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Forecasting with the Yield Curve: Level, Slope, and Output: 1875-1997

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Over the period 1875 to 1997, using the yield curve helps forecast real growth. Using both the level and slope of the curve improves forecasts more than using either variable alone. Forecast performance changes over time and depends somewhat on whether recursive or rolling out of sample regressions are used.

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I. Introduction.

Over the period 1875 to 1997, using the yield curve helps forecast real growth. In general, using both the level and slope of the curve improves forecasts more than using either variable alone. Forecast performance changes over time and depends somewhat on whether recursive or rolling (pseudo) out of sample regressions are used.

The extensive literature on the forecasting ability of the yield curve (surveyed in Stock and Watson, 2003) has traditionally concentrated on the curve's slope, but recent work has begun to emphasize the importance of the level, measured by a short-term interest rate such as the Federal Funds Rate. Stock and Watson (2003) find the short rate helps predict real GDP growth in 1971—1994 but not 1985-1999. Ang, Piazzessi, and Wei (2006) find that short rates forecast better than spreads, and that including the spread does not improve forecasts based on the short rate. Wright (2006), using probit models to predict recessions, shows that including the short rate improves forecasts based on the term spread.

The work comparing short rates and yield spreads relies on relatively recent experience, generally using data starting in 1964 or later. It seems natural to question whether the results depend on the economic and financial system, as well as the monetary regime. We begin to answer this by examining historical data. In addition, we take advantage of recent econometric work on forecast evaluation to assess the statistical significance of differences in predictive accuracy.

II. Data

The standard forecasts, using the Federal funds rate and the spread between 10-year Treasury bonds and three-month Treasury bills cannot simply be extended back in time: the Fed funds market developed only in the early 1920s (Turner, 1931), and T-bills were not authorized by Congress until 1929.

As in our previous paper (Bordo and Haubrich 2004) we construct a consistent quarterly series for output and interest rates by updating the Balke and Gordon (1986) numbers. For real output, we use their quarterly real GNP numbers for the years 1875-1983. Since the last years of this series are from the NIPA accounts, we continue the series until 1997Q2. For interest rates, we again go to Balke and Gordon, using the commercial paper rate as the short rate and the yield on corporate bonds as the long rate.[1] The corporate bond series is extended using numbers from Moody's (Balke and Gordon's source) and the six-month commercial paper rate from the Federal Reserve Bulletin, until 1997:Q2, when this series ends.

By building on the Balke and Gordon data we have a series at least designed to be consistent, although it means the yield spread is between risky securities of imprecisely defined maturity, not riskless Treasuries. Forecasts from a risky term structure should still be of interest, but in fact, as we document in our earlier paper, our spread measure behaves like a riskless term spread.

In part because we believe the monetary regime important for the predictive ability of the yield curve (Bordo and Haubrich 2004) and in part because other evidence suggests that predictive ability changes over time (Stock and Watson 2003, Estrella 2005), we also estimate our results over several sub-periods. We separately estimate the results for different monetary regimes: before and after the founding of the Federal Reserve System in 1914:1, before the Treasury-Fed Accord of 1951:1, between the

[1] Appendix B, Table 2.

Accord and the breakdown of Bretton Woods system in 1971:1. We also compare our results over the two periods compared by Ang, Piazzesi and Wei (2005) and Wright (2006); the Pre-Volcker period from 1964:1 when their data starts, to 1979:3, and from 1979:4, the start of Paul Volcker's Term as chairman.

III. Predictive Regressions.

Following most of the recent work on the subject we treat the spread and short rate as variables in a regression designed to predict future output. The regressions all take the general form of

(1) $(Y_{t+4} - Y_t) = \alpha + \beta\, Short_t + \gamma Spread_t + \delta(L)\Delta Y_t$.

Where ΔY_t is the growth rate of real GNP (at a quarterly frequency, so $(Y_{t+4} - Y_t)$ is the growth rate over the next year), *Short* is the short-term bond yield, *Spread* is the spread between long-term and short-term bonds, and $\delta(L)$ is a lag polynomial of length four (current and three lags).

We take two different approaches to estimating equation (1). The first method follows Stock and Watson (2003) and in fact uses a slight modification of their computer code. This first set of tests, termed "simulated out of sample" by Stock and Watson, estimates the regression with data only up to date *t,* so that the sample size grows over time. Predictive ability is measured by the mean squared error (MSE) of the forecasts with and without the term spread.

The second approach uses *rolling* regressions. This attempts to circumvent the problem that the out-of-sample regressions based on equation (1) assume constant coefficients. We compared the results for different prediction windows, but here report only the base case of 24 quarters (six years), as in all cases using the spread allows for better prediction of future real GNP growth, particularly for the shorter windows of three and six years.

Even with a few variables, many comparisons are possible. We specialize by restricting ourselves to the following questions. First, does the yield curve help predict future output, above and beyond using lagged Real GNP growth? Next, do both components of the yield curve, level and slope (short rate and term spread) contribute to the prediction? We make these comparisons by comparing Mean Square Errors: a lower MSE is taken as evidence of predictive ability. We thus compare the MSE of predictions from regressions using the short rate, the spread and and lags of RGNP growth to the MSE using only lags of RGNP growth. We then compare predictions using only the short rate to those using both the short rate and the spread, and compare predictions using only the spread to those using both.

To formally test whether one specification has superior forecast ability, we employ the Clark and West (forthcoming) test for nested hypotheses. This tests for differences in the MSE and accounts for the bias that arises because under the null hypothesis the less parsimonious model adds noise to the forecast.

Table 1 reports the ratio of Mean Square Errors and the Clark and West statistics for the recursive out-of-sample predictive regressions. For the entire sample, the yield curve shows weak predictive ability, and the Clark and West test indicates significance at the 10 percent level. Forecasts using both the commercial paper rate and the spread do not improve on those using just the spread, but adding the spread does improve upon using just the commercial paper rate. (The MSE ratios are biased upwards, and so in this case appear above 1, even though the forecast using both level and slope improves upon the forecast using lags of real GNP alone.) In general the yield curve does well in forecasting, particularly in the periods 1951—1997 and 1964—1979. Adding the short rate to the spread improves forecasts in only three periods (Pre-Fed, Post-Accord, and Pre-Volcker), but adding the spread to the short regression improves forecasts in seven.

We next look at rolling regressions, and Table 2 reports the results for the entire sample using prediction windows of 12, 24, 48, 60 and 100 quarters (from three to 25 years). In every case, using the short rate and the spread forecasts better than using GNP alone, and in no case does one aspect of the yield curve dominate: adding the other always significantly improves the forecast, though in one case only at the 10 percent level.

Examining the sub-samples with rolling regressions reinforces the forecast ability of the yield curve, and again neither aspect dominates. In the Pre-Fed (1875—1913) and Pre-Volcker periods, using level and slope improves upon using only GNP, but not upon either CP or Spread by itself. In the Post-Volcker years, adding CP is only marginally significant.

Using a longer prediction window shows generally similar results, (not reported here) although the predictive ability of the yield curve disappears in sub-samples after 1951 (though not for the entire post-Accord sample). In part this arises from the small sample size for later periods, once the 48 quarters are removed for estimation.

IV. Conclusion

Using the level and slope of the yield curve, measured by the short rate and the term spread, significantly increases the forecast ability of predictive regressions. The differences are quantitatively significant as well; in addition to noticeably lower mean square errors. For the Post-Fed rolling regression case with a window of 24 quarters, the mean absolute error using lags alone is 1.8%; using the commercial paper rate and the term spread lowers it to 1.6%.

Although it depends on the specific time period, neither the short rate nor the spread fully accounts for the forecast ability in the yield curve. In most cases using both improves upon using either. We continue to suspect that differences in forecast ability depend upon the monetary regime in place, but save that for future work.

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Start	end	CP & Spread/ GNP	CP & Spread/Spread	CP & spread/CP
1875:1	1997:2	1.005***** (1.588)	1.006 (0.807)	1.003***** (1.612)
1875:1	1913:4	0.973** (1.896)	0.970* (1.478)	0.966** (1.814)
1914:1	1997:2	0.995** (1.86)	1.047 (-0.371)	0.988*** (2.289)
1914:1	1950:4	0.996 (1.234)	1.056 (-0.771)	1.004* (1.489)
1951:1	1997:2	0.895*** (3.131)	0.953******* (2.547)	0.899******* (3.398)
1951:1	1971:2	1.073 (0.917)	1.096 (-0.209)	0.933* (1.413)
1964:1	1979:3	0.831******* (3.174)	0.945* (1.37)	1.021 (0.129)
1979:4	1997:2	1.002 (1.150)	1.011 (-0.242)	0.952****** (1.835)
		* sig at 90% level ** sig at 95% level ***sig at 99% level		

Table 1: Ratio of MSE and Clark-West tests for out of sample predictions with a starting sample of 20 quarters. Critical Values from Clark and West (forthcoming) and Clark and McCracken (2001).

Window	CP & Spread/ GNP	CP & Spread/Spread	CP & spread/CP
12	0.707*** (5.947)	0.877*** (3.942)	0.880*** (4.407)
24	0.782*** (4.560)	0.943*** (3.866)	1.000*** (3.267)
48	0.957*** (3.128)	0.986*** (2.956)	0.960*** (2.06)
60	0.995*** (3.169)	0.998*** (2.294)	0.968*** (3.016)
100	0.991*** (2.404)	0.999** (1.87)	1.003* (1.58)

Table 2: Ratio of MSE for out-of-sample predictions using rolling regressions with different window lengths.

Start	End	CP & Spread/ GNP	CP & Spread/Spread	CP & spread/CP
1875:1	1997:2	0.782*** (4.560)	0.943*** (3.866)	1.000*** (3.267)
1875:1	1913:4	0.971*** (2.054)	1.028 (1.214)	1.034 (1.021)
1914:1	1997:2	0.688*** (3.908)	0.872*** (3.543)	0.951*** (2.876)
1914:1	1950:4	0.690*** (3.433)	0.874*** (3.261)	0.951*** (2.602)
1951:1	1997:2	0.669*** (4.969)	0.890*** (3.440)	0.858*** (3.506)
1951:1	1971:2	0.763*** (4.847)	0.890*** (2.958)	0.835*** (2.947)
1964:1	1979:3	0.878*** (2.688)	0.979 (1.164)	1.015 (0.161)
1979:4	1997:2	0.942*** (2.487)	0.979* (1.360)	0.971*** (2.678)

Table 3: Ratios of MSE for rolling regression window=24 quarters.