Comparison of Forecasting Models for Interest Rates

by

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The interest rate forecasts currently produced by the Rodney White Center utilize three types of models. All three perform quite well, and no definitive choice among them can be made on the basis of current evidence. This paper shows the comparative performance of the three model types in terms of (a) goodness of fit over the 24 year period 1952-75; (b) predictive accuracy for 1974, 1975 and the first three quarters of 1976, using regressions based on data through 1973 only; and (c) stability of coefficients when the regressions are fitted for different subperiods. Quarterly and annual models have been developed for the rate on 3-month Treasury bills and for the corporate bond rate (Moody's series for all corporate bonds). Some results are available for other long term rates as well.

Models of the first type invoke the traditional demand and supply forces in asset markets. Long term rates are assumed to vary in such a way as to equate the demand for liquid assets to the supply.[1] Short term rates are assumed to vary in such a way as to equate the fraction of liquid assets that the public wishes to hold in the form of cash to the money supply expressed as a fraction of the supply of all liquid assets. The supply variables, while sensitive to the yields expected at the beginning of a period, are assumed to respond more slowly than asset demand to deviations of current yields from initial expectations.

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[1] If total financial wealth is given, excess demand for liquid assets at existing interest rates implies excess supply of longer term assets.

Models of the second type are naive. In one such model, each interest rate is assumed to depend only on the lagged value of that rate and the current inflation rate. The logical justification for this approach rests on two somewhat dubious propositions; (1) that nominal interest rates adjust quickly and fully to changes in the expected inflation rate, leaving expected real interest rates unchanged; and (2) that expectations about inflation are generated by a particular, very simple distributed lag of current and past inflation rates. A second naive model, resting on a theory of term structure, relates the long term rate to its own lagged value and to the current value of the short term rate. To reduce problems of simultaneous equations bias in this model, the actual value of the short term rate is replaced by an estimated value based on factors believed to be largely independent of the current value of this rate.

The third type of model combines the variables of the naive models with the demand and supply variables incorporated in the traditional models. Within the context of the traditional models, the short term rate can be considered a legitimate demand variable affecting the division of financial portfolios between liquid and long term assets, and thus the demand for both types of assets. A case can also be made for treating the current and expected inflation rates as determinants of demand. Both may raise the transactions demand for liquid assets; and anticipated inflation may induce shifts from long term financial assets to real estate or precious metals or art objects. In addition, there may be significant effects on supply: both on the volume of new long term issues and also on the supply of short term governments to the private nonbank sectors, if commercial banks reduce their holdings in order to meet increased loan demand from business.

Tables 1 and 2 demonstrate the comparative performance of the three types of models in explaining and predicting the three-month Treasury bill rate. The relationships of Table 1 are based on quarterly data and those of Table 2 on annual data.

The variables introduced in the Type 1 (traditional) models as determinants of the short term rate include the ratio of money supply to the supply of other liquid assets, as well as various factors expected to affect the demand for money relative to that for other liquid assets.

It is believed that the growth of savings and insurance intermediaries, replacing direct household investment in primary issues, has led to a considerable decline in the fraction of liquid assets that the public wishes to hold in the form of cash, at given interest rates. Both speculative and precautionary balances probably are now held very largely in non-cash forms. In particular, financial intermediaries (unlike the average household) can be expected to hold their speculative balances in the form of short term governments, while households' precautionary balances have increasingly taken the form of time and savings deposits. Furthermore, some significant part of the transactions balances of nonfinancial businesses and state and local governments may now be held in short term governments or time deposits rather than demand deposits. These developments would be expected to produce a long term secular decline in the fraction of liquid assets that the public wishes to hold in the form of money.

Since money still retains a strong comparative advantage for transactions purposes, short run changes in the demand for money relative to that for other liquid assets may be related to short run changes in the relative magnitude of transactions balances (still predominantly held in cash) and precautionary and speculative balances (now largely held in assets other than cash). The demand variables introduced to explain the short term rate attempt to capture such shifts:

1. If transactions balances are closely related to GNP while speculative balances are closely related to the consolidated financial wealth of households and nonbank intermediaries, we may expect that the ratio of GNP to financial wealth will have some influence on the preferred division between cash and other liquid assets, at given short term yields.

2. High unemployment rates may increase uncertainty about the economic future, leading to an increase in both precautionary and speculative balances and thus raising the demand for near-monies relative to the demand for cash.

3. To the extent that other unidentified demand factors have effects that persist from one period to the next and to the extent that lags exist in the adjustment of asset yields to changes in demand and supply conditions, the lagged value of the short term rate may be helpful in predicting its value in the current period.

In Table I, the dependent variable is the rate on new issues in the last month of the quarter. M1 is the money supply and L-M1 the supply of time and savings deposits in commercial banks and savings institutions plus short term Treasury securities held by the private nonbank sectors (both at end of quarter, not seasonally adjusted). U is the average unemployment rate for the quarter; Π is the percentage change in the Consumer Price Index from the preceding to the current quarter (using quarterly averages); $\Delta\Pi$ is the change in Π; and iS_{-1} is the value of the dependent variable in the last month of the previous quarter. The ratio of GNP to financial wealth is not significant when added to Model I or III.

All three of the models in Table I explain about 90 per cent of the variance in the Treasury bill rate over the 96 quarters covered. Model I gives clearly the best predictive performance, but all three models performed poorly in the first and third quarters of 1975. Durbin Watson statistics are on the low side for all three models.

When coefficients based on subperiods are compared with those for the period as a whole, we find that results for the earlier subperiod (from II/52 to IV/67) are essentially similar, except that the effect of the inflation rate is much lower than for the longer period. For the later subperiod (from I/60 to I/76) there is much greater deviation from the overall results. The coefficient of the inflation rate is now considerably higher than for the period as a whole. The coefficient of the relative money supply proves unstable in the Model I regression, while those of the unemployment rate and the lagged dependent variable are unstable in the Model III regression.

In Table 2, the dependent variable in a given year is the average of values for the last month of each of the four quarters. Thus, it centers about the middle of the third quarter. M1 and L-M1 are end-of-year figures, with the latter now including open market paper held by non-financial business. FW is the consolidated financial wealth of households and savings and insurance intermediaries at the end of the year. U is the average unemployment rate for the year. Π_2 is the percentage change in the Consumer Price Index from the third quarter of the previous year to the third quarter of the current year. This performed somewhat better than the change between annual averages for the two years. The lagged value of the dependent variable, iS_{-1}, was not significant in Models I and III.

It will be noted that the percentage of variance explained by Model III is considerably higher than for Models I and II and is comparable to that for the quarterly models. The predictive performance of Model III is clearly superior to that of Model I, which in turn is clearly superior to Model II.

Tables 3 and 4 demonstrate, for quarterly and annual data, respectively, the comparative performance of the three types of models in explaining and predicting the corporate bond rate. Causal variables in the Type I (traditional) model include the supply of liquid assets, GNP (as a determinant of transactions demand), the unemployment rate (as a determinant of precautionary demand) and the financial wealth of the consolidated household sector (as a determinant of speculative demand). Since it is likely that speculative demand is also affected by the short term rate for any given level of the long term rate, we further include the ratio of the money supply to the supply of other liquid assets, which (along with the unemployment rate) was found to be an important determinant of the short term rate (See Table 1, Model I).

The lagged value of the corporate bond rate is included to allow for adjustment lags and for the effect of omitted demand factors that persist from one period to the next. The supply of long term assets is not included as a separate variable. Any increase in this supply is eventually reflected in an increase in the financial wealth of the consolidated household sector. Initially there may simply be a redistribution of liquid assets from that sector to nonfinancial business or government, and the fraction of liquid assets held by the household sector may be informative.

The dependent variable in Table 3 is Moody's yield series for all corporate bonds in the last month of the quarter. L is the sum of currency, demand and time deposits in commercial banks, savings deposits in savings institutions, and short term governments held by the private nonbank sectors and FW1 is the financial wealth of households (both end of quarter, not seasonally adjusted). M1, Π and U are as defined in Table 1; iL_{-1} is the value of the dependent variable in the previous period; and iS*Q is the estimated value of the current short term rate based on a regression including the ratio of money supply to the supply of other liquid assets, the unemployment rate, the inflation rate and the change in inflation rate.

All five of the regressions in Table 3 explain 99 percent of the variance in the corporate bond rate over the period as a whole.

The best predictions are obtained from the naive models, using only the inflation rate or the estimated short term rate in addition to the lagged dependent variable. The first of the Model III regressions also does very well. All five regressions perform badly in the third quarter of 1974 and four of the five in the second quarter of that year.

When we examine the stability of coefficients for subperiods, we find that the effect of the inflation rate is somewhat smaller in the first subperiod and larger in the second than for the period as a whole. The same is true for the effects of the short term rate and the ratio of GNP to household financial wealth. The coefficient of the ratio of liquid assets to household financial wealth is relatively stable in Model III, while that of the relative supply of money is extremely unstable in both Models I and III. Overall, the second of the two naive models (incorporating the computed value of the short term rate) ranks highest in terms of stable effects over subperiods.

In Table 4, which deals with annual data, the dependent variable is the average over four quarters of the corporate bond yield in the last month of each quarter, and iL_{-1} is the value of the dependent variable in the previous year. iS^* is an estimate of the Treasury bill rate in the current year based on a regression including as explanatory variables the ratio of money supply to the supply of other liquid assets, the unemployment rate, the inflation rate and the change in the inflation rate from the previous year. Other variables are as in Table 2.

There is little difference among the models of Table 4 in the percentage of variance explained but predictive performance is clearly best for the naive model incorporating the estimated short term rate and the Model III relationship incorporating the inflation rate. These two relationships also show the greatest stability of coefficients over subperiods, except that the effect of inflation is much lower in the earlier subperiod and higher in the later subperiod than for the period as a whole.

Table 1: Comparison of Quarterly Models for the Three-Month Treasury Bill Rate

	Regression Statistics[1]								Predictive Performance[2]		
	Coefficient of								Number of Times Model Gave		
Model Type	$\frac{M1}{L-M1}$	$\frac{1}{U}$	Π	$\Delta\Pi$	iS_{-1}	Constant Term	$\bar{R}^2$	DW	Best Prediction	Error Greater Than 100 Basis Points	Root Mean Square Error
I	-1.514 (-3.4)	3.800 (3.1)			.788 (14.2)	1.003	.903	1.58	6	3	.726
II			.289 (2.0)		.844 (14.6)	.417	.894	1.56	3	4	.918
III	-2.064 (-4.7)	5.274 (4.3)	.658 (4.0)	-.357 (-2.5)	.517 (6.1)	1.575	.916	1.36	2	3	.839

[1] Regression statistics are based on data for the period II/52 - I/76. T-tests are shown in parentheses below regression coefficients.

[2] Based on predictions for eleven quarters (I/74 - III/76) derived from regressions utilizing data through 1973 only.

Note: M1 is demand deposits plus currency; L-M1 is other liquid assets; U is the unemployment rate; Π is the inflation rate; $\Delta\Pi$ is the change in the inflation rate; FW or FW1 is financial wealth and iS_{-1} is the lagged short term rate.

Table 2: Comparison of Annual Models for the Three-Month Treasury Bill Rate

	Regression Statistics[1]									Predictive Performance[2]		
	Coefficient of									Number of Times Model Gave		
Model Type	$\frac{M1}{L-M1}$	$\frac{1}{U}$	$\frac{GNP}{FW}$	$\Pi 2$	$\Delta\Pi 2$	iS_{-1}	Constant Term	$\bar{R}^2$	DW	Best Prediction[3]	Error Greater Than 100 Basis Points	Root Mean Square Error
I	-8.023 (-10.6)	9.502 (3.0)	11.621 (3.8)				1.020	.832	1.49	2	1	1.258
II				.264 (2.1)	.302 (3.2)	.389 (2.2)	1.604	.817	1.96	0	2	1.716
III	-3.781 (-6.8)	8.209 (4.1)		.334 (7.1)	.142 (2.4)		3.528	.932	2.11	2	0	.694

[1]Regression statistics are based on data for the period 1952-1975. T-tests are shown in parentheses below regression coefficients.

[2]Based on predictions for 1974, 1975 and 1976, derived from regression utilizing data through 1973 only.

[3]Models I and III were equally good in 1975.

Note: Variables as in Table 1.

Table 3: Comparison of Quarterly Models for the Corporate Bond Rate

	Regression Statistics[1]									Predictive Performance[2]		
	Coefficient of									Number of Times Model Gave		
Model Type	$\frac{GNP}{FW1}$	$\frac{L}{FW1}$	$\frac{M1}{L-M1}$	Π	iL_{-1}	iS*Q	Constant Term	$\bar{R}^2$	DW	Best Prediction[3]	Error Greater Than 30 Basis Points	Root Mean Square Error
I	5.124 (2.7)	-4.842 (-2.3)	-1.026 (-3.1)		.948 (34.1)		.096 (.4)	.988	1.73	0	3	.400
II				.208 (5.3)	.944 (62.0)		.211 (3.1)	.990	1.89	3	3	.257
					.910 (46.1)	.118 (5.5)	.096 (1.6)	.991	1.97	4	3	.254
III	3.334 (1.9)	-4.039 (-2.1)	-.625 (-2.1)	.208 (5.0)	.918 (36.0)		.516 (2.4)	.991	2.03	2	3	.276
	1.478 (1.4)	-1.912 (-1.3)			.924 (40.0)	.124 (5.7)	-.061 (-.3)	.991	2.04	3	5	.355

[1] Regression statistics are based on data for the period II/52 - I/76. T-tests are shown in parentheses below coefficients.

[2] Based on prediction for 11 quarters (I/74 - III/76) derived from regressions utilizing data through 1973 only.

[3] The two best models were equally good in one quarter.

Note: iL_{-1} is the lagged dependent variable and iS*Q or iS* is the estimated short term rate. Other variables are as in Table I.

Table 4: Comparison of Annual Models for the Corporate Bond Yield

	Regression Statistics[1]										Predictive Performance[2]		
	Coefficient of										Number of Times Model Gave		
Model Type	$\frac{GNP}{FW}$	$\frac{L}{FW}$	$\frac{M1}{L-M1}$	Π	$\frac{1}{U}$	iL_{-1}	iS*	Constant Term	$\bar{R}^2$	DW	Best Prediction	Error Greater Than 30 Basis Points	Root Mean Square Error
I	16.693 (2.4)	-15.494 (-1.8)	-3.246 (-3.5)		2.060 (1.4)	.889 (10.0)		-.121	.971	1.76	0	2	1.052
II				.185 (5.0)		.818 (14.5)		.644	.975	1.63	0	3	.467
						.775 (15.3)	.311 (6.4)	.216	.982	1.79	2	0	.166
III	11.755 (2.3)	-16.088 (-2.8)	-1.802 (-2.3)	.201 (4.3)		.770 (11.2)		2.178	.984	2.08	1	0	.202
	7.315 (2.3)	-10.030 (-2.1)				.868 (14.0)	.338 (7.1)	-.271	.984	2.22	0	2	.584

[1]Regression statistics are based on data for the period 1952-1975. T-tests are shown in parentheses below regression coefficients.

[2]Based on predictions for 1974, 1975 and 1976, derived from regression utilizing data through 1973 only.

Note: Variables are as in Table 3.