Predicting Economic Activity Using the Slope of Yield Curve : A Study of Indian Economy

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Abstract

This study examined the impact of slope of yield curve on the output in the Indian economy. Two definitions of the slope are used in the paper. Slope1 (difference between 10-year and 3-months government securities yield) and Slope2 (difference between 10-year and 1-year government securities yield). It was found that Slope1 and Slope2 had a significant impact on percentage change in index of industrial production (IIP), but the Slope2 was observed to a better predictor than Slope1 (at least for the Indian economy) as beta-coefficient and *t* - stat were found to be greater in Slope2 than in Slope1. Also, Slope1 had maximum impact on IIP after 7 months (lags) and Slope2 had maximum impact after 8 months (lags). The study found no significant relation between slope and the percentage change in gross domestic product (GDP) and broad market index (Sensex). The study can be used by researchers and forecasters to predict the recession in the Indian economy.

Keywords : **yield, slope of yield curve, recession, government bonds, index of industrial production, gross domestic product, term structure of interest rates**

JEL Classification : E32, E43, E44, E47

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Economists, especially macroeconomists, all over the world are interested to predict the recession in different economies. Flat and inverted yield curve is news for academicians and practitioners and gives strong signals about the economic activity. It can be negative, positive, or flat. It is positive if long term yield is more than the short term yield, negative if short term yield is higher than the long term yield, flat if yields of different maturities are the same. The question is why slope of the yield curve changes. To answer this question, various theories of term structure of interest rates have been developed in the finance literature. Irving Fisher's (1896) work marked the beginning of the theory of the term structure of interest rates and expectation hypothesis. He explained that the basis of the expectation theory of the term structure is the relationship between short-term and long-term rates. He observed that short-term and long-term rates move together and short term rates fluctuate more than the long term rates. Keynes (1930) in his book, *The Treatise on Money*, argued that monetary policy through short term interest rates affects the long term rates. But later, in his book, *The General Theory*, he abandoned this principle and explained the long-term rate of interest as a "highly conventional" or a "highly psychological phenomenon." Expectation theory was further developed by Hicks (1946), Lutz (1940), and Roll (1970, 1971). This hypothesis explains that the forward rates are the unbiased predictor of the future short term rates. It also means that if an investor holds the short term and long term bonds for the same time period, he/she will get the same yield, if yield is not same, then the arbitrageurs can earn profit. This hypothesis is criticized by

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empirical economists because it does not provide any evidence of the relationship between expectations of future short-term rates and yield curve. Some economists also criticized the expectation hypothesis because of its assumption that the long and short rates are perfect substitutes of each other. Culbertson (1957) gave the liquidity preference theory of interest rates. He argued that liquidity does not depend on the expectation of prices in the future, and if we remove liquidity, then what is left in the discussion is the speculation analysis. Kessel (1971) stated that term structure of interest rates can be explained jointly by the expectation hypothesis and liquidity preference hypothesis. They are complementary to each other. He argued that the expectation theory does not support the effectiveness of the monetary policy to impact the long term interest rates as long term interest rates depend upon the expectations of the market and not on the monetary policy. In order to affect the long term interest rates, the monetary authority has to buy and sell the long term bonds in the open market. Modigliani and Sutch (1966) developed the theory of term structure of interest rates called as the 'Theory of Preferred Habitats' (or 'Market Segmentation Theory'). They argued that investors do not prefer liquid bonds as claimed by Hicks (1946), but they prefer bonds as per their requirements. For example, life insurance companies prefer to invest in long term bonds and the commercial banks prefer to invest in the short term bonds. They do not generally shift from their preferred habitat and the yield depends upon the demand and supply of the bonds in the preferred maturity.

Generally, higher the term to maturity, higher is the yield because of liquidity premium and maturity premium. But, because of various other reasons, as cited above, sometimes we have seen that the yield curve becomes inverted and takes various other shapes. It can also be argued that during boom and expansion, the government/Central bank adopts a tighter monetary policy which increases the short term interest rates. Investors in the rising interest rates environment at the time of economic expansion believe that in future, interest rates may decrease. This increases the demand of long term bonds which causes decrease in the yield on long term bonds.

This study deals with the Indian economy instead of American or European economies, which are otherwise popular among researchers. The study does not focus on the inversion of yield curve as the predictor of the recession in the Indian economy, but on the impact of change in the slope of the yield curve on output. Economic output can be measured by IIP (index of industrial production), GDP growth (gross domestic product), and broad stock market index (Sensex). The objective of this paper is to examine if there is any significant impact of the change in slope of yield curve on percentage change in IIP, GDP growth, and Sensex, and if yes, then after how many months and/or quarters (i.e. lags).

Literature Review

It is well established in literature that slope of yield curve can be used to predict future economic output. Researchers like Plosser and Rouwenhorst (1994), Harvey (1989), and Estrella and Hardouvelis (1991) found that slope of yield curve contained information for predicting future economic output. Hvozdenska (2015) explored that after the financial crisis of 2008 in Nordic countries, the slope of yield curve significantly predicted GDP growth. He explored lags which could be used for best prediction and found that lags in slope were different for selected countries for prediction. Bernard and Gerlach (1998) also revealed that real economic activity can be predicted by the slope of yield curve. Further, Stock and Watson (1989) discovered that slope of yield curve should be included in leading indicators' index. Some researchers like Bauer and Mertens (2018) confirmed that from 1955 – 2018, recession was preceded by yield curve inversion. Rudebusch and Williams (2009) also found that the inverted yield curve indicated the high probability of recession and decrease in the output growth in the economy and Estrella and Mishkin (1997) also confirmed the same for USA and other countries. But there are some contrary results like Berk and Bergeijk (2001) found that over the period of 1970 – 1998 in 12 euro area countries, the slope of yield curve provided very limited information about GDP growth. *The Economist* ("Yield curves and economic

growth across the rich world, " 2019) reported that every past recession was preceded by the inverted slope of the yield curve. It showed that inverted yield curve gives a negative signal for the investors. It also cautioned the investors since recently, in Germany, the yield curve was inverted. It also reported that in all the eight recessions since 1960, at least one-day yield curve became inverted before recession. Singh and Shrivastav (2018) studied the impact of the 2007 – 2008 financial crisis on BRICS's countries stock markets and found that the financial crisis spilled over in these countries. Kumar and Khanna (2018) used ARCH and GARCH models to study the volatility behaviour and its spillover in stock markets in Asian countries and found that the Indian stock market was stable among the selected Asian markets.

There are mixed evidences beyond the USA regarding the predictive power of the yield curve spread. So, the relationship can be studied in the Indian context. As discussed above, the literature has provided various reasons for fluctuations in the yield curve and explained the phenomenon by three theories: expectation, liquidity preference, and market segmentation. It is also found that the yield curve slope can be used as a predictor of economic activity in an economy. Very limited research has been conducted in the Indian context in this regard. Thus, this paper is an attempt to forecast the economic activity in India using slope of yield curve. The study can help advanced and professional forecasters, policy makers, investors, and other stakeholders to predict the economic output in India.

Research Methodology

Slope of the yield curve, that is, the spread between long and short term yield can be upward, flat, and downward sloping. In upward sloping, the spread is positive ; in flat yield curve, the spread is zero ; and spread in negative yield curve is downward sloping.

Different authors have used two different definitions of the slope of the yield curve. Spread between 10-year government bond yield and 3-month government bond yield was used for analysis by Estrella and Hardouvelis (1991) and Hvozdenska (2015). Spread between 10-year government bond yield and 1-year government bond yield was used for analysis by Stock and Watson (1989) and Bauer and Mertens (2018). So, both need verification in the Indian economy.

Three dependent variables are used in the paper. First, two are monthly percentage change (from March 1997 – November 2018) in Sensex and IIP (index of industrial production). Sensex and IIP data were downloaded from Bombay Stock Exchange (BSE, 2019) and Ministry of Statistics and Programme Implementation (MOSPI, 2018) websites, respectively. The third dependent variable is quarterly percentage change (from first quarter of 1997 – second quarter of 2018) in GDP (gross domestic product at factor cost at constant prices) downloaded from Reserve Bank of India's (Reserve Bank of India, 2018a, 2018b) *Database on Indian Economy*. Percentage change is calculated by using natural log. For example, monthly percentage change in index of industrial production is calculated as :

$$Percentage\ Change\ in\ IIP = LN\left(\frac{IIPt}{IIP(t-1)}\right) \times 100$$

where,

LN is the natural log, *IIPt* is the index of industrial production in the current period, and $IIP(t-1)$ is the index of industrial production of the previous year in the same month. Percentage change in Sensex is change in index from the previous month with the same formula. Similarly, percentage change in GDP is calculated. Quarterly percentage change is the percentage change in GDP from the same quarter in the previous year.

The independent variable is slope of yield curve. Two definitions of slope are used for analysis. Slope1 (spread between 10-year government securities yield and 3-month treasury yield) and Slope2 (spread between 10-year government securities yield and 1-year government securities yield). Data of 10-years, 1-year, and 3-months government securities yield were downloaded from Reserve Bank of India's *Database on Indian Economy* (Reserve Bank of India, 2018a, 2018b).

The Model

The following model is being used in the study. Hvozdenska (2015) used a similar model for finding out the number of lags after which the GDP growth can be predicted by the slope of the yield curve.

$$Y_t = B_0 + B_1 X_{t-i} + e$$

Above is the simple regression model. Y_t is either percentage change in GDP, IIP, or Sensex. X_{t-i} is either Slope1 or Slope2 with lags from 0 – 24 months (i = 0 for data ranges from March 1999 – November 2018 and with each lag, data moves one step backward and data for 24th lag, that is, for i = 24 ranges from March 1997 – November 2016) in case of percentage change in IIP and Sensex and with lags from 0 – 8 (i = 0 for data ranges from second quarter of 1999 – third quarter of 2018, and with each lag, the data moves one step backward and data for 8th lag, that is, for i = 8 ranges from second quarter of 1997 – third quarter of 2016) quarters in case of GDP growth. So, 25 regressions are run each in case of percentage change in IIP and Sensex as dependent variable and nine regressions are run in case of GDP growth as dependent variable to see how the slope coefficients, t - stat, F - stat, p - value, and coefficient of determination change with each lag and after how many lags, slope of yield curve significantly affects percentage change in IIP, percentage change in Sensex, and percentage change in GDP. As GDP data were not available monthly, the quarterly data is used for analysis.

In short, the paper examines after how many lags, change in yield spread significantly impacts percentage change in IIP, Sensex, and GDP. Using this process, the paper analyzes the change in slope coefficient, t-stat of the slope coefficient, p-values of the slope coefficient, coefficient of determination, and F-stat of the regression from t – 0 to t – 24 months in case of percentage change in IIP and Sensex and t – 0 to t – 8 quarters in case of GDP growth.

Ordinary least square (OLS) regression model is used. In case of time series data, the variables need to

Table 1. Tests for Stationarity

	Quarterly Variables	Lag Length : Based on SIC	*t*- statistic	Prob.
GDP	ADF Test Statistics	0	–4.28881	0.00090
*Slope*1	ADF Test Statistics	0	–4.88961	0.00010
*Slope*2	ADF Test Statistics	0	–3.89025	0.00320
	Monthly Variables			
IIP	ADF Test Statistics	1	–3.99245	0.00170
Sensex	ADF Test Statistics	0	–15.4992	0.00000
*Slope*1	ADF Test Statistics	1	–5.11769	0.00000
*Slope*2	ADF Test Statistics	0	–4.37593	0.00040

Source : Author's calculations using data from BSE, MOSPI, and RBI's *Database on Indian Economy*

ADF : Augmented Dickey – Fuller

be stationary for applying OLS (Asteriou & Hall, 2011). Data in the study is time series and the Augmented Dickey – Fuller test is used to test the stationarity and all the variables are found to be stationary at the 1% level of significance (Table 1).

The results are divided into the following parts :

(i) Impact of Slope1 and Slope2 on percentage change in broad market index, that is, Sensex.

(ii) Impact of Slope1 and Slope2 on percentage change in IIP.

(iii) Impact of Slope1 and Slope2 on percentage change in GDP.

Analysis and Results

(1) Impact of Slope1 and Slope2 on Percentage Change in Broad Market Index : The results obtained from the model are depicted in the tables and graphs. Firstly, the results obtained from the model to see the impact of Slope1 on broad market index (Sensex) are shown in Table 2. Data ranges from March 1999 – November 2018 as *'t'* and

Table 2. Sensex – Slope1

Periods	Coefficients	Standard Error	*t*-Stat	*R*-Square	*F*-Stat	*P*-value
t	0.573344	0.383476	1.49512	0.009423	2.235394	0.136224
t–1	0.817459	0.379647	2.15321	0.019347	4.636293	0.032321
t–2	0.789847	0.376877	2.09577	0.018347	4.392249	0.037173
t–3	0.433753	0.377604	1.14870	0.005584	1.319504	0.251849
t–4	0.340852	0.376584	0.90511	0.003474	0.819231	0.366332
t–5	0.083484	0.376048	0.22200	0.00021	0.049286	0.824503
t–6	–0.0952	0.374017	–0.25454	0.000276	0.064789	0.799304
t–7	–0.04046	0.37363	–0.10829	0.0000499	0.011727	0.913856
t–8	–0.17387	0.364495	–0.47702	0.000967	0.227552	0.633788
t–9	–0.29928	0.358527	–0.83474	0.002956	0.696796	0.40471
t–10	–0.39106	0.356915	–1.09568	0.005083	1.200512	0.274341
t–11	–0.10535	0.352899	–0.29852	0.000379	0.089115	0.765569
t–12	0.131667	0.351982	0.37407	0.000595	0.139931	0.708686
t–13	0.066032	0.352031	0.18757	0.00015	0.035184	0.851373
t–14	–0.28392	0.350339	–0.81043	0.002787	0.656794	0.418514
t–15	–0.4121	0.347756	–1.18504	0.00594	1.404321	0.237198
t–16	–0.48338	0.342179	–1.41264	0.00842	1.995553	0.159084
t–17	–0.18747	0.339865	–0.55161	0.001293	0.30427	0.581742
t–18	–0.32577	0.333832	–0.97585	0.004036	0.952281	0.330143
t–19	–0.21852	0.325095	–0.67218	0.001919	0.451823	0.502131
t–20	–0.18746	0.319538	–0.58666	0.001462	0.344173	0.557994
t–21	–0.12069	0.307469	–0.39254	0.000655	0.154086	0.695016
t–22	–0.20008	0.301313	–0.66402	0.001873	0.440928	0.507326
t–23	–0.00614	0.284874	–0.02155	0.00000198	0.000464	0.982826
t–24	–0.09715	0.27971	–0.34734	0.000513	0.120642	0.72865

Table 3. Sensex – Slope2

Periods	Coefficients	Standard Error	*t* - Stat	*R*-Square	*F* - Stat	*P*-value
t	1.120279	0.609507	1.838009	0.014172	3.378277	0.067323
t–1	1.309495	0.607071	2.157071	0.019415	4.652956	0.032015
t–2	1.291227	0.605893	2.131114	0.01896	4.541647	0.034118
t–3	1.07402	0.607092	1.769121	0.013143	3.129791	0.078171
t–4	0.99025	0.606427	1.632926	0.011219	2.666448	0.103824
t–5	0.562781	0.608036	0.925571	0.003632	0.856682	0.355618
t–6	0.243897	0.608217	0.401002	0.000684	0.160803	0.688783
t–7	0.107515	0.60396	0.178017	0.000135	0.03169	0.858863
t–8	–0.15228	0.598697	–0.254350	0.000275	0.064694	0.799448
t–9	–0.40605	0.595598	–0.681754	0.001974	0.464789	0.496066
t–10	–0.22769	0.59563	–0.382268	0.000621	0.146129	0.702608
t–11	–0.0266	0.582302	–0.045673	0.00000888	0.002086	0.96361
t–12	0.116681	0.580946	0.200847	0.000172	0.04034	0.840992
t–13	0.283934	0.58057	0.489061	0.001017	0.23918	0.625255
t–14	0.015127	0.580419	0.026062	0.00000289	0.000679	0.97923
t–15	–0.04199	0.578528	–0.072589	0.0000224	0.005269	0.942195
t–16	–0.01917	0.572292	–0.033499	0.00000478	0.001122	0.973305
t–17	0.081465	0.567475	0.143556	0.0000877	0.020608	0.885974
t–18	–0.47195	0.562286	–0.839348	0.002989	0.704505	0.402127
t–19	–0.22789	0.561431	–0.405915	0.000701	0.164767	0.685174
t–20	–0.25584	0.548873	–0.466120	0.000924	0.217268	0.641561
t–21	–0.34368	0.538023	–0.638778	0.001733	0.408038	0.523589
t–22	–0.0865	0.531722	–0.162680	0.000113	0.026465	0.870911
t–23	–0.2434	0.524275	–0.464258	0.000916	0.215535	0.642893
t–24	–0.02751	0.518685	–0.053039	0.000012	0.002813	0.957746

moving one month back in each 't – 1' to 't – 24' lags. The 't - stat' is not significant in any of the lags, which shows that Slope1 has no substantial impact on the percentage change in Sensex, which is an indicator of broad market index. It also implies that it is not possible to predict the broad market index with the help of Slope1, that is, spread between 10-year government security benchmark yield and 3-month government security yield.

Similar results are obtained in case of Slope2, which is shown in Table 3. In both the Table 2 and Table 3, F-stat implies that R^2 is not significant in both the cases. The visuals of the results obtained (Figure 1) also indicate that coefficients are not significant at the 1% level of significance, which implies that Slope1 and Slope2 has no significant impact on percentage change in Sensex. In the Indian economy, it is not possible to predict the percentage change in Sensex with the help of yield curve slope.

(2) Impact of Slope1 and Slope2 on Percentage Change in IIP : The impact of Slope1 and Slope2 on IIP is presented in Table 4 and Table 5. In case of Slope1, although the regression results show an insignificant 't - stat' for the first month, it becomes significant after first month and the t - stat keeps increasing till the 7th month to the tune

Figure 1. Impact of Slope1 and Slope2 on Sensex

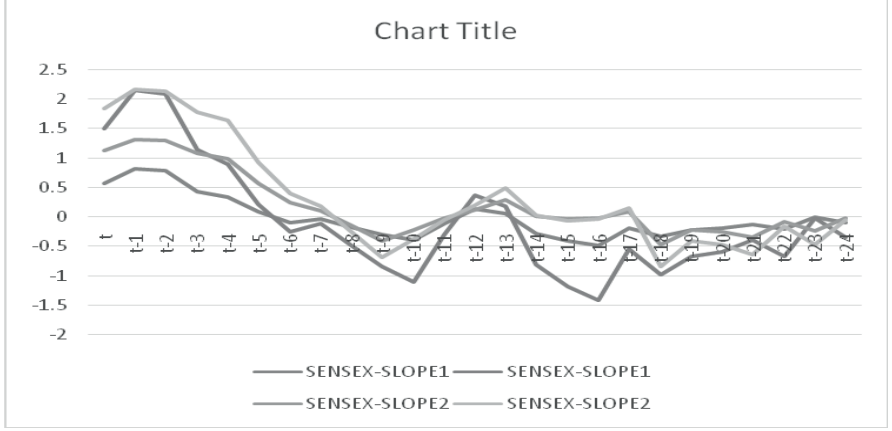


Table 4. IIP – Slope1

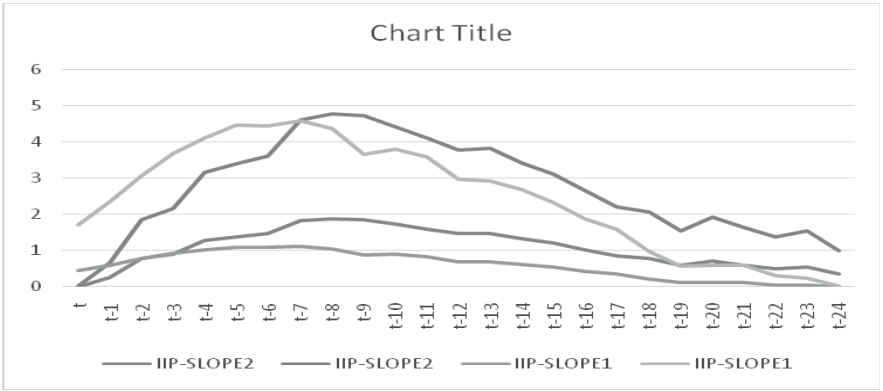
Periods	Coefficients	Standard Error	*t* - Stat	*R* - Square	*F* - Stat	*P*-value
t	0.453528	0.263125	1.723626	0.012484	2.970885	0.086091
t–1	0.609522	0.260445	2.340314	0.022776	5.47707	0.020105
t–2	0.783889	0.256356	3.057812	0.038266	9.350215	0.002488
t–3	0.931071	0.253037	3.679581	0.054476	13.53931	0.00029
t–4	1.0249	0.250478	4.091786	0.066507	16.74271	0.0000589
t–5	1.106507	0.248171	4.458648	0.077996	19.87954	0.0000128
t–6	1.093427	0.246974	4.4273	0.076987	19.60098	0.0000146
t–7	1.125675	0.246048	4.575016	0.081783	20.93077	0.00000771
t–8	1.050503	0.241058	4.357879	0.074771	18.99111	0.0000196
t–9	0.876028	0.240043	3.649458	0.053635	13.31854	0.000324
t–10	0.9042	0.238726	3.78761	0.057534	14.34599	0.000193
t–11	0.845397	0.236213	3.578959	0.051689	12.80894	0.000419
t–12	0.702834	0.237578	2.958334	0.035904	8.751741	0.003409
t–13	0.693761	0.23767	2.919006	0.034989	8.520594	0.003853
t–14	0.635252	0.237508	2.674657	0.029542	7.153791	0.008006
t–15	0.549967	0.236997	2.320562	0.022402	5.385006	0.021168
t–16	0.439062	0.234405	1.873093	0.01471	3.508478	0.062297
t–17	0.369066	0.23247	1.58759	0.010611	2.520442	0.113724
t–18	0.22646	0.229405	0.987164	0.00413	0.974493	0.324578
t–19	0.127804	0.223471	0.571904	0.00139	0.327074	0.567934
t–20	0.131037	0.219587	0.596741	0.001513	0.3561	0.551255
t–21	0.125443	0.21121	0.593925	0.001499	0.352747	0.553133
t–22	0.064567	0.20722	0.311586	0.000413	0.097086	0.755632
t–23	0.04704	0.195747	0.24031	0.000246	0.057749	0.810299
t–24	0.006638	0.192271	0.034522	0.00000507	0.001192	0.97249

of 4.57. The slope coefficient at the 7th month is 1.12, which means that with a 1% increase in spread between 10-year and 3-months, the percentage change in IIP increases by 1.12% after the 7th month. Also, the coefficient at '$t-7$' is at the maximum, and after that, it starts falling (Table 4). The coefficients are significant even up to the 14th lag as well, that is, the impact of change in slope is noteworthy up to the 14th lag and shows a decline after that. Figure 2 lucidly depicts the trend explained above. I obtained similar results for impact of Slope2 on percentage change in IIP. However, Slope2 is one period ahead of Slope1 and the coefficients obtained from Slope2 are relatively greater than the coefficients obtained from Slope1 (Table 5 and Figure 2). After 8th lag, coefficients and *t* - stat are maximum. Coefficient is 1.878, which shows that with 1% change in Slope2, the percentage change in IIP changes by 1.878% after 8-months. After 8th lag coefficient, *t*-stat decreases but remains significant up to 15th lag. This implies that Slope1 significantly impacts the percentage in IIP and after the 7th lag, it has maximum impact. Also, the impact of Slope2 on percentage change in IIP is higher than what it is for Slope1. The practitioners can use these results for forecasting.

Table 5. IIP – Slope2

Periods	Coefficients	Standard Error	*t* - Stat	*R* - Square	*F* - Stat	*P*-value
t	0.006157	0.421865	0.014595	0.000000906	0.000213	0.988368
t–1	0.278028	0.42091	0.660541	0.001853	0.436314	0.509554
t–2	0.776607	0.417322	1.86093	0.014522	3.46306	0.064003
t–3	0.89691	0.415879	2.156659	0.019408	4.651176	0.032047
t–4	1.297271	0.410473	3.160428	0.040771	9.988306	0.001782
t–5	1.385348	0.408744	3.389281	0.046604	11.48722	0.000822
t–6	1.466504	0.407031	3.602932	0.052347	12.98112	0.000384
t–7	1.831859	0.397508	4.608354	0.08288	21.23693	0.00000666
t–8	1.87818	0.39283	4.78115	0.088651	22.8594	0.00000308
t–9	1.855842	0.391417	4.741348	0.087309	22.48038	0.00000368
t–10	1.737005	0.393466	4.41463	0.076581	19.48896	0.0000154
t–11	1.591949	0.386461	4.119294	0.067344	16.96858	0.0000527
t–12	1.466023	0.38765	3.781822	0.057369	14.30218	0.000198
t–13	1.479898	0.387333	3.820741	0.058486	14.59806	0.00017
t–14	1.33332	0.389278	3.425112	0.047547	11.7314	0.000725
t–15	1.216449	0.389581	3.122458	0.039836	9.749741	0.002018
t–16	1.026458	0.387549	2.648589	0.028986	7.015023	0.008631
t–17	0.855339	0.385985	2.215992	0.020469	4.910621	0.027651
t–18	0.7951	0.383501	2.073268	0.017963	4.29844	0.039237
t–19	0.595167	0.384004	1.5499	0.010119	2.40219	0.122511
t–20	0.721035	0.374427	1.925699	0.015535	3.708318	0.055349
t–21	0.600874	0.367979	1.632904	0.011219	2.666376	0.103828
t–22	0.496341	0.363993	1.363601	0.00785	1.859408	0.173998
t–23	0.554857	0.358635	1.547136	0.010083	2.39363	0.123176
t–24	0.352496	0.35571	0.990966	0.004161	0.982014	0.322721

Figure 2. Impact of Slope1 and Slope2 on IIP



(3) Impact of Slope1 and Slope2 on Percentage Change in GDP : The regression results of GDP and Slope1 and Slope2 do not show any level of significance at any of the periods. So, Slope1 and Slope2 have no significant impact on the percentage change in GDP (refer to Table 6, Table 7, and Figure 3). Hence, Slope1 or Slope2 cannot

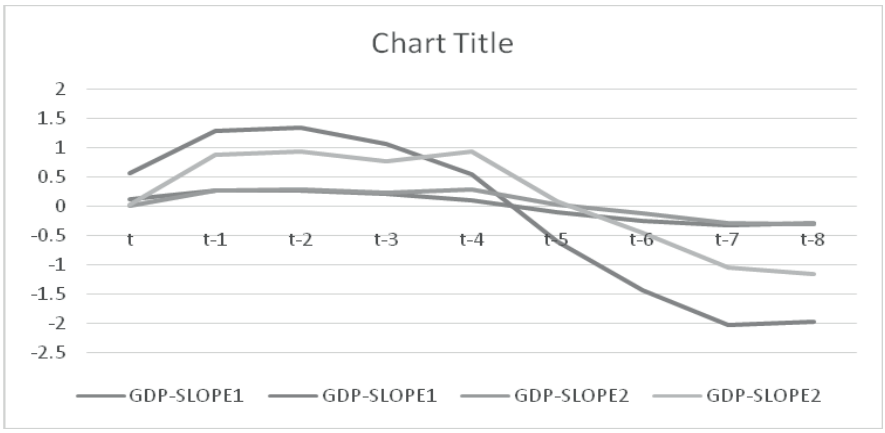
Table 6. GDP – Slope1

Quarters	Coefficients	Standard Error	*t* - Stat	*R* - Square	*F* - Stat	*P* - value
t	0.113887	0.206241	0.55220	0.003996	0.304926	0.582431
t–1	0.255065	0.198721	1.28353	0.021217	1.647447	0.203207
t–2	0.262146	0.195464	1.34115	0.02312	1.798675	0.183867
t–3	0.20488	0.192406	1.06483	0.0147	1.13387	0.290323
t–4	0.099744	0.18318	0.54452	0.003886	0.296497	0.587681
t–5	–0.11234	0.181624	–0.61852	0.005009	0.38257	0.538081
t–6	–0.2545	0.176671	–1.44054	0.026579	2.075163	0.153821
t–7	–0.33544	0.164088	–2.04425	0.05212	4.178942	0.044393
t–8	–0.28875	0.144941	–1.99220	0.04963	3.968878	0.04994

Table 7. GDP – Slope2

Quarter	Coefficients	Standard Error	*t* - Stat	*R* - Square	*F* - Stat	*P* - value
t	0.008445	0.30659	0.027545	0.00000998	0.000759	0.978097
t–1	0.266905	0.304124	0.877619	0.010033	0.770215	0.382917
t–2	0.282117	0.302163	0.933657	0.01134	0.871716	0.353438
t–3	0.234055	0.301529	0.776229	0.007866	0.602531	0.440023
t–4	0.277291	0.296873	0.934040	0.011349	0.872431	0.353241
t–5	0.024856	0.296281	0.083892	0.0000926	0.007038	0.933363
t–6	–0.13251	0.294344	–0.450191	0.00266	0.202672	0.653854
t–7	–0.29554	0.283033	–1.044202	0.014144	1.090359	0.299702
t–8	–0.30758	0.264573	–1.162564	0.017473	1.351556	0.248644

Figure 3. Impact of Slope1 and Slope2 on GDP



be used to predict GDP growth in the Indian economy, which is contrary to most of the existing literature and reasons for the same requires further investigation, which is beyond the scope of this study.

Conclusion

The objective of the study is to find out the impact of spread of government bond yield, that is, the difference between long term and short term government bond yield (called as slope of the yield curve) on the output in the Indian economy. As macroeconomists always try to predict the business cycle, this study is a step towards that. In the study, slope of yield curve is used to forecast the percentage change in IIP, Sensex, and GDP. I used monthly data of percentage change in IIP, Sensex, and government's security yield to find out the impact of yield spread on percentage change in IIP and Sensex. However, for GDP, the quarterly data is employed. The data period taken is from March 1997 – November 2018.

By analyzing the impact of Slope1 (difference between 10-year and 3-month government securities yield) and Slope2 (difference between 10-year and 1-year government securities yield) on broad market index, I did not find any significant influence of the variables to predict the broad market index (Sensex). So, this study shows that slope of the yield curve is not helpful to forecast GDP and Sensex in the Indian economy. However, we conclude, from the results, that the Slope1 and Slope2 have a significant impact on percentage change in IIP, but the Slope2 is a better predictor than Slope1 (at least for the Indian economy) because beta-coefficient and *t*-stat is greater in Slope2 than in Slope1. Also, Slope1 has maximum impact after 7-months (lags) and Slope2 has maximum impact after 8-months (lags). So, the study concludes that spread between long term and short term government bond yield can be used to predict IIP in the Indian economy.

Research Implications, Limitations of the Study, and Scope for Further Research

The study does not find any significant impact of Slope1 and Slope2 on the broad market index and GDP, although the study shows that Slope1 and Slope2 can be used to predict IIP in the Indian economy. Slope2 is the better predictor of IIP and has maximum impact after 8 months. As suggested by the literature that yield spread can be used as a predictor of GDP growth, but in case of India, this study does not find any significant relation, which

requires further research. Also, as IIP is used as proxy for GDP, the results show that in India, it is possible to predict IIP with the help of slope of yield curve, but it is not possible to forecast GDP. This also requires further investigation. The study is limited to the Indian economy but can be extended to other emerging economies. Further, the study uses least square regression model for data analysis, and other advanced models can also be used. Also, this study can be used by forecasters and other stakeholders to predict the slowdown in the economy.

Author's Contribution

Rahul Rangotra conceived the idea, reviewed the existing literature, developed the data analysis techniques, did the numerical computations, and wrote the manuscript.

Conflict of Interest

The author certifies that he has no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter, or materials discussed in this manuscript.

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