Predicting the Direction of Interest Rate Movements

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An important factor in bond trading is determining the future direction of interest rates. If one expects interest rates to increase, the appropriate strategy would be to seek a safe haven by hedging or simply moving to cash. If interest rates are expected to fall, a trader might be inclined to purchase more speculative long-term bonds or even invest in bond futures.

We develop a simple probit model that can predict the direction of interest rate movements. Using realistic out-of-sample tests applied to data supplied by the Federal Reserve System, this model predicts the direction of interest rates one month in advance with rather more than 60% accuracy for the January 1988 -April 2001 time period. The model is equally good in predicting rises and falls in interest rates for 5-, 7-, 10-, and 30-year yields. These out-of-sample forecasts show reasonable success for all but one of eight 20-month subperiods. More moderate but still considerable success is obtained using data supplied by our own yield curve estimates.

Overall, these results are not strong enough to suggest that the model can be used as a stand-alone signal for bond trading strategies. They are interesting enough, however, to be a useful input into determining appropriate bond strategies.

This model uses information embedded in the term structure of interest rates to predict directional changes in long-term interest rates. There is a considerable literature that asserts that the term structure does indeed incorporate useful information about future economic activity. Fama [1984], Fama and Bliss [1987], Hardouvelis [1988], and Mishkin [1988] all find evidence that forward rates can predict future spot interest rates. Estrella and Hardouvelis [1991] find that increases in the slope of the term structure foreshadow improvements in real economic activity. Estrella and Mishkin [1997] report that increases in the slope of the term structure are associated with increases in inflation as long as five years ahead. Estrella and Mishkin [1998] find that declines in the slope of the term structure can indicate an increased likelihood of future recessions.

An additional important question is whether changes in the slope of the term structure and/or forward interest rates foreshadow directional changes in long-term interest rates. If a change in the slope of the term structure provides useful information concerning real economic activity and/or future inflation, then changes in the slope of the term structure may be related to changes in longer-term interest rates.

Specifically, we suggest that an increase in the slope of the term structure foreshadows an increase in longer-term interest rates as future economic activity is expected to improve and/or future inflation is expected to increase. The converse would be true for a decline in the slope of the term structure.

Similarly, if forward rates incorporate information about future spot rates of interest, then changes in the forward rate may indicate updated expectations of future interest rates. Therefore an increase in, for example, the one-month forward rate for seven-year yields would foreshadow an increase in seven-year yields in one month's time.

I. THE MODEL

We are interested only in predicting whether long-term yields are to rise or fall. This zero-one specification of the forecast naturally leads to two variations of the probit model:

$$P(Y_{t+h} = 1) = F(\text{Constant} + \text{Change in Slope}_t) \tag{1}$$

$$P(Y_{t+h} = 1) = F(\text{Constant} + \text{Change in Forward Rate}_t) \tag{2}$$

Equation (1) says that, making a forecast at date t, the probability that the long-term yield Y in h periods in the future will rise ($Y_{t+h} = 1$), or fall ($Y_{t+h} = 0$), is a function F of a constant and the change in the slope of the yield curve. Equation (2) is the same, except that the forecast direction of long-term yields is a function of the change in the forward rate rather than a change in the slope of the yield curve.[1]

We estimate Equations (1) and (2) via a maximum-likelihood probit regression rather than ordinary least squares since the dependent variable is dichotomous, taking only the value of one or zero. An important feature of these equations is that all our forecasts are out-of-sample. This means that we use only information that is available in the market at date t to make forecasts h periods ahead. Therefore the model does not permit data snooping.

We need considerably more information about the yield curve to estimate Equation (2). Equation (3) shows how the forward rates are calculated, and illustrates why we require the full yield curve to implement Equation (2):

$${}_{0.0833}f_{7.0833} = \left[\frac{(1+{}_0R_{7.0833})^{7.0833}}{(1+{}_0R_{0.0833})^{0.0833}}\right]^{1/7} - 1 \tag{3}$$

The left-hand variable in Equation (3) is the one-month forward rate for seven-year yields. According to the unbiased expectations theory of interest rates, this expression represents the seven-year yield that is expected to evolve in one month's time. This forward rate is found as the ratio of the total return of the long 7.0833-year yield and the shorter-term one-month yield. This ratio is then converted to an annual yield by finding the ratio's seventh root and then subtracting one.

The important point is that to calculate the seven-year forward rate we need spot yields at unusual maturities, 7.0833 years in this case. To obtain this information, we need to have an estimate of the full yield curve. Unfortunately the Federal Reserve data are available only at specific key maturities, so we are unable to use the forward rate version of the probit forecast model in this instance.

We chose to test the ability of Equation (1) to forecast the direction of future long-term rates of interest using the three-month stop yield and the constant-maturity yield data as published by the Federal Reserve Bank of New York. To check for robustness, we also apply the changes in the slope and changes in the forward rate specifications of the probit model to five-, seven-, and nine-year yields obtained from our own estimates of the Treasury zero-coupon yield curve. Lehman Brothers supplies the bond data used to estimate these yield curves.

Unfortunately, for reasons explained later, we can estimate these yield curves only over a shorter time horizon, from January 1988 to March 1997. All the same, by using our own estimates of the yield curve, we are able to test both specifications of the probit model.

The slope is measured as the spread between the long-term rate whose direction is being forecasted and the three-month stop yield. In the alternative specification of the probit model, we calculate the one-month forward rate for the long rate whose direction is being forecasted. The dependent variable is equal to one if the long-term yield rose for that month, or equal to zero if the long-term rates declined for that month. Along with a constant, the probit model uses either the change in the slope, or the change in the forward rate as of date t to forecast the direction of the long-term yield in h period's time.

The forecast output can be loosely interpreted as a probability measure in that the output number varies from zero to one. Zero is interpreted as no possibility of an increase in the long-term yield; one means that long-term rates would rise with certainty. Throughout the exercise, neither of these outcomes is observed. Instead, as is standard practice in implementing probit regressions, we interpret a probit probability forecast of 0.5 or greater as predicting that the long-term rate would rise, and a probit probability forecast of less than 0.5 as predicting that the long-term rate would fall.

II. RESULTS USING TREASURY DATA

We choose the constant-maturity Treasury data because we need a long time series (15-years-plus) to accurately assess the performance of the probit predictions over many subperiods, and there are few sources of quality information that go back this far in time. The three-month stop yield and the 5-, 7-, 10-, and 30-year constant-maturity yields are collected from January 1983 through April 2001.

Since the three-month stop yield series ends on June 2000, we replace this series with the three-month secondary yield for the remaining months of the sample. We prefer to do this rather than use the secondary yields throughout, as the stop yields more clearly reflect current market conditions. The results of use of the secondary three-month yields throughout are slightly worse than using the stop yield, where available.

We use the first 60 months, from January 1983 through December 1987, to make our initial estimates of Equation (1). Then, according to this information, the model forecasts whether the long-term rate would increase next month, January 1988, or in any of the subsequent three months. We then reestimate Equation (1) for the 61- month period, from January 1983 through January 1988, to predict whether long-term yields would increase in the subsequent four months from February 1988. We continue to do this, rolling forward month by month, until March 2001.

Exhibit 1 shows the overall sample success rate in predicting the direction of long-term yields for one, two, three, and four months ahead in time. Clearly, forecasts beyond one month are not of much use, as the success rates are not any different from mere chance. One-month forecasts are much more interesting, since they successfully predict the direction of the long-term yield rather more than 60% of the time.

The second and third panels in Exhibit 1 offer an explanation as to why we obtain these results. The second panel shows the in-sample pseudo-R^2 proposed by Estrella [1998]. This statistic serves the same purpose as the traditional R^2 in ordinary least squares regressions, namely, as a measure of goodness of fit, except that it is better suited to regressions where the dependent variable can take on a value of only one or zero.

We see that the pseudo-R^2 is much higher for all yield series for the one-month horizon, and much lower for longer forecast horizons. The in-sample fit of Equation (1) is much better for the one-month horizon than for the longer forecast horizons. Evidently the relative rankings of in-sample fit carry over into out-of-sample performance.

In the third panel of Exhibit 1, we report the sample correlations between changes in the slope of the term structure, calculated in the same manner as in our probit regressions, and changes in the long-term rate calculated one, two, three, and four months ahead in time. Clearly, the correlation between changes in the slope and

EXHIBIT 1
Overall Sample Results

Success Rates— Out-of-Sample	**Forecast Horizon** One Month	Two Months	Three Months	Four Months
Yield				
5-Year	64.38%	47.50%	49.38%	46.58%
7-Year	63.75%	45.63%	49.38%	47.21%
10-Year	63.13%	49.38%	48.75%	49.69%
30-Year	60.63%	52.50%	52.50%	54.66%
Pseudo-R^2-in Sample				
5-Year	9.03%	1.49%	1.88%	2.47%
7-Year	6.43%	1.35%	1.86%	2.71%
10-Year	5.77%	1.52%	1.96%	3.49%
30-Year	4.89%	1.65%	2.35%	4.69%
Sample Correlations				
5-Year	32.31%	1.74%	9.24%	11.55%
7-Year	30.17%	1.51%	10.32%	15.20%
10-Year	28.40%	0.16%	10.24%	18.51%
30-Year	26.02%	2.45%	11.61%	19.91%

EXHIBIT 2

Prediction Results for Five- and Seven-Year Yields

		Number of Times					Percent		
Time Period	**Months**	**Actual Rise**	**Successfully Predict Rise**	**Successfully Predict Fall**	**Fail Rise**	**Fail Fall**	**Correct**	**Predict Rise**	**Predict Fall**
5-Year Yields									
Overall	160	71	44	59	27	30	64.38	61.97	66.29
Jan. 88–Aug. 89	20	11	2	7	9	2	45.00	18.18	77.78
Sept. 89–Apr. 91	20	8	6	6	2	6	60.00	75.00	50.00
May 91–Dec. 92	20	8	7	7	1	5	70.00	87.50	58.33
Jan. 93–Aug. 94	20	9	7	9	2	2	80.00	77.78	81.82
Sept. 94–Apr. 96	20	9	6	9	3	2	75.00	66.67	81.82
May 96–Dec. 97	20	8	4	6	4	6	50.00	50.00	50.00
Jan. 98–Aug. 99	20	11	8	6	3	3	70.00	72.73	66.67
Sept. 99–Apr. 01	20	7	4	9	3	4	65.00	57.14	69.23

		Number of Times					Percent		
Time Period	**Months**	**Actual Rise**	**Successfully Predict Rise**	**Successfully Predict Fall**	**Fail Rise**	**Fail Fall**	**Correct**	**Predict Rise**	**Predict Fall**
7-Year Yields									
Overall	160	66	43	59	23	35	63.75	65.15	62.77
Jan. 88–Aug. 89	20	11	2	7	9	2	45.00	18.18	77.78
Sept. 89–Apr. 91	20	8	8	7	0	5	75.00	100.00	58.33
May 91–Dec. 92	20	7	7	6	0	7	65.00	100.00	46.15
Jan. 93–Aug. 94	20	8	6	9	2	3	75.00	75.00	75.00
Sept. 94–Apr. 96	20	8	5	11	3	1	80.00	62.50	91.67
May 96–Dec. 97	20	8	4	4	4	8	40.00	50.00	33.33
Jan. 98–Aug. 99	20	10	7	7	3	3	70.00	70.00	70.00
Sept. 99–Apr. 01	20	6	4	8	2	6	60.00	66.67	57.14

the one-month-ahead change in the long-term rate is much higher than for the remaining three forecast horizons. It is no surprise then that one-month forecasts perform better than the rest.

Exhibits 2 and 3 show the details of the one-month forecast. Exhibit 2 shows the results for predicting the direction of the five- and seven-year yields, and Exhibit 3 shows the results for predicting the direction of the 10- and 30-year yields. In each exhibit, we show the number of times the probit model successfully predicts, and fails to predict, the rise and fall in the candidate yield and the percentage success rate for the overall period and for eight 20-month subperiods.

Results indicate that the probit model is reasonably successful over the entire sample period, as well as in all subperiods except one. The May 1996-December 1997 subperiod includes the worst of the East Asian currency crisis, so perhaps these poor results reflect the market turmoil of this time.[2]

Additionally note that the probit model performs equally well in predicting rises and falls in long-term interest rates and that the results are consistent for all four target yields.

Another interesting question is whether the predictions of this model can be used to make money. Exhibits 4 and 5 are designed to shed light on this question. We add together the absolute value of all yield increases and declines for the entire period and similarly for all subperiods. If one were to sell bonds when yields are predicted to rise, and buy when yields are predicted to fall, we can measure the success of the model in terms of its ability to correctly pick up the changes in yield that were actually available.

Exhibits 4 and 5 show the total number of basis point changes available, along with the total number that would have been picked up by implementing the model. We also show the basis point impact of failures of the model. The key statistic is provided in the last column of each exhibit, which shows the difference between the basis points suc-

EXHIBIT 3
Prediction Results for Ten- and Thirty-Year Yields

Time Period	Months	Number of Times					Percent		
		Actual Rise	Predict Rise	Predict Fall	Fail Rise	Fail Fall	Correct	Predict Rise	Predict Fall
10-Year Yields									
Overall	160	64	41	60	23	36	63.13	64.06	62.50
Jan. 88–Aug. 89	20	10	3	8	7	2	55.00	30.00	80.00
Sept. 89–Apr. 91	20	9	7	5	2	6	60.00	77.78	45.45
May 91–Dec. 92	20	6	6	6	0	8	60.00	100.00	42.86
Jan. 93 –Aug. 94	20	8	6	9	2	3	75.00	75.00	75.00
Sept. 94–Apr. 96	20	8	5	11	3	1	80.00	62.50	91.67
May 96–Dec. 97	20	8	4	5	4	7	45.00	50.00	41.67
Jan. 98–Aug. 99	20	10	7	7	3	3	70.00	70.00	70.00
Sept. 99–Apr. 01	20	5	3	9	2	6	60.00	60.00	60.00

Time Period	Months	Number of Times					Percent		
		Actual Rise	Predict Rise	Predict Fall	Fail Rise	Fail Fall	Correct	Predict Rise	Predict Fall
30-Year Yields									
Overall	160	70	44	53	26	37	60.63	62.86	58.89
Jan. 88–Aug. 89	20	9	3	9	6	2	60.00	33.33	81.82
Sept. 89–Apr. 91	20	11	7	3	4	6	50.00	63.64	33.33
May 91–Dec. 92	20	6	6	6	0	8	60.00	100.00	42.86
Jan. 93–Aug. 94	20	10	8	8	2	2	80.00	80.00	80.00
Sept. 94–Apr. 96	20	8	5	11	3	1	80.00	62.50	91.67
May 96–Dec. 97	20	8	4	4	4	8	40.00	50.00	33.33
Jan. 98–Aug. 99	20	10	7	6	3	4	65.00	70.00	60.00
Sept. 99–Apr. 01	20	8	4	6	4	6	50.00	50.00	50.00

cessfully picked up by the model and the basis point impact of failures of the model.

The difference is always positive for the overall period by a great amount, usually over 1,000 basis points. The difference is always positive in all subperiods by substantial amounts, except once again for the May 1996 through December 1997 period. Even here, however, the ten-year yield predictions show a small gain, and the five- and thirty-year yields show modest losses. The only truly poor result is for the seven-year yield predictions, where a substantial overall loss of 55 basis points is evident for this 20-month subperiod.

III. OWN YIELD CURVE RESULTS

Our first estimates rely on constant-maturity Treasury data. While the Federal Reserve is supposed to publish this information with less than a month's lag, researchers may wish to use their own yield curves. The benefit is that one is able to apply the forward rate specification of the probit forecast model if one has an estimate of the entire yield curve. Accordingly, we check the robustness of our results by using long-term yields obtained by our own estimates of the Treasury yield curve.

The first task is to select the data. We use the University of Houston's Fixed Income database, which is compiled from data supplied by Lehman Brothers. This database consists of monthly information on most publicly traded bonds since 1973. The data include month-end prices (noted as quoted or matrix-priced), yields to maturity, time to maturity, coupons, and any embedded options.

We use a subset of the database, selecting all bond prices from January 1988 through March 1997, which is the last date in our database. We start our sample in January 1988 for two reasons. First, we want to avoid the unusual circumstances surrounding the October 1987 stock

EXHIBIT 4

Potential Basis Point Gains from Five- and Seven-Year Yields

Time Period	Months	Actual Rise	Predict Rise	Predict Fall	Total Success	Fail Rise	Fail Fall	Total Fall	Difference
5-Year Yields									
Overall	160	3503	1033	1441	2474	534	495	1029	1445
Jan. 88–Aug. 89	20	552	75	258	333	183	36	219	114
Sept. 89–Apr. 91	20	355	110	95	205	48	102	150	55
May 91–Dec. 92	20	502	148	239	387	22	93	115	272
Jan. 93–Aug. 94	20	406	187	154	341	56	9	65	276
Sept. 94–Apr. 96	20	488	185	234	419	30	39	69	350
May 96–Dec. 97	20	365	87	95	182	69	114	183	-1
Jan. 98–Aug. 99	20	423	177	180	357	38	28	66	291
Sept. 99–Apr. 01	20	412	64	186	250	88	74	162	88
7-Year Yields									
Overall	160	3303	1017	1301	2318	445	540	985	1333
Jan. 88–Aug. 89	20	497	70	239	309	143	45	188	121
Sept. 89–Apr. 91	20	355	168	112	280	0	75	75	205
May 91–Dec. 92	20	416	135	162	297	0	119	119	178
Jan. 93–Aug. 94	20	398	168	153	321	61	16	77	244
Sept. 94–Apr. 96	20	472	145	237	382	62	28	90	292
May 96–Dec. 97	20	377	83	78	161	73	143	216	-55
Jan. 98–Aug. 99	20	410	178	169	347	43	20	63	284
Sept. 99–Apr. 01	20	378	70	151	221	63	94	157	64

EXHIBIT 5

Potential Basis Point Gains from Ten- and Thirty-Year Yields

Time Period	Months	Actual Available	Predict Rise	Predict Fall	Total Success	Fail Rise	Fail Fall	Total Fall	Difference
10-Year Yields									
Overall	160	3137	957	1179	2136	419	582	1001	1135
Jan. 88–Aug. 89	20	466	81	228	309	108	49	157	152
Sept. 89–Apr. 91	20	351	134	77	211	38	102	140	71
May 91–Dec. 92	20	367	120	112	232	0	135	135	97
Jan. 93–Aug. 94	20	381	155	123	278	59	44	103	175
Sept. 94–Apr. 96	20	453	135	234	369	55	29	84	285
May 96–Dec. 97	20	374	88	105	193	64	117	181	12
Jan. 98–Aug. 99	20	361	162	157	319	25	17	42	277
Sept. 99–Apr. 01	20	384	82	143	225	70	89	159	66
30-Year Yields									
Overall	160	2703	836	929	1765	342	596	938	827
Jan. 88–Aug. 89	20	406	64	168	232	89	85	174	58
Sept. 89–Apr. 91	20	341	148	67	215	27	99	126	89
May 91–Dec. 92	20	261	92	68	160	0	101	101	59
Jan. 93–Aug. 94	20	345	145	134	279	30	36	66	213
Sept. 94–Apr. 96	20	394	111	201	312	51	31	82	230
May 96–Dec. 97	20	336	71	86	157	57	122	179	-22
Jan. 98–Aug. 99	20	290	122	115	237	27	26	53	184
Sept. 99–Apr. 01	20	330	83	90	173	61	96	157	16

market crash. Second, the farther back in time one goes, the less liquid the U.S. bond market becomes.

As the liquidity of the U.S. bond market increased gradually as the government borrowed more and more in the 1980s, it is not obvious where the start date of our study should be. If we include October 1987, we ought to include many months of prior information to dilute the potential bias that this single observation may create, which means we will be using less liquid information. Hence we choose January 1988 as the start date, avoiding both October 1987 and earlier less liquid observations.

Next, we eliminate any bonds with any special features (e.g., put and call options). These embedded features change bond prices and make prices more sensitive with respect to interest rate movements and changes in the business environment. Next, we eliminate all matrix-priced bonds from the sample, because Sarig and Warga [1989] and Warga [1991] show that the use of matrix-priced information may lead to serious errors. We double-check the remaining sample by eliminating all bonds that are not included in one of the database's indexes. We would assume that bond traders will be more careful in pricing bonds that are included in an index.[3]

Now we estimate zero-coupon yield curves. There are two mainstream approaches to estimating the term structure of spot rates. The first is a parsimonious representation defined by an exponential decay term. This approach is developed by Nelson and Siegel [1987] and extended by Svenson [1995]. The second approach (which the Fed uses) is a spline representation that can be classified into parametric and non-parametric techniques. McCulloch [1971] introduces the parametric cubic spline, and Fisher, Nychka, and Zervos [1995] and Waggoner [1997] develop the non-parametric splines.[4]

We opt to use parsimonious approaches since Jordan and Mansi [2000] suggest that the parsimonious approach may result in more accurate yield curves than spline methods. We mainly use Nelson and Siegel [1987] because of its simplicity and proven success. This approach has become increasingly popular in empirical studies. Elton et al. [2001] find that the Nelson and Siegel [1987] results are almost identical to those obtained using McCulloch [1975].

The marked advantage of using Nelson and Siegel [1987] is that it imposes a functional form on the term structure, resulting in a more stable forward (and spot) curve, and it requires fewer data points than spline methods. For some months, however, the Nelson and Siegel [1987] method proved too inflexible and was unable to converge. In these few instances, we use Svenson [1995], which is in essence an extension of Nelson and Siegel [1987] that allows for more flexibility in the yield curve shapes.

All the parameters for the Nelson and Siegel [1987] and Svenson [1995] models are estimated using maximum likelihood, applying the Broyden, Fletcher, Goldfarb and Shanno (FGS) algorithm to maximize the log-likelihood function. We estimate spot rate curves for Treasury bonds for every month over the period January 1988-March 1997. We estimate the yield curves up to ten years' maturity because we find like Elton and Green [1998] that beyond ten years the lack of on-the-run Treasuries creates a liquidity problem. In all, 111 maximizations are performed to estimate all the term structures.

We extract the five-, seven-, and nine-year yields from these zero-coupon yield curves, and use them along with the three-month stop yield to calculate the changes in the slope of the yield curve. We then run our probit regression [Equation (1)] on the first 60 months, from February 1988 through January 1993, and use this information to predict the probit probability of a long-term interest rate rise in February 1993. We continue to make out-of-sample forecasts of directional changes in long-term interest rates by rolling forward month-by-month in the same manner. Similarly, we calculate the one-month forward rates for five-, seven-, and nine-year yields using information extracted from our yield curve estimates, and then apply the forward rate specification of the probit model [Equation (2)] to these data as before.

Exhibit 6 reports the results of this exercise using a one-month forecast horizon.[6] Note that the sample period is much shorter, only 50 months, so we do not break the results into subperiods. The first half of Exhibit 6 reports the results using the change in the slope of the yield curve as the predictor variable, and the second half shows the results using the forward rate as the predictor variable in the probit model.

Using the change in the slope of the term structure as the predictor variable, the probit model has only modest success. When measured by the number of instances that the probit model successfully predicts long-term interest rate rises and falls, only the nine-year and seven-year yield predictions show any degree of success. The five-year yield results are discouraging, since a success rate of 50% is what we would expect by mere chance.

One could argue that a more interesting measure of success is the ability of the probit model to pick up the basis point changes in long-term yield. Measured by this criterion, the probit model's results when using the slope of the term structure as the predictor variable are much more encouraging.

EXHIBIT 6

Prediction Results Using Own Estimated Yield Curves

Change in Slope Specification February 1993 to March 1997	Number of Months	Number of Times: Actual Rise	Predict Rise	Predict Fall	Fail Rise	Fail Fall	Percent: Correct	Predict Rise	Predict Fall
5-Year Yields	50	28	14	11	14	11	50.00%	50.00%	50.00%
7-Year Yields	50	27	15	12	12	11	54.00%	55.56%	52.17%
9-Year Yields	50	25	12	15	13	10	54.00%	48.00%	60.00%

February 1993 to March 1997	Percent Correct	Number of Basis Points: Actual Available	Predict Rise	Predict Fall	Total Success	Fail Rise	Fail Fall	Total Fail	Difference
5-Year Yields	55.47%	1162	359	286	645	274	243	517	127
7-Year Yields	58.88%	1103	352	297	649	230	224	454	196
9-Year Yields	58.49%	1059	301	319	619	244	195	440	180

Forward Rate Specification February 1993 to March 1997	Number of Months	Number of Times: Actual Rise	Predict Rise	Predict Fall	Fail Rise	Fail Fall	Percent: Correct	Predict Rise	Percent Fall
5-Year Yields	50	28	16	11	12	11	54.00%	57.14%	50.00%
7-Year Yields	50	27	17	12	10	11	58.00%	62.96%	52.17%
9-Year Yields	50	25	16	17	9	8	66.00%	64.00%	68.00%

February 1993 to March 1997	Percent Correct	Number of Basis Points: Actual Available	Predict Rise	Predict Fall	Total Success	Fail Rise	Fail Fall	Total Fail	Difference
5-Year Yields	61.56%	1162	414	302	715	220	227	447	269
7-Year Yields	66.29%	1103	432	299	731	150	222	372	359
9-Year Yields	74.02%	1059	407	377	784	138	137	275	509

The second panel of Exhibit 6 reports that the probit model picks up at least 100 basis points for all long-term yields. Furthermore, this is always well more than 50% of the basis point changes that occurred during this time, and the model was equally successful in predicting basis point rises and falls in long-term yields.

The second panel of Exhibit 6 (using the change in the forward rate as the predictor variable) indicates that the probit model has considerable success in predicting one-month-ahead directional changes in long-term yields. First, measuring success as the number of times the probit model successfully predicts long-term interest rate rises and falls, the forward rate version of the model is able to forecast directional changes in five-, seven-, and nine- year yields at rates well above 50%. Furthermore, it is equally successful in forecasting rises and falls in long-term rates.

The strongest results are that the forward rate version of the model is able to pick up at least 250 basis points for all long-term yields, or more than 60% of all basis point changes in yield for the overall period.

IV. SUMMARY AND CONCLUSIONS

We develop two variations of a probit model to predict the direction of long-term yields. We estimate this model via probit regressions, and conduct out-of-sample tests on two data sets. The first variation of the probit model uses the change in the slope of the yield curve as the predictor variable, and we conduct out-of-sample tests on this version using the Fed's constant-maturity yield estimates. The second variation uses changes in the forward rate as the predictor variable, and we conduct out- of-sample tests on both versions of the model using our own yield curve estimates.

For the constant-maturity Treasury estimates, the model performs well in the 160-month period from January 1983 through April 2001, correctly predicting the direction of 5-, 7-, 10-, and 30-year yields more than 60% of the time. The model performs well in seven of eight 20-month subperiods and is equally successful in predicting rises and falls in yield. This model can potentially capture extra value for bond portfolios.

We confirm the robustness of the model using inputs obtained by our own estimates of the Treasury yield curve. In this case, we show that both variations of the probit model can pick up more than 55% of all basis point changes in yield that actually occurred during the 50-month period February 1993-March 1997. While these results are not strong enough to serve as a summary statistic for bond trading, they indicate that this probit model may provide useful information for bond investors and analysts.

ENDNOTES

[1]It does not make sense to combine the two prediction variables into one probit model because the change in the slope and the change in the forward rate are highly correlated.

[2]The East Asian currency crisis started in July 1997 and continued well into 1998.

[3]We thank Arthur Warga for providing this advice.

[4]For a complete overview of the different methods, see Green and Odegard [1997].

[5]As in the Fed data forecasts, our own yield curve estimates produce poor two-, three-, and four-month forecasts, so for the sake of brevity we omit these results.

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