechanisms. If so, liberalizing the import of agricultural products and improving distribution mechanisms would be an important step for improving macroeconomic stability.

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DATA DEFINITIONS AND SOURCES

Wholesale price index (WPI): Quarterly data, including the manufacturing and primary products subcomponents, are from the Wharton Econometric Forecasting Associates (WEFA) database (1980/81=100). Annual data are from *International Financial Statistics* (IFS) line 63 (1990=100).

Consumer price index (CPI): Quarterly and annual data are from IFS line 64 (1990=100).

Index of industrial production (IP): From IFS line 66 (1990=100).

Real GDP (GDP): From IFS line 99b.p (at 1980/81 prices).

Narrow money (M1): Quarterly and annual data are from IFS line 34, *Money*.

Broad money (M3): Quarterly and annual data are from IFS. Defined as the sum of *Money* (line 34) and *Quasi-Money* (line 35).

Call rate (CALL): Quarterly data is from the WEFA database. For annual data, the money market rate from IFS is used (line 60b).

US producer prices (USPPI): From IFS line 63 (1990=100).

Oil prices (OIL): Price of U.K. Brent, from IFS line 112.

Exchange rate (ERATE): The period average U.S. dollar/Indian rupee rate from IFS line rf.

Stock prices (STK): From IFS line 62.

Rainfall (RAIND): Data provided by the Centre for Monitoring the Indian Economy (CMIE).

Details of Empirical Results

Table 1: Unit Root Tests

	Test Statistic							
	Augmented Dickey-Fuller Test				Phillips-Perron Test			
	Constant		Constant and Trend		Constant		Constant and Trend	
Variable	Level	Δ	Level	Δ	Level	Δ	Level	Δ
Sample: 1982Q2–1998Q2								
LM3	-0.567	-4.620	-2.639	-4.541	-1.164	-9.528	-3.72	-9.597
LM1	-0.496	-3.549	-2.595	-3.533	-0.079	-4.871	-5.653	-14.781
LIP	-0.579	-2.612	-2.090	-2.583	-0.607	-14.717	-6.474	-14.574
OGAP	-2.666	-3.317	-2.632	-3.254	-4.029	-12.906	-4.002	-12.825
LWPI	0.256	-2.350	-2.086	-2.291	0.347	-5.713	-1.704	-5.693
LWPIM	-1.301	-3.018	-1.074	-2.666	-0.423	-7.641	-1.276	-7.579
LWPIP	0.286	-3.253	-3.137	-3.305	0.134	-7.067	-2.319	-7.063
LCPI	0.175	-3.270	-3.226	-3.282	-0.364	-7.497	-2.789	-7.421
LERATE	-0.057	-4.535	-1.843	-4.497	-0.065	-5.729	-2.048	-5.688
LUSPPI	-0.963	-3.081	-2.158	-3.086	-0.840	-6.043	-1.826	-6.016
LOIL	-1.717	-4.842	-2.233	-4.780	-2.120	-7.410	-2.758	-7.334
RAIND	-4.938	-5.850	-4.922	-5.811	-7.047	-15.560	-7.016	-15.419
LSTK	-1.662	-4.012	-0.534	-4.368	-1.582	-5.520	-0.883	-5.685
CALL	-3.121	-3.589	-3.187	-3.533	-4.670	-13.613	-4.707	-13.511
Sample: 1957/58–1997/98								
LCPI	0.415	-4.897	-4.287	-4.948	0.895	-4.479	-3.146	-4.470
LGDP	2.017	-4.878	-0.409	-5.622	1.986	-6.970	-0.361	-8.042
LMI	3.712	-4.029	-0.902	-6.507	4.929	-6.777	-1.182	-10.332
LM3	2.285	-2.051	-3.583	-2.971	3.543	-2.984	-3.493	-4.406
LOIL	1.114	-3.735	-1.180	-3.758	-1.084	-6.352	-1.458	-6.316
MMR	-3.674	-8.965	-5.855	-8.823	-4.541	-11.295	-5.968	-11.243
OGAP	-5.052	-6.232	-4.984	-6.138	-5.274	-8.945	-5.205	-8.796
OGAPA	-5.397	-7.399	-5.322	-7.289	-6.651	-11.809	-6.562	-11.580
OGAPI	-5.022	-5.227	-5.006	-5.155	-3.322	-5.245	-3.271	-5.153

Note: Δ is the first difference of the variable. Mackinnon (1991) critical values for the Augmented Dickey-fuller (ADF) and Phillips-Perron (PP) tests at the 1%, 5%, and 10% significance levels are -3.533, -2.906, -2.590 (with constant) and -4.104, -3.479,-3.167 (with constant and trend) respectively for the quarterly data. Values for the annual data slightly higher. Four lags were used in the ADF test on quarterly data, one on annual data. The truncation lag in the PP test was set at three.

Table 2: Johansen Maximum Likelihood Approach [1/]

Sample Period: 1982Q2 to 1998Q2

(I) Cointegrating vector: LWPI, LIP, LM3, CALL

Null	Alternative	Maximum Eigen Value	95% Critical Value	Trace	95% Critical Value
r=0	r=1(r>=1)	28.92*	27.1	57.92*	47.2
r<=1	r=2(r>=2)	21.85*	21.0	29.00	29.7
r<=2	r=3(r>=3)	5.47	14.1	7.15	15.4
r<=3	r=4(r>=4)	1.68	3.8	1.68	3.8

(II) Cointegrating vector: LWPI, LIP, LM1, CALL

Null	Alternative	Maximum Eigen Value	95% Critical Value	Trace	95% Critical Value
r=0	r=1(r>=1)	33.92**	27.1	52.03*	47.2
r<=1	r=2(r>=2)	12.55	21.0	18.11	29.7
r<=2	r=3(r>=3)	5.55	14.1	5.55	15.4
r<=3	r=4(r>=4)	0.00	3.8	0.00	3.8

(III) Cointegrating vector: LWPIM, LIP, LM3, CALL

Null	Alternative	Maximum Eigen Value	95% Critical Value	Trace	95% Critical Value
r=0	r=1(r>=1)	23.63	27.1	43.15	47.2
r<=1	r=2(r>=2)	9.94	21.0	19.52	29.7
r<=2	r=3(r>=3)	6.69	14.1	9.57	15.4
r<=3	r=4(r>=4)	2.89	3.8	2.89	3.8

(IV) Cointegrating vector: LWPI, LIP, LM1, CALL

Null	Alternative	Maximum Eigen Value	95% Critical Value	Trace	95% Critical Value
r=0	r=1(r>=1)	17.68	27.1	38.94	47.2
r<=1	r=2(r>=2)	13.00	21.0	21.25	29.7
r<=2	r=3(r>=3)	7.22	14.1	8.26	15.4
r<=3	r=4(r>=4)	1.04	3.8	1.04	3.8

(V) Cointegrating vector: LWPI, LIP, LM3, CALL, LUSPPI

Null	Alternative	Maximum Eigen Value	95% Critical Value	Trace	95% Critical Value
r=0	r=1(r>=1)	45.33**	33.5	90.28**	68.5
r<=1	r=2(r>=2)	21.40	27.1	44.95	47.2
r<=2	r=3(r>=3)	11.38	21.0	23.55	29.7
r<=3	r=4(r>=4)	9.61	14.1	12.17	15.4
r<=4	r=5(r>=5)	2.56	3.8	2.56	3.8

(VI) Cointegrating vector: LWPIM, LIP, LM3, CALL, LUSPPI

Null	Alternative	Maximum Eigen Value	95% Critical Value	Trace	95% Critical Value
r=0	r=1(r>=1)	37.20	33.5	88.13**	68.5
r<=1	r=2(r>=2)	23.55	27.1	50.93*	47.2
r<=2	r=3(r>=3)	13.68	21.0	27.38	29.7
r<=3	r=4(r>=4)	13.27	14.1	13.70	15.4
r<=4	r=5(r>=5)	0.42	3.8	0.42	3.8

1/ On the basis of a series of F-tests, the lag length in the VARs was set at 5 in all cases. Alternative hypothesis for the trace statistic is in brackets. *: significant at the 5 percent level;**: significant at the 1 percent level.

Table 3: Cointegration Using A Residuals Based Approach

Unit root tests for residuals from the OLS regression.[1]
Sample period: 1982Q2 to 1998Q2

(I) LWPI = 2.02 + 0.74* LM3 - 0.54*LIP - 0.0004*CALL
DF = -3.18 (-4.27)

(II) LWPI = 2.38 + 0.73*LM1 - 0.45*LIP - 0.0008*CALL
DF = -5.57** (-4.27)

(III) LWPIM = -1.59 + 0.59*LM3 -0.45*LIP - 0.0003*CALL + 0.94*LUSPPI
DF = -3.94 (-4.63)

(IV) LWPIM = 0.02 + 0.63*LM1 - 0.38*LIP - 0.0003*CALL + 0.59*LUSPPI
DF = -6.29** (-4.63)

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[1]Zero lags in the ADF test was chosen in all cases on the basis of the Akaike and Schwarz criterion. 5 percent critical values are in brackets and are taken from Mackinnon (1991).
**:significant at the 1% level.

Table 4: Estimates of Output Gap Models

Sample Period: 1982Q2 to 1998Q2

Dependent Variable	DLWPI	DLWPIM
Constant	0.010 (2.85)	0.005 (1.92)
DLWPI (-1)	0.416 (3.27)	...
DLWPI (-3)	0.391 (3.24)	...
DLWPI (-4)	-0.307 (2.37)	...
OGAP (-1)	-0.119 (2.67)	-0.155 (3.64)
OGAP (-2)	0.184 (3.62)	0.054 (1.12)
OGAP (-3)	0.019 (0.38)	0.064 (1.40)
OGAP (-4)	-0.075 (1.68)	-0.046 (1.06)
DLERATE(-3)	...	0.071 (2.73)
DLUSPPI (-1)	...	0.241 (2.29)
DLUSPPI (-3)	...	0.382 (3.44)
DLWPIP (-3)	...	0.209 (4.07)
R^2	0.419	0.656
$\bar{R}^2$	0.30	0.58
LM (4)	3.75	4.43
White	24.35	26.06
Jarque-bera	0.57	2.14

Note: t-statistics in parentheses.

Table 5: Estimates of Inflation Equations on Annual Data

Sample Period: 1957/58-1997/98

Dependent Variable DLWPI

Constant	0.025 (1.24)	0.011 (0.89)	0.065 (5.16)	0.063 (5.39)
DLWPI (-1)	0.206 (1.91)	0.220 (2.08)	0.045 (0.31)	0.090 (0.66)
DLM3 (-1)	-0.405 (3.23)	...	...	...
DLGDP (-1)	-0.571 (3.62)	...	...	...
MONG3(-1)	...	0.467 (4.53)	...	...
DLOIL (-1)	0.079 (4.28)	0.078 (4.24)	0.11 (4.61)	0.103 (4.62)
ECM (-1)	-0.235 (3.44)	-0.242 (3.59)	...	...
OGAP (-1)	...	...	-0.502 (1.57)	...
OGAPA (-1)	...	...	...	-0.413 (2.72)
OGAPI (-1)	...	...	...	0.373 (1.66)
R^2	0.685	0.678	0.428	0.516
$\bar{R}^2$	0.637	0.640	0.379	0.459
LM (1)	0.27	0.02	4.84	3.60
White	8.78	5.13	2.95	4.77
Jarque-bera	0.78	0.62	0.07	0.24

Note: t-statistics in parentheses. MONG3 is defined as DLM3-DLGDP in this table.

Table 6a: Leading Indicators of Inflation: Bivariate Granger Causality Tests

Indicator Variables	Lags of VAR							
	1	2	3	4	5	6	7	8
	Sample: 1982Q2-1998Q2							
DLM1	0.230	0.353	0.255	0.369	0.484	0.388	0.487	0.494
DLM3	0.455	0.744	0.711	0.828	0.512	0.537	0.637	0.532
DLIP	0.001	0.005	0.001	0.002	0.003	0.007	0.009	0.014
MONG1	0.000	0.001	0.000	0.000	0.000	0.002	0.001	0.002
MONG3	0.001	0.003	0.000	0.001	0.002	0.004	0.002	0.001
CALL	0.192	0.231	0.710	0.775	0.942	0.925	0.870	0.101
OGAP	0.470	0.007	0.003	0.003	0.006	0.009	0.019	0.015
DLUSPPI	0.020	0.024	0.081	0.155	0.281	0.408	0.480	0.477
DLOIL	0.039	0.130	0.302	0.085	0.120	0.184	0.203	0.158
DERATE	0.087	0.272	0.734	0.772	0.720	0.701	0.755	0.710
DSTK	0.116	0.188	0.528	0.579	0.649	0.534	0.558	0.466
DLWPIM	0.933	0.608	0.675	0.444	0.470	0.474	0.435	0.456
	Sample: 1992Q2-1998Q2							
DLM1	0.010	0.039	0.146	0.265	0.213	0.049	0.132	0.062
DLM3	0.060	0.220	0.284	0.436	0.319	0.492	0.652	0.593
MONG1	0.004	0.012	0.035	0.057	0.066	0.109	0.126	0.058
MONG3	0.039	0.235	0.197	0.244	0.322	0.443	0.245	0.122

Note: P-values shown for the likelihood ratio tests of the null hypothesis that the indicator variable does not Granger-cause inflation.

Table 6b: Leading Indicators of Manufactured Inflation: Bivariate Granger Causality Tests

Indicator Variables	Lags of VAR							
	1	2	3	4	5	6	7	8
	Sample: 1982Q2-1998Q2							
DLM1	0.041	0.020	0.053	0.111	0.189	0.160	0.240	0.286
DLM3	0.241	0.491	0.349	0.595	0.713	0.833	0.823	0.847
DLIP	0.009	0.031	0.020	0.065	0.123	0.154	0.222	0.303
MONG1	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.003
MONG3	0.003	0.013	0.010	0.023	0.032	0.057	0.054	0.095
CALL	0.483	0.696	0.877	0.987	0.996	0.987	0.984	0.974
OGAP	0.140	0.053	0.034	0.090	0.152	0.247	0.311	0.345
DLUSPPI	0.020	0.062	0.018	0.073	0.137	0.187	0.321	0.433
DLOIL	0.076	0.190	0.381	0.462	0.509	0.613	0.387	0.495
DERATE	0.175	0.392	0.241	0.301	0.314	0.317	0.588	0.580
DLWPIP	0.812	0.209	0.097	0.120	0.158	0.228	0.356	0.493
DSTK	0.037	0.083	0.303	0.482	0.632	0.429	0.336	0.425
	Sample: 1992Q2-1998Q2							
DLM1	0.023	0.049	0.097	0.156	0.043	0.049	0.109	0.044
DLM3	0.176	0.469	0.212	0.307	0.243	0.356	0.560	0.662
MONG1	0.124	0.203	0.028	0.027	0.014	0.001	0.001	0.001
MONG3	0.450	0.803	0.426	0.480	0.566	0.444	0.490	0.682

Note: P-values shown for the likelihood ratio tests of the null hypothesis that the indicator variable does not Granger-cause inflation.

Table 7a: Forecast Error Variance of Inflation Explained by Variable (In percent)

Indicator Variable	Horizon (in quarters)							
	1	2	3	4	6	8	12	24
	Sample: 1982Q2-1998Q2							
DLM1	1.1	1.1	8.5	8.6	12.4	12.7	13.7	13.8
DLM3	2.4	2.7	7.8	8.4	12.4	13.6	13.8	13.8
MONG1	6.3	10.1	17.0	16.7	16.7	16.8	17.6	17.9
MONG3	11.4	14.2	16.2	16.1	16.2	15.0	15.6	16.0
DLIP	6.3	8.2	8.1	8.5	9.1	9.2	9.4	9.5
OGAP	3.0	9.5	9.6	9.6	9.6	9.5	9.5	9.5
DLUSPPI	9.8	9.5	9.0	11.5	11.5	11.8	12.4	12.5
DLOIL	2.6	5.4	5.4	8.1	10.9	11.1	12.3	12.4
DLERATE	0.4	3.8	5.1	5.4	9.4	9.3	9.8	10.0
DLSTK	6.4	12.9	14.2	14.2	13.6	14.7	15.5	15.7
DLWPIM	1.4	1.9	5.0	5.1	7.2	7.1	7.4	7.3
	Sample: 1992Q2-1998Q2							
DLM1	40.7	42.4	43.7	43.8	48.3	51.2	49.3	55.5
DLM3	38.0	36.9	40.2	39.6	41.6	44.3	43.1	43.0
MONG1	33.6	35.6	40.1	39.2	43.9	47.7	47.1	47.7
MONG3	17.1	17.1	23.1	22.5	21.6	22.9	22.6	23.9
DLUSPPI	8.9	16.4	40.6	40.6	48.1	50.4	60.1	75.5

Note: Six lags included in the estimated VAR.

Table 7b: Forecast Error Variance of Manufactured Inflation Explained by Variable
(In percent)

Indicator Variable	Horizon (in quarters)							
	1	2	3	4	6	8	12	24
	Sample: 1982Q2-1998Q2							
DLM1	8.8	12.1	12.0	12.0	15.0	15.3	15.2	15.3
DLM3	3.0	3.1	3.1	3.1	7.6	7.7	8.2	8.3
MONG1	28.0	29.9	27.9	27.4	27.7	26.4	26.6	26.9
MONG3	19.4	19.3	20.3	22.4	21.8	21.1	21.7	22.4
DLIP	9.1	9.3	10.0	12.5	12.9	12.7	13.6	14.2
OGAP	6.7	8.9	9.1	11.3	10.8	10.8	11.1	11.2
DLUSPPI	4.9	4.9	6.9	12.0	11.4	12.0	12.3	12.4
DLOIL	1.3	1.3	2.1	3.9	6.2	6.5	6.8	6.8
DLERATE	1.1	1.0	1.3	1.9	3.7	5.3	5.5	5.6
DLSTK	9.9	14.4	15.6	16.3	15.7	16.0	16.3	16.3
DLWPIP	0.0	4.6	16.5	17.2	18.0	18.5	18.7	18.7
	Sample: 1992Q2-1998Q2							
DLM1	28.3	33.6	29.1	26.6	47.3	46.7	47.2	47.3
DLM3	12.1	12.1	11.1	10.0	13.8	14.1	14.8	15.5
MONG1	57.3	61.1	62.0	66.7	63.4	62.0	62.0	61.4
MONG3	16.8	16.0	15.9	25.2	25.2	27.0	28.2	29.6
DLUSPPI	10.4	10.5	10.9	10.9	12.5	14.2	15.6	15.9
DLWPIP	3.3	3.0	4.6	5.3	17.7	16.6	18.2	19.8

Note: Six lags included in the estimated VAR.