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MACROECONOMIC VARIABLES AND THE PERFORMANCE OF THE INDIAN STOCK MARKET

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Abstract

In this paper we analyze relationships among selected macroeconomic variables and the Indian stock market. By employing a vector error correction model, we find that three long-term equilibrium relationships exist among these variables. Our results suggest that domestic inflation is the most severe deterrent to Indian stock market performance, and domestic output growth is its predominant driving force. After accounting for macroeconomic factors, the Indian market still appears to be drawn downward by a residual negative trend. We attribute this to economic mismanagement, since the size of the downward pull mitigates after 1990, coinciding with the beginning of Indian economic reforms.

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Abstract

In this paper we analyze relationships among selected macroeconomic variables and the Indian stock market. By employing a vector error correction model, we find that three long-term equilibrium relationships exist among these variables. Our results suggest that domestic inflation is the most severe deterrent to Indian stock market performance, and domestic output growth is its predominant driving force. After accounting for macroeconomic factors, the Indian market still appears to be drawn downward by a residual negative trend. We attribute this to economic mismanagement, since the size of the downward pull mitigates after 1990, coinciding with the beginning of Indian economic reforms.

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I. Introduction

Since its independence in 1947, a multitude of problems have stood in India's way of realizing its true economic potential. Included in the social and political problems are recurring fights among various religious sects, an ever-increasing population, archaic bureaucratic procedures, infighting among and within political parties, and nationalist movements led by a variety of separatist groups. Economic problems have included counter-productive tax rates, debilitating customs duties that stymied foreign investments, and the Indian government's socialist approach that kept the economy as well as the stock market closed to foreigners.

Although India continues to struggle with socio-political problems, it has recently made tremendous strides in the economic front via reforms that were introduced by the Rao Administration in the early part of 1991.[1] The most significant of the reforms was perhaps the opening of the economy to foreign investment on very liberal terms and allowing, for the first time in independent India's history, direct and indirect investments by foreign nationals and institutional investors in India's equity markets. These reforms have produced positive results. India's industrial exports and foreign investment today are growing at the country's fastest rate ever. The country's foreign exchange reserves skyrocketed to $20 billion in 1995 from less than $1 billion in June 1991. Similarly, several Indian stocks (Mahindra and Mahindra, and Reliance Industries Limited for example) are now traded on international markets. Additionally, several closed-end (for

[1] P.V. Narasimha Rao became the Prime Minister of India after the assassination of Rajiv Gandhi. Mr. Rao's Finance Minister, Manmohan Singh, is credited with spearheading this economic revolution. Rao's government fell in 1996 but the reforms seem to have taken a permanent hold on the Indian economy.

example, the India Growth Fund and the India Fund, listed on the NYSE, and the unlisted Magnum Fund) and open-end mutual funds (for example, Morgan Stanley India Fund) are currently available to foreign investors.[2] Also, foreign brokerage houses are now being allowed through joint ventures with Indian investment bankers to participate in primary as well as secondary markets in India.

Given the newfound interest in the Indian stock markets, an intriguing question is how these markets have performed over the years. To answer this question we examine the return generating process of the Bombay Stock Exchange (BSE). The BSE, which dates back to the 19th century, is the largest and most active stock exchange in India, accounting for between 65% and 70% of the value of the country's total stock transactions. Time series data over a reasonably long period are available on the BSE. The BSE is also well established emerging equity markets and thus, provides a showcase for other emerging markets in the world.

We analyze the long-term relationship between the BSE and certain relevant macroeconomic factors. We employ a vector error correction model (VECM) (Johansen (1991)) in a system of five equations to investigate the presence of cointegration (and, by implication, long-term equilibrium relations) among these factors.[3] We find three cointegrating relationships with sensible long-run elasticities. The complete system of long-run and short-run effects indicates that domestic inflation and domestic output growth are the primary determinants of prices of the BSE. Further, our model indicates that the BSE has in general underperformed, although its post-

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[2] In explaining the new found fascination over the Indian stock markets, McTigue (1993) comments: "India's allure is that it looks a bit like another China. After 40 years of socialism, its inwardly turned economy is opening up to world trade. It already has the world's largest middle class of 200 million people, several thousand listed companies, and half a dozen exchanges that have been present for decades."

[3] In statistics, cointegration points to a linear combination of nonstationary time series resulting in a stationary series. In

1990 performance appears to have improved in relation to the earlier period.

This paper's contributions are as follows. First, by embracing a study period that extends beyond 1990, this paper provides the first attempt to compare the pre-reform performance of the BSE with its performance in the post-reform period. The time period examined by existing studies on the time-series behavior of the BSE do not cover post-reform years. Sharma and Kennedy (1977) and Sharma (1983) test the weak-form efficiency of the BSE. Both of these studies, with the former covering the 1963-1973 period and the latter encompassing the 1973-1978 period, conclude that Indian stocks generally conformed to random-walk behavior in that successive price changes were independent. Based on quarterly data, Poterba and Summers (1988), however, find evidence of mean reversion in Indian stock prices, suggesting a deviation from random-walk behavior. Darrat and Mukherjee (1987) apply a vector autoregression model (VAR) along with Akaike's final-prediction-error on the Indian data over 1948-1984 and find that a significant causal relationship (in the sense of Granger, 1969) exists between stock returns and selected macroeconomic variables.

Second, by employing Johansen's VECM, which has become a standard technique for examining cointegrating relationships among the financial variables, the current paper avoids a potential misspecification problem in the VAR technique employed in the Darrat and Mukherjee paper. If the variables used by their paper are cointegrated, then the model may be misspecified as it excludes an additional channel of influence resulting from a long-term equilibrium relationship among these variables (Engle and Granger (1987)).

Third, the current paper provides interpretations of multiple cointegrating relationships in a

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economics, the existence of such a linear combination indicates a long-term equilibrium relationship (Granger (1986)).

system of equations (unlike the single cointegrating vector models of Baillie and Bollerslev (1989), Hafer and Jansen (1991), Diebold, Gardeazabel, and Yilmaz (1994), Engsted and Tanggaard (1994), Harris, McInish, and Schoesmith (1995), Mukherjee and Naka (1995), Chinn and Frankel (1995), Lo, Fund, and Morse (1995), Cushman and Lee (1996), and Dutton and Strauss (1997)). Also, we demonstrate the effects of macro-economic factors on the Indian stock market by constructing the impulse responses as well as variance decompositions. Finally, the results of this paper are likely to have implications for other emerging stock markets. Our preliminary result indicates that the downward trend of the Indian stock market has been restrained in the post-reform years. This may be a lesson for countries like China, which continue to impose varying degrees of foreign investment restrictions.

The paper proceeds along the following lines. Section II presents the asset valuation model and its implications for pricing of macroeconomic factors. Section III discusses the data and the methodology. Section IV reports results, and Section V offers conclusions.

II. An Asset Valuation Model

According to the basic discounted cash flows model, the price of a financial asset is equal to the discounted value of the future cash flows to be derived from the asset:

(1) $$P = \sum_{t=1}^{n} \frac{CF_t}{(1+RRR)^t}$$

Any change in an asset's cash flows (CF) should have a direct impact on its price. Thus, the asset’s expected growth rates which influence its predicted cash flows will affect its price in the same direction. Conversely, any change in the required rate of return (RRR) should inversely affect the asset's price. The required rate of return has two basic components—the nominal risk-free rate and the premium commensurate with the asset's risk. The nominal risk-free rate in addition is comprised of the real rate of interest and the anticipated inflation rate.

A country's stock index therefore is affected by factors that influence its economic growth or bring about changes in its real rate of interest, expected rate of inflation, and risk premium. Based on what Chen, Roll and Ross (1986) describe as "simple and intuitive financial theory," we hypothesize that nominal interest rates, inflation, output and the money stock will affect the variables implicit in the above model and therefore should influence the Bombay Stock Exchange index.[4]

We expect a positive correlation between the nominal interest rate and the risk-free rate of the valuation model. Thus, a change in nominal interest rates should move asset prices in the opposite direction. Actual inflation will be positively correlated with unanticipated inflation, and will *ceteris paribus* move asset prices in the opposite direction. It may be argued that the effect on the discount rate would be negated if cash flows increase at the same rate as inflation. However, cash flows may not go up with inflation. DeFina (1991), among others, suggests that pre-existing contracts would deny any immediate adjustments in the firm's revenues and costs. Indeed, one might argue that cash flows should initially decrease if output prices lag input costs in response to rising inflation.

Any growth in output, should, in general, affect the future cash flows of domestic firms in the same direction. *Ceteris paribus*, stock prices should move in the same direction. The direction of impact of money supply on stock prices needs to be determined empirically. On the one hand, it can argued that monetary growth, due to its positive relationship with the inflation rate (Fama

[4] Initially, we also used exchange rates in our analysis, but found that our results held when they were not included. For most of the period of this study, India's exchange rates were managed.

1982), will adversely affect stock prices. On the other hand, it may also be argued that monetary growth brings about economic stimulus, resulting in increased cash flows (corporate earnings effect) and increased stock prices. One may also add that in the case of India the money stock might very well convey information about India’s risk-free rate, which is otherwise masked by the government control of nominal interest rate in much of our study period. When the interest rate is pegged by the government, underlying pressure from agents’ liquidity preference which is ordinarily reflected in the interest rate is instead reflected in changes in the money stock. Since the money supply has a negative relationship with interest rates, this implies a direct relationship between the former and the stock price.

To sum up, the arguments put forth above lead us to hypothesize a negative relationship between interest rates or inflation and stock prices, and a positive relation between output growth and stock prices. The relation between the money stock and stock prices is to be empirically determined. We summarize these arguments by the following expression:

(2) $$\text{Stock Index Value} = f(\underset{-}{\text{interest rates}}, \underset{-}{\text{inflation}}, \underset{+}{\text{output growth}}, \underset{?}{\text{money stock growth}})$$

III. Methodology

A. Procedure

We apply the VECM method developed by Johansen (1991). The VECM is defined as:

(3) $$\Delta Y_t = m + \sum_{j=1}^{k-1} \Gamma_j \Delta Y_{t-j} + \Pi Y_{t-1} + \Phi D_t + e_t$$

where Δ is a first difference notation, μ includes non-seasonal deterministic components, Y_t is a *px*1 vector (p=5 for this study), Γ_j and Π are *pxp* coeffiicients matrices representing short-term and long-term impacts, respectively. The matrix Π is decomposed into two matrices, $\Pi=\alpha\beta'$. Here, α and β are *pxr* matrices ($r<p$) and denote respectively the loading (or weight) and the cointegrating space (or vectors) with order r. D_t is a seasonally centered dummy vector and ε_t is a residual vector.

The VECM procedure involves the following steps.[5] First, an appropriate lag (k) is selected such that the residuals from each equation are not autocorrelated. Second, the eigenvectors are estimated based on the full information maximum likelihood method proposed by Johansen (1991). Third, the order of cointegration (r) is determined by using the following test statistics:

$$TR = -T \sum_{i=r+1}^{p} \ln(1 - \hat{\lambda}_i) \tag{4}$$

$$\lambda_{\max} = -T\ln(1 - \hat{\lambda}_{r+1}) \tag{5}$$

The test statistics (4) and (5) are respectively called the trace test (TR) and maximum eigenvalue test (λ_{max}), where $\hat{\lambda}'s$ are the estimated eigenvalues. The critical values are obtained from Osterwald-Lenum (1992). The fourth step tests if meaningful restrictions can be placed on the r unrestricted cointegration vectors (as shown by Johansen and Juselius (1994)). The final step calls for summarizing long-run and short-run responses of nominal stock prices to shocks in the other variables using impulse response functions and variance decompositions (as in Lutkepohl and Reimers (1992)).

B. Data and Description of Variables

Variables we use to represent India's stock market and its output, inflation, money stock

[5] For details of the methodology described here, see Johansen (1995).

and interest rate are respectively the BSE, the Industrial Production Index, the Consumer Price Index, a narrowly-defined money supply (comparable to M1), and the money market rate in the Bombay interbank market. All data sets were extracted from the International Financial Statistics (IFS).[6] Similar sets of variables have been used by Chen, et. al. (1986), Darrat and Mukherjee (1987), Hamao (1988), Brown and Otsuki (1988), Darrat (1990), Lee (1992), and Mukherjee and Naka (1995).

All variables except interest rates are transformed into natural logs. Logged values of the nominal stock index, output, inflation, and money are denoted as BSE, y, P, M, while interest rates are denoted as R.[7] We expect that there will be one or more long-run cointegrating relationships between the levels of the variables, consistent with macroeconomic fundamentals. Further, there should be short run relationships between the changes (growth rates) of these variables that are consistent with the valuation model. The first differences of the first four series are denoted with the prefix Δ.

A careful examination of the raw data over the study period spanning the first quarter of 1960 through the fourth quarter of 1995 suggests that all variables except R are non-stationary in levels.[8] The stationarity of R can be explained by the fact that the Indian government tightly controlled lending markets over most of the sample period covered in our study as evidenced by intermittent periods of virtually constant nominal interest rates in the 1960's and 1970's. Such a condition is inconsistent with two features of integrated series. First, an integrated variable equals the sum of its past innovations. However, pegging an interest rate temporarily requires suppressing innovations from the market, and amounts to breaking this condition. Second, if the

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[6] IFS codes 62, 66c, 64, 34, and 60b, with 1985 as a base year.
[7] Note that real and nominal variables are respectively in lower and upper case.

interest rate is integrated, it should have an infinite population variance. Pegging violates this condition by maintaining a constant value with a zero (or extremely low) variance.

Assuming that interest rates are pegged, the return on debt investments was probably set to cover inflation over the long run (thus ensuring a positive real return to debt holders). To capture this, we constructed a variable whose level tracks this long-run interest rate constraint. We call this variable B which is the value of a synthetic investment in hypothetical debt instruments (essentially a nominal bond index).[9] To derive a series for this variable, we first set its initial value to an arbitrary constant, and extrapolate the value of the synthetic bond investment by compounding R through time. For comparative purposes, we choose the initial value of the synthetic bond, B_1 to equal P_1, the first observation of the logged price level in the data set. We then obtain the next value of the synthetic bond investment B_2 as the value of the logged investment the previous period plus the interest rate, and so on. This variable B is thus non-stationary in levels but tracks movements in the underlying stationary variable, R, which can be recovered by differencing.[10]

IV. Empirical Results

A. Summary Statistics

[Insert Table 1]

Table 1 presents the summary statistics on the levels of the variables in Panel A and their first differences in Panel B. The average quarterly nominal return on stocks (ΔBSE) is 2.1%

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[8] We rely on unit root tests (discussed in the next section) to check stationarity properties of the variables.
[9] Note that this is not a synthetic bond price.
[10] It should roughly track P and BSE, underperforming the latter due to its lower risk, and outdistancing the former to satisfy investors' desire for positive real returns.

(8.4% annually). Also, India has experienced relatively stable output growth (about 6% annually) and inflation (about 7.5% annually). Though this inflation rate is high compared to developed countries, it is relatively low in comparison with many developing countries. ΔBSE has both a higher mean and standard deviation than ΔB, indicating that equity holders are compensated for their extra risk. As expected, the maximum value of B exceeds that of P, indicating that debt holders do earn real returns. However, the standard deviations of the differences of these variables indicate that interest rates are more variable than inflation, apparently because they sometimes change drastically (note that minimum and maximum values of ΔB). This probably reflects occasional large adjustments to the interest rate peg.

B. Tests of Cointegration

[Insert Table 2]

The Dickey and Fuller (1981) test reveals that all variables are integrated of order one (i.e., they are nonstationary in levels but stationary in first differences).[11] The results are consistent with the existing literature for other countries including the U.S.A. Table 2 provides the test statistics for cointegrating vectors and critical values at the 5% significance level. We select eight lags and include a trend term (TREND) in the cointegrating vector in our analysis for reasons discussed in the next section. The TR tests suggest that there are three cointegrating vectors while the λ_{max} tests indicate four possible cointegrating relationships. Cheung and Lai (1992) find that TR test is more robust than the λ_{max} test with respect to skewness and leptokurtosis in the residuals.[12] As such, the analysis presented below is based on r=3.

[11] The results (not shown here) are robust to various lags and are available upon request. The tested equations contain a constant and linear trend.

[12] The residuals of the B and M equations are not normal. This is a combined effect of skewness and

[Insert Table 3]

Panel A in Table 3 presents the coefficients of the unrestricted cointegrating space (β matrix). The eigenvectors are ordered from the largest to the smallest in terms of eigenvalues as suggested by Johansen and Juselius (1990). Panel B reports the eigenvectors normalized around P when we constrain the system to have three cointegrating vectors.

C. Analysis of Restrictions on the Cointegrating Space

The three cointegrating vectors do not directly identify the long-run relationships. To decipher such relationships, we impose a set of restrictions, drawn from macroeconomics, on the cointegrating space.[13] First, we restrict money to be neutral in the long-run, i.e., a one to one relation between M and P. The second restriction, expressed as $B = P + d_1 y$ relates the nominal bond value to the price level and economic activity (d_1 is interpreted as the long run elasticity). When the latter does not grow, a debt investment offers no real return.[14] At this point we do not restrict d_1.

Our third restriction, which links BSE to these macroeconomic variables, is more complex since it must identify the system given the previous two restrictions. Initially we examined whether $BSE = P + y$ (i.e., the nominal stock index tracks nominal income). While this restriction is identifying, in conjunction with the other two it is easily rejected.[15] At this juncture we added a trend to the cointegrating space and found that the restriction $BSE = P + y + d_2 TREND$, in conjunction with the other two restrictions, could be rejected (even at the 20% level). We

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leptokurtosis.

[13] We are grateful to Henrik Hansen for clarifying how the CATS software estimates systems like the one proposed here.

[14] Our results are robust to restrictions which permit plausibly sized positive returns.

[15] We also examine several other plausible restrictions (including adding variables to the system). These

conjecture that the trend is a proxy for some unavailable stochastically trending variable.

[Insert Table 4]

Panel A of Table 4 presents the restricted estimates of β. The first restriction on the eigenvector, β_1, implies that $P = M$, the second restriction, on β_2, implies that $B = P - 1.642y$, and the third restriction on β_3, implies that $BSE = P + y - 0.055TREND$. According to the second restriction, when there is no economic growth, the value of bond investments moves in direct proportion to prices. Further, the value of bond investments is negatively related to economic activity. This is consistent with an inverse response of output growth to interest rates, and an interest rate peg that covers inflation. This is also consistent with an economy where most capital is loaned, and is tantamount to a primitive IS function. Johansen and Juselius (1994) found a similar result for the U.S.A.

The third cointegrating vector shows that nominal stock prices grow at a rate equal to the sum of the growth rates of prices and output (i.e., nominal GDP), minus a downward trend. We surmise that the downward trend represents the drag on the Indian stock market due to possible limitations on foreign investment. In equilibrium, nominal stock prices should track nominal income, plus an equity premium. In international markets, money should move from the more closed economies to the more open ones. So countries like India should have underperformed in the sample period, while countries like the U.S. should have attracted this capital and outperformed expectations.[16]

Panel B reports the α matrix, giving the loadings (weights) and t-ratios on the three

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restrictions do not help us in interpreting the cointegrating relationships.

[16] The 8.4% annual return in our sample is nearly matched by the S&P 500, even though the latter is generally perceived to be far less risky.

cointegrating vectors.[17] Money growth is affected by the quantity theory restriction and the nominal income-stock relation. These are consistent with sensible money demand arguments. In the first vector, if prices increase (increasing money demand), the error correction term becomes more negative, and the coefficient in α suggests that this leads to increased money growth. In the second vector, if nominal bond gains exceed nominal income, individuals become wealthier, and this wealth effect will increase money demand. Since interest rates were apparently pegged in India (so that money supply is horizontal), these effects are to be expected. Industrial production is negatively related to the third vector. We conjecture that if interest rates increase, the bond value will exceed the price level, making the error correction term positive, leading to declines in industrial production, and a typical inverse relation between rates and output.

D. Analysis of Restrictions on the Loading Matrix

It is plausible to restrict the coefficients on the error correction terms in the P and B equations to be zero (since they are not highly significant as in Panel B from Table 4). However, we only restrict those on B in a matrix α to be zero since the decisions on interest rates (and implicitly the bond variable) will be independent of long run factors, as government decision-makers often ignore such factors. The restrictions on β are the same as before and we continue to permit the cointegrating vectors to affect P. Arithmetically, this restriction splits the system into a four-equation conditional system in BSE, y, P, and M, and one marginal equation for B (see Johansen, 1995, p.122).

[Insert Table 5]

The estimates with restrictions on both β and α are reported in Table 5. The restrictions, which provides a joint test of the hypotheses that the three cointegrating vectors β are constrained

[17] Note that some of the cointegrating relationships do not affect prices or bonds at low significance levels.

and none of the coefficients of B enters in α, might be rejected at the 5% level. However, because the excess kurtosis in our data makes large test statistics more likely, we claim that a p-value derived under the assumption of normality of 4.3% is outside our rejection region.[18] Comparing the results between Table 4 and Table 5, the estimates of β and α are similar though the t-values slightly increase in Table 5 (Panel B). The only substantive change to the loadings matrix is that the first cointegrating vector now enters the ΔP and Δy equations with marginal significance. These indicate that increases in M above P leads to inflation and increased industrial production.[19]

The matrix Π in Panel C relates the growth rates of the variables to the levels of the variables. The VECM allows us to make inferences on the long-run impacts of the variables in levels to those in differences. The variables' responses to themselves (diagonal elements) are significant and negative, indicating positive autocorrelation. The macroeconomic effects shown in Π are rational. Inflation is positively related to money supply moves. Money growth is positively related to consumer price and stock price movements, which is reasonable since both increase money demand and interest rates were pegged. Industrial production is negatively related to interest rate moves.[20] It is also marginally positively related to money moves. If M is endogenous, beneficial economic shocks would increase money demand (and thus M) as well as industrial production, producing a non-causal positive correlation between money and industrial production.

Nominal stock returns reveal a negative trend. The results also indicate that stock returns and money growth rates trend in equal and opposite directions. This suggests long-term shifts

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[18] According to the LR test, the test statistic is 18.79 distributed as a chi-square with 10 degrees of freedom and the p-value is 0.043.

[19] The latter is suggestive of money illusion.

[20] This is to be expected since both increase money demand and interest rates were pegged.

from holding nominal wealth in stocks to holding it in money and increased reliance on untraceable cash transactions. Panel C also indicates that stock returns are not significantly affected by the macroeconomic variables. This is to be expected, since the non-stationary levels of these macroeconomic variables should not impact the stationary BSE stock returns. However, this does not rule out the possibility that (stationary) macroeconomic shocks will affect the BSE stock returns. We analyze the effects of these shocks in the next section.

E. Impulse Response Functions and a Variance Decomposition

The restricted VECM model estimated above can be rearranged into a VAR in levels. Let a VAR corresponding with our VECM be: $Y_t = m + \sum_{j=1}^{k} \Gamma_j \Delta Y_{t-j} + \Phi D_t + e_t$. According to the Engle-Granger representation theorem, the weight and cointegrating matrices are restricted as:

$$ab' = -(I_n - \Pi_1 - \Pi_2 - ... - \Pi_j) \text{ and } \Gamma_s = -(\Gamma_{s+1} - \Gamma_{s+2} - ... - \Gamma_j),\ s = 1,2,...j-1.$$

From this, we construct the impulse response functions and a variance decomposition for BSE (see Lutkepohl and Reimers, 1992). Both of these are dependent on the ordering of the variables. This should place the "most exogenous" variables last. Since BSE is our primary variable, we place it first. Due to government control of interest rates, we place B last. The other three variables are ordered y, M, and P. [21]

Figure 1 shows the impulse responses of the BSE. Shocks to the variables are assumed to be one standard deviation above zero (i.e., a large, but not uncommon positive shock). The largest effect is from consumer prices, where a positive shock forces the market down by 15%

[21] We choose this order because the Indian government, due to its large presence in the economy, is likely to have more indirect control over consumer prices and money than output.

over six years. This is consistent with our hypothesis. Similar results have been reported by Fama and Schwert (1977), Fama (1981), Geske and Roll (1983), Chen *et al* (1986) and Lee (1992) for the U.S.A., Darrat and Mukherjee (1987) for India, Hamao (1988), and Mukherjee and Naka (1995) for Japan, and Darrat (1990) for Canada.

The next largest effect is from industrial production, where a positive shock leads to about a 10% increase in stock prices over six years. The same relationship is found by Fama (1981, 1990), Chen *et al* (1986), Geske and Roll (1983) and Lee (1992) in the U.S.A., by Mukherjee and Naka (1995) in Japan, and by Darrat (1990) in Canada, among others. Smaller effects are found from the other three variables. Shocks to stock prices lead to virtually no change in stock prices. Shocks to money lead to a small increase in stock prices. Shocks to the bond investment (which could be viewed as increases in nominal interest rates) lead to a small short-run increase in stock prices, which dissipates over time. This is somewhat at odds with the valuation model. However, recall that the nominal rate includes an expected inflation component which is negatively correlated with stock prices. So, it may be that our result for bond investments is tracking increases in the real return to debt. If this is correlated with the real return to equity, then the sign of this last impulse response is sensible.

The coefficient we estimated for the downward trend (reported in Table 5, but not plotted here) indicates that the BSE underperforms by about 0.4% per quarter. Over a six year horizon, this corresponds to about a 10% shortfall. This is large enough to cancel one industrial production shock of the size used in Figure 1. Thus the trend will not be a dominant feature of the BSE's performance since shocks to all variables occur every quarter. However, it does suggest that there is an important missing element in explaining BSE performance. We conjecture that this downward trend represents the drag on the economy from the socialist policies followed during most of our sample. We test this by allowing for a trend break after the last quarter of 1990. The break is not significant - presumably due to the small number of degrees of freedom but it is in the right direction, indicating a 25% moderation in the size of the downward trend after the introduction of reforms.

Figure 2 reports a decomposition of the forecast error variance of stock prices. The ordering is the same here. Not surprisingly, at short horizons almost all of the variance is attributable to stock prices themselves. However, at the six year horizon about 40% of the variance of stock prices can be split between industrial production and prices, and about 10% more attributed to bond investments.

These two figures indicate that the long-run performance of the Bombay market is primarily driven by shocks to output growth and price inflation. Further, there are smaller, yet substantial effects from shocks to interest rates. Since shocks are by definition unpredictable this result does not suggest that this market is inefficient. However, there is also a significant downward trend that we were unable to capture with observed variables. At first glance, this suggests that the BSE is not efficient. We suspect that this is not the case and that the downward trend is an efficient response to socialist economic policies. However, only future research can confirm our conjecture.

V. Summary and Conclusions

This paper analyzes long-term equilibrium relationships between a group of macroeconomic variables and the Bombay Stock Exchange Index. The macroeconomic variables are represented by the industrial production index, the consumer price index, M1, and the value of an investment earning the money market rate. We employ a vector error correction model to explore such relationships in order to avoid potential misspecification biases that might result from the use of a more conventional vector autoregression modeling technique.

We find that these five variables are cointegrated and three long-term equilibrium relationships exist among these variables. One is long-run monetary neutrality, one relates interest rates to output (i.e., an IS function), and the third relates nominal stock prices to nominal GDP and a downward trend. The signs on these relations are consistent with macroeconomic theory, indicating .

Analysis of our results indicates that industrial production is the largest positive determinant of Indian stock prices, while inflation is the largest negative determinant. In addition, we found a modest downward trend in Indian stock prices that could not be explained by variables which are publicly available. We conjecture that this represents the drag placed on the Indian economy by the closed-economy socialist policies followed during the major part of our sample period. Although sufficient time has not passed since 1991 to make conclusive remarks regarding the impact of the reforms on the BSE, preliminary results reveal that the magnitude of the negative trend has decreased by about 25% in the post-reform years.

Table 1

Summary Statistics

Panel A. Level Specifications

Name	Observations	Mean	Standard Error	Minimum	Maximum
P	144	3.6459	0.8154	2.3795	5.1246
B	144	3.5384	0.8506	2.3795	5.2418
M	144	5.1475	1.2541	3.2780	7.5409
y	144	3.8423	0.5587	2.8273	4.9301
BSE	144	3.3077	1.0228	2.3321	5.8605

Panel B. First Differences

Name	Observations	Mean	Standard Error	Minimum	Maximum
ΔP	143	0.0192	0.0232	-0.0694	0.0947
ΔB	143	0.0146	0.0625	-0.1980	0.1666
ΔM	143	0.0296	0.0701	-0.3956	0.4894
Δy	143	0.0200	0.0098	0.0050	0.0597
ΔBSE	143	0.0211	0.0825	-0.1791	0.2914

Note: P, B, M, y, and BSE denote the price level, nominal bond index, nominal money stock, output, and the nominal Bombay stock exchange index. Four of the variables (BSE, P, y, M) are transformed into natural logs. Their first differences are then growth rates.

Table 2

Cointegration Tests

Trace (TR) and λ_{max} Test Statistics

Eigenvalue	λ_{max} Statistic	Trace Statistic	H_0 : r =	P-r	λ_{max} 5% Critical Value	Trace 5% Critical Value
0.202	30.69	96.07	0	5	24.35	86.96
0.153	22.53	65.38	1	4	20.21	62.61
0.144	21.13	42.85	2	3	16.73	42.20
0.112	16.19	21.72	3	2	13.08	25.47
0.039	5.53	5.53	4	1	12.39	12.39

Note: The critical values are taken from Osterwald-Lenum (1992).

Table 3

Coefficients of the Cointegrating Space

Panel A: Transposed β

	P	B	M	y	BSE	TREND
β_1	18.412	-0.077	31.846	-8.765	-5.597	-0.328
β_2	17.991	2.503	1.605	-5.034	-0.056	-0.243
β_3	-5.858	9.394	-0.857	3.313	0.038	0.145
β_4	20.566	6.513	-9.676	23.765	-4.218	-0.475
β_5	-3.076	24.031	-6.980	0.240	-3.930	-0.118

Panel B: Reduced Rank β, Transposed and Normalized Around P

	P	B	M	y	BSE	TREND
β_1	1.000	0.059	-1.730	0.476	0.304	0.018
β_2	1.000	0.139	0.089	-0.836	-0.059	-0.014
β_3	1.000	-1.604	1.853	-0.566	-0.006	-0.025

Note: Panel A reports the coefficients on the variables of the eigenvectors for the unrestricted cointegrating space. Panel B reports the coefficients after the cointegrating space is restricted to three vectors.

Table 4

Restrictions on β

Panel A: Transposed β

	P	B	M	y	BSE	TREND
β_1	-1.000	0.000	1.000	0.000	0.000	0.000
β_2	-1.000	1.000	0.000	1.642	0.000	0.000
β_3	-1.000	0.000	0.000	1.000	1.000	0.055

Panel B: Values of α Conditional on these Restrictions

	α_1	α_2	α_3	t-values	For the	α's
ΔP	0.069	-0.008	-0.012	1.979	-1.344	-0.836
ΔB	0.024	-0.003	-0.002	1.961	-1.603	-0.473
ΔM	-0.441	0.077	0.079	-2.982	3.223	1.279
Δy	0.120	0.018	-0.084	1.947	1.816	-3.262
ΔBSE	0.168	-0.076	0.101	0.908	-2.566	1.318

Note: Panel A presents the restricted estimates of the coefficients of the cointegrating space, in implicit form. Panel B reports the coefficients of the loading matrix of the cointegrating vectors, as well as their t-ratios.

Table 5

Joint Restrictions on β and α

Panel A: Transposed β

	P	B	M	y	BSE	TREND
β_1	-1.000	0.000	1.000	0.000	0.000	0.000
β_2	-1.000	1.000	0.000	1.749	0.000	0.000
β_3	-1.000	0.000	0.000	1.000	1.000	0.058

Panel B: Restricted α

	α_1	α_2	α_3	t-values	for	α's
ΔP	0.074	-0.008	-0.012	2.131	-1.437	-0.865
ΔB	0.000	0.000	0.000	0.000	0.000	0.000
ΔM	-0.444	0.076	0.069	-3.017	3.239	1.186
Δy	0.133	0.016	-0.081	2.172	1.652	-3.338
ΔBSE	0.139	-0.071	0.103	0.756	-2.427	1.414

Panel C: Long-term Impact Matrix Π

	P	B	M	y	BSE	TREND
ΔP	-0.054	0.012	0.074	-0.013	-0.008	-0.000
	(-2.33)	(-0.87)	(2.13)	(-0.49)	(-1.44)	(-1.44)
ΔB	0.000	0.000	0.000	0.000	0.000	0.000
ΔM	0.299	0.069	-0.444	0.045	0.076	0.004
	(3.04)	(1.17)	(-3.02)	(0.40)	(3.240)	(3.240)
Δy	-0.068	-0.081	0.133	-0.158	0.016	0.001
	(-1.68)	(-3.39)	(2.198)	(-3.43)	(1.67)	(1.67)
ΔBSE	-0.170	0.103	0.139	0.250	-0.071	-0.004
	(-1.39)	(1.42)	(0.76)	(1.80)	(-2.43)	(-2.43)

Note: Values in parentheses denote t-values. The long-term impact matrix reflects all restrictions.

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Figure1: Impulse Responses of the Bombay Stock Index

In Nominal Terms

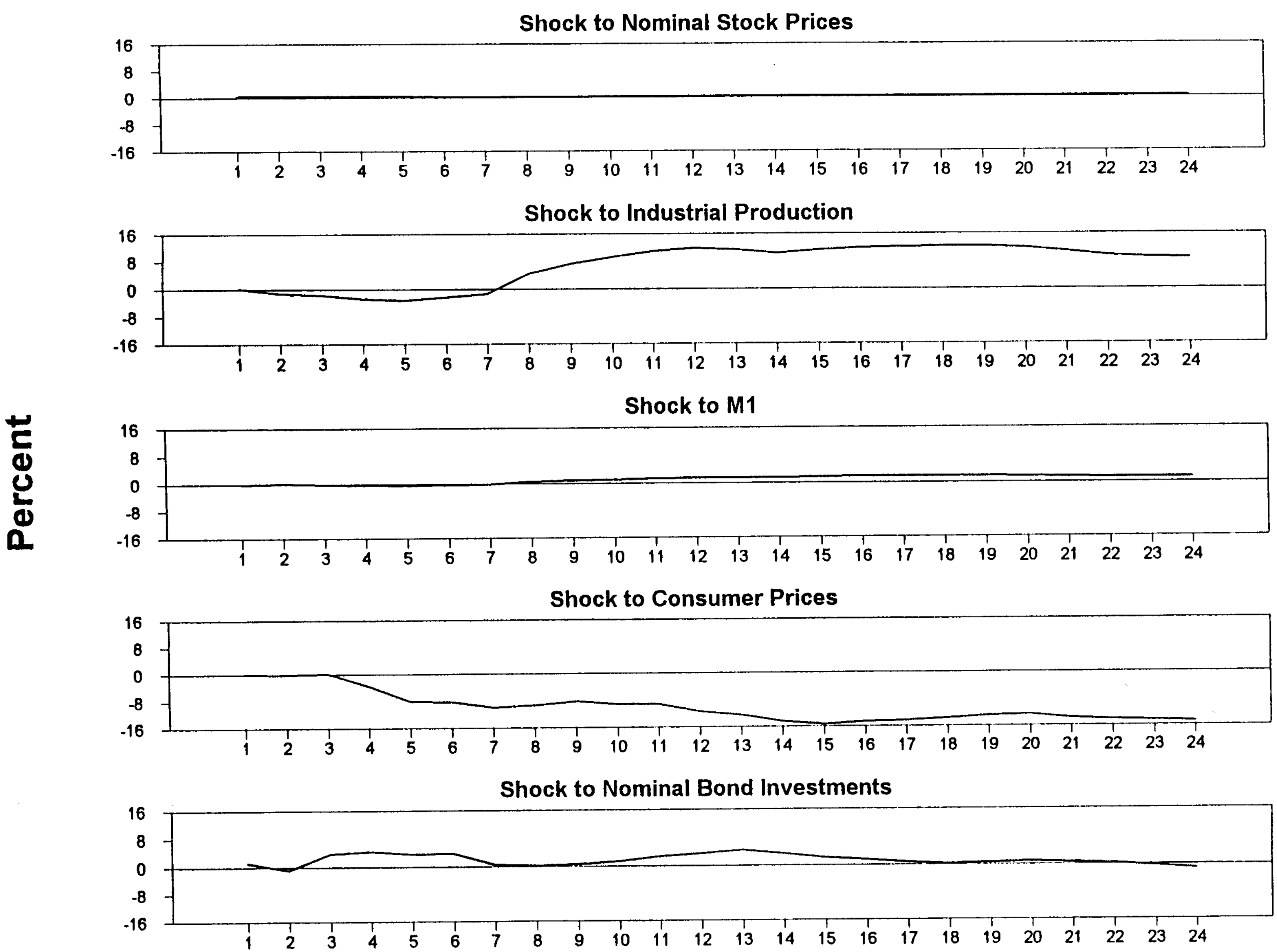

Figure 2: Variance Decomposition of the Bombay Stock Index