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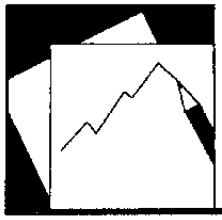

IMF Working Paper

Yield Spread as a Leading Indicator of Real Economic Activity: An Empirical Exercise on the Indian Economy

K. Kanagasabapathy and Rajan Goyal

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Yield Spread as a Leading Indicator of Real Economic Activity: An Empirical Exercise on the Indian Economy

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Abstract

There is growing evidence that the yield spread could serve as a leading indicator of real economic activity. This paper is an attempt to test this hypothesis for the Indian economy by relating movements in the yield spread in the government securities market to movements in the index of industrial production. The results show that yield spread could, inter alia, be considered as a leading indicator of industrial activity in India.

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Keywords: Yield curve; yield spread; leading indicators

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INTRODUCTION

There is growing empirical evidence across a range of economies suggesting that yield spread could serve as a leading indicator of real economic activity. Studies carried out in case of developed economies, e.g., G-7 countries, Belgium and Netherlands show that the yield spread or the slope of yield curve has the ability to predict economic upswings or recessions upto 2-4 years in advance. While there has been evidence of association between yield spreads and real economic activity in each case, predictability varies across the countries. It has been suggested that country-wise variations in the predictive power is on account of the differences in regulatory regimes among the economies. Although the phenomenon has been widely examined in developed market economies, similar studies are virtually absent in the case of developing economies. In part, this is because in developing economics with administered interest rates, the yield curve has been either completely absent or not market determined and thus did not form a suitable test case. Until the 1990s, the Indian financial system was characterised by a highly regulated regime, which has since been gradually liberalised. By the mid-1990s, there has been considerable improvement in terms of volumes, variety of instruments, number of participants and dissemination of information, and a yield curve particularly in case of government securities started emerging since 1996. The present paper is an attempt to test the relationship between the yield spreads and real economic activity in the Indian context. The paper is organized as follows: Section I of the paper explains the economic rationale behind observed association between the yield spread and real economic activity, Section II presents a survey of the literature on the phenomenon under study, Section III briefly explains the developments in Indian financial markets and the emergence of the yield curve, Section IV sets out the empirical results of our exercise conducted on the Indian Government Securities Market. Section V investiages how far the evidence that the transmission path suggested in case of developed economies holds in the Indian context and final section concludes the study.

I. YIELD SPREAD AS PREDICTOR OF REAL ECONOMIC ACITIVTY—THEORETICAL RATIONALE

The literature offers alternative hypotheses to explain the observed relationship between the yield spread and real economic activity. One of the propositions is that relationship stems from the effects of monetary policy. The slope of the yield curve reflects the policy stance and actions taken by the monetary authority in the current period. A temporary monetary contraction by the central bank in current period increases the nominal short-term interest rates and owing to price rigidities, real short-term interest rates while leaving long-term interest rates intact. This results in a lowering of a yield spread and a flattening of the yield curve. At the same time, high real interest rates also means low level of investment in the current period and hence lower output in the near future. Hence the association between lowering of yield spread and the fall in future output growth.

An alternative explanation to the observed association between yield spread and economic activity has been given in terms of expected future Monetary Policy. An expectation of easy monetary policy and future expansion of money supply leads to decrease in the future real short-term rate of interest and an expansion of real output. At the same time, there may be a rise in current nominal long term rate of interest if the inflation premium is more than the expected decline in real interest rates and hence a rise in the yield spread in the current period. This argument is consistent with the evidence put forward by Fama (1990) which

states that an increase in today's spread is associated with future increase in inflation premium and the future decrease in the real interest rate.

Another variant of above hypothesis runs in terms of expectations of financial market participants regarding future growth. If there are expectations of a recession/upswing in the near future, it is likely to result in fall/rise in long term nominal interest rates since during period of low/high real growth, inflation rates tend to fall/rise. Thus one might observe an empirical regularity that a negative/positive yield spread is likely to be associated with the future recession/upswing.

Mishkin (1991) explains the association of yield spread and real economic activity in terms of productivity of capital and the business cycle. He interprets the real yield spread as the difference between longer run and short-run marginal productivity of capital. The argument is set out as follows: at the peak of the business cycle, capacity utilization is almost 100 percent and short-run capital productivity is higher as compared to longer-run capital productivity, since in the longer-run activity is expected to slow down. On the other hand, at the trough, productivity in the short run is low and there is expectation of an upswing in the longer run. Thus there is a positive relationship between yield spread and the real economic activity.

A recent study (Peel and Taylor, 1998), has examined the transmission channels of the influence of yield spread on the real economic activity. By using a variant of the innovation decomposition method, it found the evidence that movements in the nominal interest rate yield curve affect real economic activity through the demand side of the economy. To test this, the output series was decomposed into permanent or supply innovations and temporary or demand innovations. In case of output series purged of temporary innovations, slope coefficient was statistically insignificant, while in case of output series purged of permanent innovations, slope coefficient was statistically significant.

II. Survey of Literature

Fama, as early as in 1986 and later Stambaugh in 1988, mentioned that term structure appears to predict real economic activity though these were not supported by any detailed statistical analysis. They presented graphs showing that rise and fall in forward rates precedes economic upswing and recession respectively. Since then a number of studies have been conducted to test the existence of relationship between yield spread and the real economic activity. Study conducted by Estrella and Hardouvelis (1991) on U.S. economy has been the first detailed work in this area. To ascertain relationship they regressed yield spread on growth rates of real GNP and also fitted the probit model to test whether yield curve can predict presence or absence of a future recession. For these exercises, quarterly data on real GNP and yield spread computed from average annualized yields of 10-year government bonds and 3-month treasury bills for the period from 1955 to the end of 1988 was used. They found the evidence that positive slope of the yield curve is associated with the future increase in real economic activity, and that it has additional predictive power over other leading indicators. They also found the evidence that the slope of the yield curve can predict cumulative changes in real output for up to 4 years into future and successive marginal changes in real output up to a year and half into future. However, forecasting accuracy in predicting future recession was found to be highest 5-7 quarters ahead.

These results were confirmed by other studies as well. Harvey (1991) found that in case of Germany, slope of yield curve has significant ability to predict future GNP growth. Hu (1993) and Davis and Henry (1994) confirmed presence of similar associations in case of G-7 and the United Kingdom respectively. Hu derived a closed-form formula of the term structure to formalize the link between yield curve and the real activity. The evidence was found that the slope of the yield curve is positively related to the expected growth in real output. Further, yield spread between long-term and short-term government bonds serves as a good predictor of the future economic growth and it has more forecasting power than the changes in stock prices. Similarly, it also compares favourably with the univariate time series forecasting model.

Berk and Bikker (1995) while constructing composite leading indicators for 16 industrialised economies, found that in case of 10 countries inclusion of yield spread gave statistically significant results. Further, in all the cases yield curve retained its leading indicator properties when short-term rate was also included. This corroborated the earlier findings of Estrella Hardouvelis (1991) that yield spread in the United States retains its predictive power for real economic activity after including the short-term interest rate. The implication of these findings is that the yield spread contains information about variables other than the current monetary policy.

Estrella and Mishkin (1998) examined the ability of yield spread to predict recession in case of France, Germany, Italy, United Kingdom and United States. They found that the ability to predict recession has been highest in case of United States and Germany followed by United Kingdom and Italy.

Bernard and Gerlach (1998) examined the relationship in case of France, Germany, Italy, United Kingdom, United States, Belgium, Canada, Japan and the Netherlands. Following Estrella and Hardouvelis (1991), they also ran probit regressions to ascertain the relationship. It was observed that the slope of the yield curve had information about the likelihood of a future recession in all the eight countries. However, they found notable differences across the countries and the information content of the yield curve was found to be highest in case of Germany, Canada and United States and lowest in case of Japan. The paper suggests that differences may stem from cross-country variations in the regulation of financial markets, which may have prevented interest rates from accurately reflecting financial market participants' expectations about the future course of macro-economic conditions. Notably, till early eighties (included in the sample period), Japanese economy was characterized by tight regulation of financial markets. To carry the investigation further they also tested the impact of foreign term spread in predicting the domestic recession. The inclusion of foreign term spread as additional regressor improved the results substantially, in particular, addition of German spread in case of Japan and U.S. spread in case of the United Kingdom.

Bonser-Neal and Morley (1997), tested the association between yield spread and real economic activity in case of 11 industrialised countries using data for the period 1971 to 1996. Study made out-of-sample forecasts for real GDP growth based on the yield spread and found them better than those based on past value of real GDP. Yield spread explained nearly 30-50 percent of the variation in future real economic activity in case of Canada, Germany and the United States. Association was found to be weakest in case of Japan and Switzerland where yield spread on average explained less than 10 percent of variation in future real economic activity.

To sum up, the evidence available through empirical studies are:

- Yield spread acts as a lead indicator of real economic activity. The positive slope of the yield curve is indicative of future economic upswing. Similarly, flatness or a negative slope of the yield curve indicates likelihood of future economic recession.

- Yield spread has additional predictive power over other leading indicators and contains information about variables other than the current monetary policy.

However aforesaid relationship exits between yield spread and real economic activity subject to the following conditions:

- Market determined yield curve is present, and it truly reflects the expectations about inflation/future movements in short-term rates or to state alternatively, regulation of financial markets should be limited.

- The financial markets are integrated and fairly liquid, and information efficient.

III. Developments in Indian Financial Markets and Emergence of Yield Curve

It is concluded in Section II above that existence of a relationship between yield spread and the economic activity requires presence of a yield curve and that yields truly reflect market expectations. Therefore, absence of any study in this area particularly in Indian case is quite obvious given the fact that Indian financial markets were highly regulated till early 1990's and a domestic rupee yield curve did not exist till recent period. Therefore, any attempt to test relationship between yield spread and economic activity in the Indian context must first ascertain presence of a rupee yield curve and the degree to which yields truly reflect market expectations.

A. Deregulation of Indian Financial Markets and Evolution of Yield Curve

An open, unified, sufficiently deep and liquid market is an essential prerequisite for the presence of a yield curve. The Indian financial system till early 1990s was characterised by administered structure of interest rates and restriction on various market players viz. financial institutions, mutual funds, corporates. Entire spectrum of interest rates both on assets and liability sides was so determined by the authorities that comfortable spread was always ensured. Since lending and borrowing operations did not involve any interest rate risk, there was no incentive (or the need) for the market players to actively manage their assets and liabilities. There were also restrictions on portfolio allocations in the form of specified targets. Apart from these, lack of depth and liquidity in the securities market, non-availability of instruments with varying maturities and infrastructural deficiencies in terms of trading and payment and settlement systems were also the major impediments in the emergence of rupee yield curve. In the case of government securities, the yield curve was predetermined and not market related. As a result, there was no trading interest in the securities.

Since late 1980s and early 1990s the Reserve Bank has taken several measures to develop, integrate and enhance efficiency in money and Government securities markets. Following the recommendations of Chakravarty Committee in 1985 and later Vaghul Committee in 1987, a multi-pronged strategy was adopted for deregulating the regime of administered structure of

interest rates, removal of barrier to entry, introduction of new instruments and setting up of new institutions. As a result, interest rates on all money market instruments were freed and with the introduction of auction system, since early 1990s, yields on treasury bills and Government dated securities are also market determined. Another significant step was to replace ad-hoc treasury bills with the scheme of ways and means advances within the specified limits. Apart from these, reform measures enhanced the participation in money and Government securities markets. While the money markets were gradually opened to the non-bank participants, a shift from a regime of administered interest rate to a market based pricing of securities attracted larger participation including the non-banks.

Setting up of DFHI and STCI along with introduction of Primary Dealers system in 1996 further enhanced the liquidity and depth in the markets. Primary Dealers ensured maximum participation in the primary auctions and provided two-way quotes on Government securities. Beginning of active Open Market Operations (OMO) by RBI also infused liquidity. Other efforts which made significant impact on the development process of these markets were introduction DVP system by RBI, introduction of screen based trading by NSE, computerization of SGL operations and dissemination of information by RBI on secondary market trading, all imparted considerable transparency in trading and settlement system of money and Government securities markets.

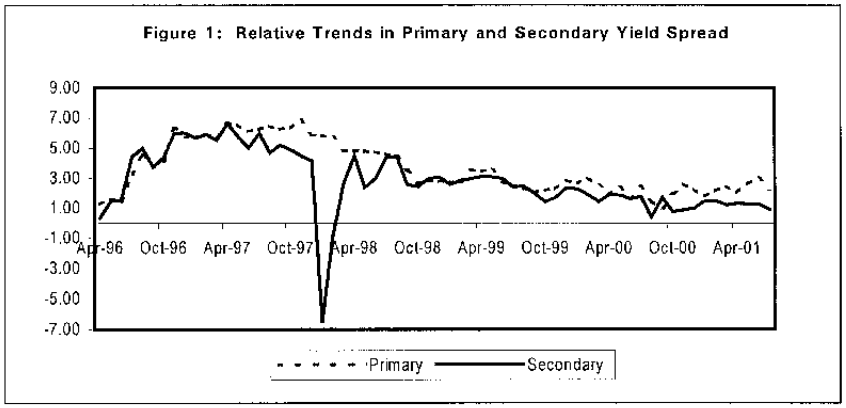
Another important measure to enable emergence of yield curve has been to exempt inter-bank liabilities from maintenance of CRR and SLR, taken in April 1997. Since, reserves are required to be maintained on a fortnightly basis and demand and time liabilities as on a particular day (the reporting Friday) form the basis for maintenance of reserves, exemption of inter-bank liabilities was expected to help development of term money market and eventually emergence of a yield curve.

These reform measures taken since late 1990s had a profound impact on the market depth and liquidity as reflected in sharp rise in market turnover. The volume of secondary market transactions in Government Securities recorded a ten-fold increase from Rs. 50,569 crore in 1994-95 to Rs. 539,255 crore in 1999-2000. Similarly daily turnover in call money market also recorded a nearly three-fold rise over the same period.

With removal of restrictions, introduction of auction system and freeing of interest rates scenario, financial markets changed completely. Now the participants are required to handle interest rate risk, market risk by managing their assets and liabilities appropriately. Consequently, an element of competitive pricing and substitutability in response to interest rate movements gradually entered into the operations of banks and institutions leading to market integration. The empirical work on Indian Financial Markets indicates that policy induced effects are readily transmitted across different markets particularly since 1996. There is a correspondence between changes in monetary policy stance and the movement in yields of money market securities, treasury bills and Government dated securities. It has been observed that there is a co-integration between call money rates, cut-off yields on 91-day and 364-day treasury bills and redemption yields on long-term Government dated securities (Joshi, 1998). Though the study obtains evidence for inter-linkages across the term structure for gilts in India, it concludes that complete integration of the term structure or the efficiency of trading across maturities is still evolving. Similarly, Bhoi and Dhal (1998) have observed that excluding call rates, yields on all the money market and gilt securities exhibit co-movement with the 91-day treasury bills. In the recent period, Joshi and

Bhattacharya (2000) have found the evidence supporting integration of financial markets. Their results showed that the Bank Rate has emerged as a more effective instrument of policy in terms of its impact on the financial markets as compared to other instruments.

While introduction of auction system has helped in market development and emergence of yield curve, cut-off yields in primary auctions are yet to be truly market determined. Reserve Bank continues to be one of the players in primary auctions and decides the cut-off prices. In an evolving market system, RBI manages both the primary debt issuance and the open market operations to reduce volatility and enable orderly conditions in the financial markets. This happens particularly during the periods when monetary tightening measures are taken to ward off volatility in forex market. For instance, during the period from September 1997 to April 1998, there has been a large divergence between the primary and secondary yield spreads. During this period, primary cut-off yields on 91-day treasury bills were far below the secondary market rates and RBI took heavy devolvements (Figure 1).



Two important points emerge from the empirical exercises conducted on Indian financial markets, which have the relevance for our present paper. First, rupee yield curve (particularly in case of gilts market) started emerging only since 1996. Secondly, only secondary market yields truly reflect the market expectations and primary market yields may at time be policy induced. In view of these observations, the sample period for the present exercise has been taken from April 1996 to July 2001. Further as only secondary market yields are truly reflective of market expectations, yield spreads for the present exercise have been worked out on the basis of secondary market yields.

IV. Results of Exercise Conducted on Indian Government Securities Market

To ascertain the relationship between term structure and economic activity in India, following Estrella and Hardouvelis (1991) and Estrella and Mishkin (1995), we attempted two types of exercises:

- Linear regression to determine the ability of slope of yield curve to predict growth in industrial output; and

- Probit model to estimate probability of slow down in industrial activity with changes in the slope of the yield curve.

To carry out these exercises, industrial activity was measured in terms of Index of Industrial Production (IIP) which is observed at a monthly interval. The annualised percentage change in the industrial output as measured by IIP, is defined as

$$G_{t,\,t-12} = [\log (IIP_t / IIP_{t-12})] * 100$$

where IIPt-12 and IIPt are seasonally adjusted index of industrial production (IIP) during the months t-12 and t respectively. Gt, t-12 is the percentage change in the index during a month over the corresponding month of the previous year.

The slope of yield curve has been measured in terms of yield spread. Spread has been computed on the basis of annualised secondary market yields on Treasury Bills and Government dated Securities. Yields have been worked on residual maturity basis. Spread is defined as:

$$Yield\ Spread = R_L - R_s$$

where RL is the monthly average of secondary market yield on Government dated securities with 10-year residual maturity. Rs is the monthly average of secondary market yield on treasury bills/Government dated securities with residual maturity of 2-3 months.[2]

For the present exercise data for the period from April 1996 to July 2001 has been used. This constitutes nearly 65 observations. The number of observations is restricted by the length of sample period and by the fact that IIP data is prepared at monthly interval only.

A. Regression Evidence

The estimated linear regression equations took the following form:

$$G_{t,\,t-12} = a + b \,.\, spread_{t-k}$$

where k denotes the forecasting horizon in months. Before estimating the equations, both the series were tested for stationarity by way of Augmented Dickey-Fuller Unit root test (ADF). The unit root test shows that both the series are stationary, i.e., I(0).[3] Table 1 presents the regression results on the ability of the yield spread/slope of the yield curve to predict variations in the index of industrial production. Results are consistent with the evidence obtained in developed economies that a steeper (flatter) yield curve indicates faster (slower) future growth in real output. It may be seen from the table that coefficient for spread with lag of 9 months, is statistically significant. Hence, yield spread is able to predict likely growth rate of industrial output 9 months ahead.

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[2] For short term rates, yields for residual maturities for up to 14 days, 15-91 days, 92-182 days, 183-364 days and one year were also studied. Predictive ability has been maximum in case of 2-3 months.

[3]

Variable	ϕ	Conclusion
Industrial Growth Rate	-3.21	I(O)
Yield Spread	-4.67	I(O)

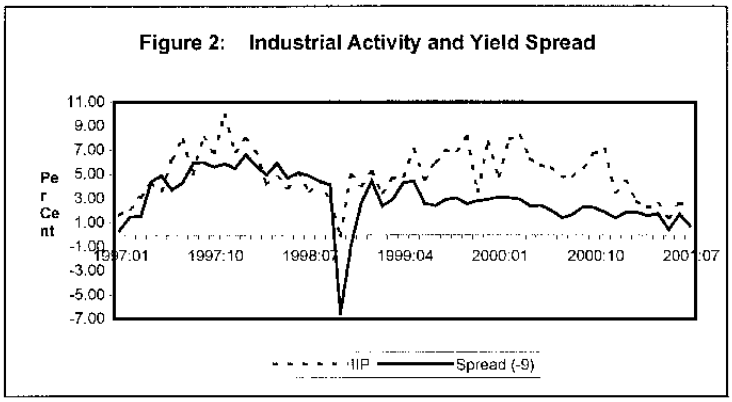
Table 1. Results of Regression Equations[1/]

No. of Lags	A	B	R^2	D.W.
3	4.99	0.01	0.16	2.40
		(0.07)		
4	4.51	0.15	0.17	2.26
		(1.04)		
5	4.81	0.07	0.18	2.23
		(0.50)		
6	4.58	0.11	0.21	2.07
		(0.75)		
7	4.71	0.11	0.28	2.39
		(0.80)		
8	4.41	0.21	0.29	2.35
		(1.53)		
9	3.76	0.45*	0.41	2.37
		(3.63)		
10	5.72	-0.17	0.25	2.46
		(1.21)		
11	4.67	0.17	0.24	2.29
		(1.22)		
12	5.28	-.02	0.22	2.40
		(0.15)		

Parentheses contain t statistics.
** Significant at 5 per cent level.*

[1/] Standard errors have been corrected for first order auto-correlation by including the autoregressive term as per the Chochrane-Orcutt procedure.

Figure 2 plots rate of growth of industrial output and yield spreads with lag of 9 months. It may be observed that changes in the slope of the yield curve tracks the movements in future output growth. Significantly, sharp decline in yield spreads below 1.0 percent during April 1996, January 1998 and August 2000 are associated with sharp decline in future industrial growth rates after 9 months in each case.



B. Probability of an Industrial Slowdown

The objective of this exercise is to estimate probability that for a given yield spread whether or not the industrial slowdown would occur. In other words, dependent variable is binary in nature which indicates presence or absence of industrial slowdown. In order to relate the binary variable to the slope of yield curve, we have estimated the following non-linear model:

$$P\,[\,X_t = 1 \mid spread_{t-k}\,] = \phi\,(a + b\,.\,spread_{t-k})$$

where P denotes probability, ϕ is a cumulative normal distribution. Industrial slowdown for this exercise has been defined as the growth rate of IIP equal to or less than 4 percent or alternatively equal to or less than 3 percent. In case of economic slowdown X equals unity. The above model is a usual probit model and its log-likelihood function is as follows:

$$log\ L = \sum_{X_t=1} \log \phi\,(a + b.\,spread_{t-k}) + \sum_{X_t=0} \log \phi\,(1 - a - b.\,spread_{t-k})$$

Results for probit model with different spread lags are stated in the Tables 2 and 3. As expected from the regression results above, the spread coefficients with lag 8 and 9 are statistically significant. To measure the goodness of fit of the equation, the ***pseudo–R^2***, as suggested by Judge and others (1982) have been computed. It is defined as 1-log L (unrestricted)/log L (restricted), where log L is the log-likelihood of the estimated equation. Like R^2 in OLS, pseudo-R^2 also corresponds to the hypothesis that all the coefficients except constant term are zero. Negative sign of the coefficient imply that increase in yield spread at month t is associated with decrease in probability that growth rate of IIP would be below or equal to 4 percent (or 3 percent) in the months t+8 and t+9.

Table 2. Results of Probit Model

(IIP equal or below 4 percent)

No. of Lags	A	B	Pseudo - R^2	χ^2
3	-0.47	0.01	0.03	2.32
		(0.09)		
4	-0.02	-0.15	0.08	6.23
		(1.68)		
5	-0.18	-0.08	0.02	5.05
		(1.06)		
6	-0.03	-0.15	0.05	9.19
		(1.66)		
7	-0.06	-0.13	0.05	9.65
		(1.65)		
8	0.64	-0.39*	0.23	22.40
		(3.01)		
9	0.36	-0.30*	0.17	20.71
		(2.61)		
10	-0.36	-0.06	0.01	14.35
		(0.70)		
11	-0.27	-0.10	0.03	17.87
		(1.25)		
12	-0.39	-0.07	0.01	19.67
		(0.87)		

Parentheses contain t statistics.

**** Significant at 5 percent level.***

Table 3. Results of Probit Model

(IIP equal or below 3 percent)

No. of Lags	A	B	Pseudo - R^2	χ^2
3	-0.86	-0.02	0.00	1.22
		(0.02)		
4	-0.63	-0.10	0.02	2.84
		(1.14)		
5	-0.60	-0.11	0.02	3.44
		(1.23)		
6	-0.58	-0.11	0.03	4.01
		(1.29)		
7	-0.26	-0.25	0.14	10.62
		(2.74)		
8	1.82	-1.38*	0.53	35.38
		(3.07)		
9	0.37	-0.53*	0.28	21.93
		(2.86)		
10	-0.56	-0.15	0.05	12.64
		(1.63)		
11	-0.72	-0.11	0.03	15.08
		(1.17)		
12	-0.78	-0.08	0.01	14.80
		(0.86)		

Parentheses contain t statistics.
** Significant at 5 percent level.*

In-sample estimates of probability of industrial slowdown and yield spread movements from April 1996 to July 2001 are plotted in Figure 3. It may be observed that all the peaks in the estimated probability were associated with a industrial slowdown. Since April 1996, there have been three instances when growth rate in IIP fell below or close to 1.5 percent. In each case, estimated probability is relatively high.

Figure 3: Probability of Industrial Slowdown and Growth Rate

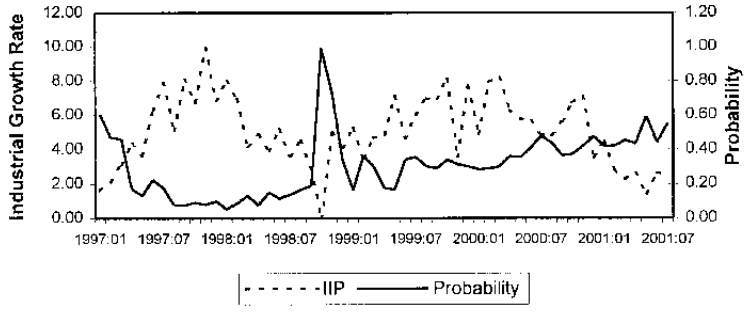


Table 4. In-Sample Estimates of Probability of Industrial Slowdown as a Function of Yield Spread

Month	Yield Spread (In percent)		Probability of Industrial Slow Down		IIP Growth Rate (In percent)
	Lag 8	Lag 9	Lag 8	Lag 9	
Jan-97	1.49	0.35	0.53	0.60	1.61
Oct-98	-0.86	-6.56	0.83	0.99	0.00
May-01	1.71	0.44	0.49	0.59	1.69

C. Out-of-Sample Estimates

After having estimated the parameters of probit model, now it is possible to predict likely growth path of industrial output by making out-of-sample forecast. Table 3 below states out-of-sample estimates of probability of slow down in industrial output on the basis of the parameters of estimated probit model and the cumulative normal distribution.

Table 5. Out-of-Sample Estimates of Probability of Industrial Slowdown as a Function of Yield Spread

Month	Yield Spread (t-9)	Probability of Industrial Slow-Down	Industrial Growth Rate (Actual)
Jul-01	0.78	0.53	2.6
Aug-01	0.90	0.51	2.9
Sep-01	1.01	0.50	2.0

Interestingly, out-of-sample estimates for the probability that industrial output growth rate would be below 4 percent level, for the month of July, August, and September 2001 were .53, .51 and .50, respectively. Actual growth rates for these months have been placed at 2.6 percent, 1.8 percent and 1.6 percent respectively.

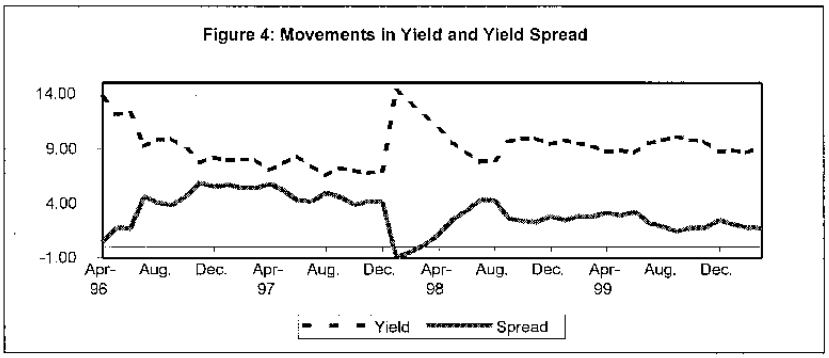
V. Yield Spread and Industrial Activity: Transmission Path

As brought out in Section I of the paper, the transmission path for the relationship between yield spread and the economic activity, as observed in the developed economies works in the following manner:

Policy changes or Expectation changes → short-term interest rates → Yield Spread
Yield Spread → Investment/Production Decisions → Industrial Activity

It would be of interest to investigate how far the evidence that the transmission path suggested in case of developed economies holds in the Indian context.

While the variations in yield spread can be caused by changes in both or either of the short or long-term yields; in the Indian context, as long-term expectations are stable, the spreads are largely dictated by the variations in short-term interest rates, and long-term rates remain relatively stable. This assertion is corroborated by Figure 4 where we have plotted the secondary market yields on government securities with residual maturities of 2-3 months and its spread from yields on residual maturity of 10 years.



For a broad understanding of the transmission path, we may test the following propositions:

- Changes in yield spread or short-term interest rates affects investment/production decisions; and

- Investment/production decisions leads to variations in industrial activity.

A. Evidence

The short-term rates affect mainly the demand for working capital or short-term business requirements of the entrepreneurs. Since investment decisions are generally long-term in nature and are influenced by the cost of long-term funds, one may argue that the investment decisions for that matter the real economic activity should not get significantly affected by the variations in short-term interest rates. However, this presumption is not correct and the role of working capital in the economic activity has been well documented in the economic literature. As pointed out by Keynes (1960), an increase in the volume of employment will usually require a more or less proportionate increase in the volume of working capital. In the similar vein, Mckinnon (1973) had indicated that lack of financing of key inputs—replacement parts, various semi-finished materials, labour services—entire factories may be shut down. Inclusion of working capital as an input in the production function is consistent with the Fisher's view (1974) that at the firm level cash balances can be viewed as a productive input. He distinguishes between physical production function, and the delivered production function, and it is the latter form which includes cash balances as input. An earlier study (Laumas and Williams, 1984) in the Indian context, observed that lower availability of the working capital not only lowers the capacity utilisation but also affects the plans for further investment reflected in the lower demand for fixed capital.

In view of above, we estimated following equations to establish relationship between short-term interest rates and industrial activity.

$$Ln(WC) = f(spread, Ln(Y), dummy2)$$

$$Ln(VL) = f(Ln(FCL), Ln(WCL))$$

where

WC	-	Working capital in nominal terms
WCL	-	Working capital (in real terms) per employee
FCL	-	Gross fixed capital (in real terms) per employee
VL	-	Gross value added (in real terms) per employee
Spread[4]	-	Difference in secondary market yields of government paper with residual maturities of 10 year and 2-3 months.
Y	-	Gross domestic product in nominal terms at market prices
Dummy	-	For the year 1998-99 (to capture change in classification by ASI from this year)
T	-	Trend to capture increase in productivity

Generally the requirement for working capital would emanate from demand for output and could get influenced by the cost of procuring short-term capital. Therefore, a priori, variations in the working capital employed should be adequately explained by the yield spread (short-term interest rate) representing the cost element and the variations in national income, a proxy for the demand for industrial output. Accordingly, the first equation for working capital requirement has been specified as the function of yield spread and the lagged national income. For ascertaining the relationship between working capital and industrial output, we have proposed to estimate standard production function equation with working capital as an additional argument.

Ideally, the above equations should be tested with monthly data series, as it would also corroborate the results obtained in Section III of the present paper, relating yield spread and IIP. However, lack of data on working capital employed by manufacturing units, restrict us to analyse the data on annual basis. For this exercise, data for gross value added, gross fixed capital, working capital and employees have been obtained from Annual Survey of Industries (Factory Sector). Dummy has been used for the break in data series due to change of classification of the data furnished by Annual Survey of Industries. Value added was deflated with WPI for manufactured products and fixed capital was deflated with WPI for 'machinery and machine tools.'

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[4] Since secondary market yields for these maturity are not available for the period prior to 1996, for the sake of increasing the number of observations, spread has been computed by using call rates and weighted average coupon rate (on dated government securities), for this exercise.

Estimated equations are as below:

Working Capital Equations: Period = 1989-90 to 1998-99

$$Ln(WC) = -3.62 + .03\ SPREAD - 1.10\ Ln\ (Y_{-1}) - 0.58\ DUMMY \quad \text{-------} \quad (1.a)$$
$$\qquad\qquad (2.3) \qquad (6.5) \qquad (4.5)$$

$R^2 = 0.96$ D.W. = 2.6

$$DWC = -5.57 - .02\ CALL - 1.26\ Ln\ (Y_{-1}) - 0.68\ DUMMY \quad \text{-------} \quad (1.b)$$
$$\qquad\qquad (2.0) \qquad (9.6) \qquad (5.3)$$

$\bar{R}^2 = 0.96$ D.W. = 2.7

Production Function Equation: Period = 1980-81 to 1997-98

$$Ln\ (VL) = -1.8 + .39\ Ln\ (FCL) + .12\ Ln\ (WCL) + .03\ T \quad \text{--------} \quad (2)$$
$$\qquad\qquad (3.1) \qquad (1.9) \qquad (3.5)$$

$\bar{R}^2 = 0.99$ D.W. = 2.5

Equation 1 shows that the quantum of working capital responds significantly to the variations in yield spread. Estimates indicate that with the fall in short-term interest rates or rise in spread demand for working capital would increase and vice-versa. This is consistent with the Proposition I above.

Equation 2 estimates logarithmic form of Cobb-Douglas production function for the manufacturing sector with working capital as an additional argument. Estimated values reveal that output responds significantly to the variations both in the working and fixed capital stock. Obviously, the contribution of working capital is lower than fixed capital. Production elasticity with respect to working capital is 0.12, which implies for a given level of fixed capital and labour, one percentage increase in working capital leads to 0.12 percent of value addition. These results are consistent with our Proposition II.

While the equation (2) clearly establishes the contributions of working capital to output generation, it need not necessarily imply that changes in working capital cause changes in output. It may still be argued that causation might run either from output to working capital or vice-versa or both ways. To ascertain the direction of causation, we conducted the Granger's Causality Test for the variables WCL and VL. The results are as below:

Period	=	*1980-81 to 1997-98*
No. of Lags	=	3
Null Hypothesis:		F-Statistic
WCL does not granger cause VL		4.13*
VL does not granger cause WCL		0.33

** Significant at 5 per cent level.*
Both the variables were differenced once for making them stationary.

From results we can reject the null hypothesis that WCL does not granger cause VL at 5 percent level of significance. However, the null hypothesis that VL does not granger cause WCL holds. Thus, results adequately establish that causation runs from working capital to output.

Above results satisfactorily explain the transmission path as indicated by the Propositions I to II above. This further strengthens our evidence for the association between industrial production and yield spread observed in the Indian context. However, due to lack of monthly data, it is not possible to determine the lag structure of the transmission path.

VI. CONCLUSIONS

The present paper provides evidence on the ability of yield spread to predict industrial activity in the Indian context. Empirical results are consistent with the similar studies conducted in case of other countries. Findings of the study are as follows: first, the regression results show that yield spread is positively related to industrial growth. Higher (lower) yield spread or steeper (flatter) yield curve is followed by higher (lower) industrial growth rate. Yield spread explains 41 percent of the variation in the future real economic activity. Secondly, estimates computed through probit model indicate that probability of future industrial slow down or recession rises (falls) with the fall (rise) in the yield spread. This further strengthens the regression findings that industrial activity and the yield spread are positively related. Thirdly, the out-of-sample estimates of probit model show that slope of the term structure reasonably predicts the occurrence of industrial slowdown 8-9 months in advance. Fourthly, impact of short-term interest rates or yield spread is transmitted to real industrial activity via its impact on working capital. Study shows that with the demand for working capital falls/rises with the fall/rise in the yield spread. Also that working capital makes significant contribution to the output generation. Thus, the yield spread could be considered, *inter alia*, as a lead indicator of industrial growth in India, the precision of predictability is high in event of large changes in the yield spread.

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