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WHICH YIELD CURVE SPREAD IS THE BEST FOR PREDICTING THE RECESSIONS IN THE U.S ECONOMY? A WAVELET APPROACH

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ABD'de Resesyonu Tahmin Etmek İçin Hangi Verim Eğrisi Yayılımı En İyisidir? Bir Dalgacık Yaklaşımı

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ABSTRACT

Using out-of sample methods, we compare the performance of the wavelet-based probit model and standard probit model in forecasting recession in the U.S. Additionally, the performance of different financial indices, such as term spreads, credit spreads, interest rates, was evaluated in both the wavelet-based probit model and the standard probit model. The out-of-sample exercises are employed respectively for three, six, twelve and twenty-four-months ahead forecasts. We use four different wavelet filtering methods including Haar, Symlet, Coiflet and Daubechies to obtain low frequency fluctuations of observed series. According to numerical results, forecasting performance of the wavelet-based model outperforms standard probit model for three, six and twelve month-ahead forecasting. Moreover, the yield curve spread between between 3-Year Treasury Constant Maturity Rate - 1-Year Treasury Constant Maturity Rate and the yield curve spread between between 3-Year Treasury Constant Maturity Rate – Federal Funds Rate among indexes have better results in forecasting a recession in the U.S.

ÖZET

Örnek dışı yöntemleri kullanarak, dalgacık tabanlı probit modelinin ve standart probit modelinin ABD'deki ekonomik durgunluk tahminindeki performansını karşılaştırırız. Ayrıca, dalgacık tabanlı probit modelinde ve standart probit modelinde vadeli spreadler, kredi spreadleri, faiz oranları gibi farklı finansal endekslerin tahmin performansı ölçülmektedir. Örneklem dışı çalışmalar sırasıyla üç, altı, on iki ve yirmi dört aylık tahminlerde uygulanmaktadır. Gözlenen serilerin düşük frekanslı dalgalanmalarını elde etmek için, haar, symlet, coiflet ve daubechies olmak üzere dört farklı dalgacık filtreleme yöntemi kullanırız. Sayısal sonuçlara göre, dalgacık tabanlı modelin tahmin performansı, üç, altı ve on iki ay öncesinden tahmin için standart probit modelinden daha iyi performans göstermektedir. Ayrıca, GS3MFFM ve GS3MGS1'in verim eğrisi dağılımları arasında ABD'de durgunluk tahmininde daha iyi sonuçlar olduğu görülmüştür.

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INTRODUCTION

According to some economists such that Stijn Claessens and M. Ayhan Kose (2009), a recession starts when the economy begins to shrink and stop growing while others such that Business Cycle Dating Committee of the NBER think that it starts when the gross domestic product declines for two consecutive quarters. Additionally, according to the Business Cycle Dating Committee of the NBER, a recession causes economics activities to fall and lasts for several months. With the beginning of the recession, many variables such as unemployment, industrial production, and retail sales, gross domestic product are negatively affected. On the other hand, it is difficult to predict the end of the recession and the effect of it on the economy. For these reasons, forecasting future economic activities in the U.S are crucial for not only policy-makers but also private economic agents, for instance, investors around the globe. Therefore, we will focus on the recession forecasting and contribute to the literature of forecasting methods for economic recession.

In this context, a considerable amount of research tried to find out which financial variable is the best for predicting the U.S. business cycle regime. Most studies found that the difference of term spread between the yields on long-term and short-term Treasury securities is a powerful instrument and includes useful information to predict future recession and economic activity in the U.S.

Interestingly, the yield curve spread did not attract researchers ' attention in predicting U.S. economic activity until the study of Stock and Watson (1989). The essential breakthrough with the use of yield curve spread to predict economic activities in the U.S. began with this study. Stock and Watson (1989) tried to predict future economic recessions using seven variables out of various financial indexes, including the yield curve spread between the 10-year Treasury bond spread and 1-year Treasury bill yield.

With the approach in the previous paragraph, the yield curve spread has become more prominent to predict future economic activities. One of the first remarkable study considering the yield curve spread after Stock and Watson (1989) was from Estrella and Hardouvelies (1991). They examined the lagged output growth, lagged inflation, the index of leading indicators, the real short-term interest rates and the yield curve spread using quarterly data from 1955 to 1988 to predict future rate of growth in real GDP. Their results suggested that the yield curve spread has more predictive power than the other indexes they compared and includes useful information to predict economic activities and a positive of the slope yield curve indicates that real economic activity will increase, along with consumption, consumer durable, and investment.

Shortly after the work of Estrella and Hardouvelies (1991), the yield curve spread again proved to be superior in predicting economic activities. Hu (1993) found that there is a positive relationship between the yield curve spread and future economic growth. Having the yield curve spread a promising performance in predicting future economic activities led to the question of whether the yield curve spread could predict a future recession. Estrella and Mishkin (1996) tried to find the answer to the question: Is there a relationship between the recession and the yield curve spread? To answer this question, they used quarterly data from the first quarter of 1960 to the first quarter of 1995 and included the yield curve spread with New York Stock Exchange (NYSE) price index, the leading index of Commerce Department, and lagged growth in real GDP to compare their prediction performance. They assessed the relationship between the recession and the yield curve spread using a probit model. Their study reported that the yield spread measured by the difference between the 10-year Treasury bond and 3-month Treasury bill has a better performance than other financial indicators in predicting recession two to six quarters ahead.

A few years later, Estrella and Mishkin (1998) compared out-of-sample results of different financial indexes such as interest rates, spreads, stock price indexes, monetary aggregates, a leading indicator in predicting future U.S. recessions. They evaluated various financial indexes not only by individually but also by using reasonable combinations with each other in the standard probit model. They examined the results in three different context. First, the in-sample results are not consistent with out-of-sample results. Although the six-month commercial paper-Treasury bill spread works very well in-sample exercise for one and two quarters ahead, it has no predictive power on out-of-sample exercises for all horizon. The second context is the determining ideal out-of-sample horizon for each financial index. For example, the yield curve spread has remarkable forecast performance for all range of horizon. Although some indexes such as stock prices, the Commerce and Stock-Watson leading indicators outperform the yield curve spread in predicting one quarter ahead prediction, the yield curve spread tends to dominate other variable beyond one-quarter ahead predictions. The third and the last principle is that the yield curve spread has better performance using individually rather than a combination with other variables.

Moreover, some researchers used different functional forms rather than using a standard probit model to improve forecast accuracy. For instance, Katayama (2010) improved forecast performance by using non-gaussian cumulative distribution function and again proved that the yield curve spread between 10-year Treasury yield and the Federal Funds rate has better results than other indexes in performing out-of-sample forecasting exercise. As a result, considering all these studies, the yield curve spreads are effective tools to predict future recessions in U.S.

However, despite all these findings in the literature, two questions have emerged to improve forecast performance. The first question is about the selection of the yield curve spread from more than one candidate. For example, while Estrella and Mishkin (1991) considered the yield curve spread as the difference between the 10-year Treasury bond and 3-month Treasury bill in their study, Stock and Watson (1989) used the yield curve spread of the 10-year Treasury bond spread and 1-year Treasury bill yield.

Moreover, the other one is about removing time trend and noise. Considering low frequencies of the yield curve spread may be more efficient than directly using the original series, which contains high-frequency fluctuations because irrelevant information in time series may deteriorate forecast accuracy. However, limited research tried to solve this question. Azevedo (2013) used low-frequency filters in his research and found that targeting low-frequency fluctuations on series rather than the original series is useful for macroeconomic forecasting. For these reasons, we will use the maximal overlap discrete wavelet transform (MODWT) to improve the forecast accuracy by eliminating high-frequency fluctuations from the original series.

First, we obtained yield curve spreads and credit spreads using different interest rates, treasury bills, government bonds, and corporate bonds yields. Then, we compared the performance of filtered series with the original series and measured the usefulness of different yield curve spreads in the forecasting exercise. The numerical results show that our model that used MODWT to eliminate the high-frequency fluctuations outperforms the model using the original series in terms of the quadratic probability score. Although decomposing the yield curve spread into low-frequency fluctuations improved the forecasting performance for three to twelve months ahead exercise, it did not cause any improvement on the performance of forecasting twenty-four month ahead recession probability in the U.S. economy. In addition, the results of the model selection concluded that our proposed model with the yield curve spread as the single explanatory variable is the best model.

The rest of the thesis organized as follows. Section 1 introduces wavelet transform, the probit model and the data set. Section 2 presents forecast methodology, the quadratic probability score, and out-of-sample results and performance. Finally, section 5 concludes.

1. METHODOLOGY

1.1. Wavelet Transform

Analyzing time series in both time and frequency domain with wavelet transform is a common and proper statistical tool among Economists. Wavelet transform works in both time and the frequency domain and can easily extract the nonstationary features of variables over a wide extent of frequencies (Fan and Gencay, 2010). For this reason, information about both the time and frequency domains present in a signal can be identified easily with wavelet transform. Therefore, this makes a wavelet-based analysis of yield curve spread to be an appropriate tool for predicting U.S. recessions in this study. In the next section, the mathematical details of wavelet transform and different types of wavelet transforms are presented.

1.1.1. What is wavelet?

A wavelet is a wave like a function that is fluctuating in a finite time period. A real-valued wavelet function, $\psi(t)$, defined on the real axis $(-\infty, \infty)$ satisfies following two conditions:

$$\int_{-\infty}^{\infty} \psi(t)\, dt = 0 \ \ and \ \int_{-\infty}^{\infty} \psi(t)^2 dt = 1.$$

Although $\psi(.)$ has to make some excursions away from zero, any excursions it makes above zero must be cancel out by the excursions below zero (Gencay, Selçuk and Whitcher,2001). A time series $x(t)$ can be transformed by the continuous time wavelet transform (CWT) as follows:

$$W(u, s) = \int_{-\infty}^{\infty} x(t)\psi_{u,s}(t)dt,$$

where u is the location, s is the scale parameter and $W(u, s)$ is called as a wavelet coefficient. The wavelets are generated from $\psi_{u,s}(t) = \frac{1}{\sqrt{s}}\psi(\frac{t-u}{s})$ that is translated by u and dilated by s. It can be used to work with different frequencies by using scale parameter. However, analyzing all wavelet coefficients for different scales with continuous wavelet transform are impossible (Eroglu, 2019). In addition, the continuous wavelet transform has important problems such that complexity in computation and redundancy of decomposition with finite number of scales. To overcome these problems, the discrete wavelet transform that decomposes the signal into mutually orthogonal set of wavelets, unlike CWT, is introduced.

1.1.2. Discrete Wavelet Transform (DWT)

Let $\{h_l\}_{l=0}^{L-1}$ denote a discrete wavelet filter, where L is the finite number of non-zero elements (length). Similar as in case of the CWT, three conditions that the DWT wavelet filter have to be satisfied are as follows:

$$1. \sum_{L=0}^{L-1} h_l = 0, \qquad 2. \sum_{L=0}^{L-1} h_l^2 = 1, \;\; 3. \sum_{l=0}^{L-1} h_l h_{l+2n} = 0 .$$

Where n is a positive integer. The first two conditions are discrete equivalents to their continuous counterparts. The third one is new, and together with the second one, it says that the transformation has to be orthonormal. Besides those three conditions an additional one has to be imposed on time series itself – it has to have length N $=2^J$, where J Є N. Hence only time series with length equal to the power of two can be analyzed using the DWT. Let $x = (x_0, \ldots, x_{N-1})^T$ be a $Nx1$ vector which represents a dyadic time series. Then DWT transformation can be written in the following form:

$$\mathbf{W} = \mathcal{W}\mathrm{X}.$$

Where $\mathcal{W}$ *is* NxN wavelet transformation matrix, which elements are the filters and zeros $\mathcal{W}$ denotes $Nx1$ vector of wavelet coefficients.

$$X = \mathcal{W}^T\mathbf{W}.$$

which means that time series can be reconstructed using wavelet coefficients. The second result of transformation's orthonormality is:

$$\|X\|^2 = X^T X = \mathbf{W}^T \mathrm{W} = \|\mathbf{W}\|^2,$$

Where $\|X\|$ *and* $\|\mathbf{W}\|$ stand for the norm of X and **W**, respectively. It means that the total energy of time the series is equal to the total energy of wavelet coefficients. This result is important for further work with wavelthe et spectrum of the process. Let us assume that the length of X is equal to 2^J. Then we decompose **W** and $\mathcal{W}$ in the following way:

$$\mathbf{W} = [\mathbf{W}_1, \mathbf{W}_2, \cdots \mathbf{W}_J, \mathbf{V}_J] = [\mathcal{W}_1, \mathcal{W}_2, \ldots, \mathcal{W}_J, \mathcal{V}_J]X.$$

Where $\mathbf{W}_J$ is the vector of j-th level wavelet coefficients and $\mathbf{V}_J$ is the vector of j-th level scaling coefficients. Furthermore, length of wavelet coefficients $T/_{2^{j-1}}$ for each $j = 1,2, \ldots, J$ and length of scaling coefficients is $T/_{2^J}$.

1.1.3. Pyramid algorithm

Mallat (1989) proposed the pyramid algorithm for computation of the DWT in practice. In the first stage, there is a decomposition of the original time series X into two vectors. The first one is $\frac{N}{2}$ $x1$ vector of wavelet coefficients $\mathbf{W}_1$ which satisfies $\mathbf{W}_1 = \mathcal{W}_1\mathrm{X}$. The matrix $\mathcal{W}_1$ *is* $\frac{N}{2}$ xN

matrix of wavelet transformation, which consists of wavelet filters h_l and zero elements. In each next row the filters, are circularly shifted. The second obtained vector is $\frac{N}{2}\ x1$ vector of scaling coefficients $\mathbf{V}_1$ satisfying $\mathbf{V}_1 = \mathcal{V}_1 X$. The next stage of the algorithm is similar to the first one. We make another decomposition, but not with original time series, but with V_1. Again, we will obtain two new series – a $\frac{N}{4}\ x1$ vector of wavelet coefficients W_2 and a $\frac{N}{4}\ x1$ vector of scaling coefficients V_2. We will follow this approach in all stages of the algorithm and then we will obtain $Nx1$ vector of wavelet coefficients W_1 from the equation $W = \mathcal{W}X$.

Empirical literature using wavelets usually prefers non-matrix notation then (following Gencay et al. 2002) we can write the first stage of the DWT as

$$w_{1,t} = \sum_{l=0}^{L-1} h_l X_{2t-l} mod N \quad for\ t = 0,1,2,\ldots,\frac{N}{2}-1,$$

$$v_{1,t} = \sum_{l=0}^{L-1} g_l X_{2t-l} mod N \quad for\ t = 0,1,2,\ldots,\frac{N}{2}-1,$$

where mod denotes modulo operator. The equations above are the circular convolution of wavelet filter h (respectively g) and time series X. While applying the same logic as before we write the other steps of the transformation as:

$$w_{j,t} = \sum_{l=0}^{L-1} h_l v_{1,2t-l} mod \frac{N}{2} \quad for\ t = 0,1,2,\ldots,\frac{N}{4}-1\ and\ j > 1,$$

$$v_{j,t} = \sum_{l=0}^{L-1} g_l v_{1,2t-l} mod \frac{N}{2} \quad for\ t = 0,1,2,\ldots,\frac{N}{4}-1\ and\ j > 1.$$

All other steps are executed similarly. Previous equations imply that the DWT is a cascade filter. In this study, we used Haar, Daubechies, Symlet and Coiflet wavelet filters. Now we describe these discrete wavelet filters.

1.1.4. Haar Wavelet

The oldest known filter in the wavelet family is haar wavelet (Gencay et al. 2002). Its corresponding wavelet function is represented by this equation:

$$\psi_t = \begin{cases} 1\ if\ t \in \left[0, \frac{1}{2}\right) \\ -1\ if\ t \in \left[\frac{1}{2}, 1\right) \\ 0\ \ otherwise. \end{cases}$$

Its corresponding scaling function has got the following form:

$$\phi_t = \begin{cases} 1 \; if \; t \, \epsilon [0,1) \\ 0 \; otherwise. \end{cases}$$

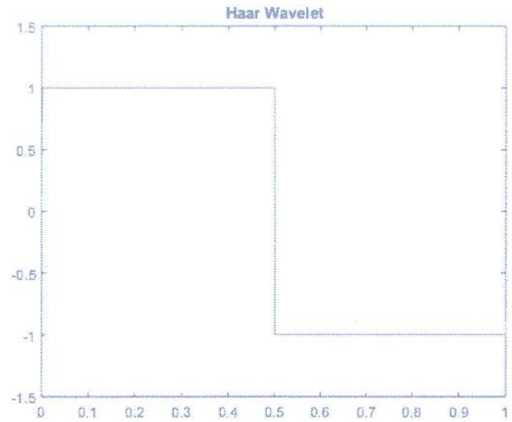

Figure 1: Haar Wavelet

1.1.5. Daubechies wavelet

Daubechies (1988) proposed this type of discrete wavelet transformation. It was derived from compact support criterion with maximum vanishing moments. According to Gencay et al. (2002) the most obvious formal definition of Daubechies wavelet is through its square gain function:

$$\mathcal{H}(f) = 2\sin^L(\pi f) \sum_{l=0}^{\frac{L}{2}-1} \binom{L/_2 - 1 + l}{l} \cos^{-2l}(\pi f).$$

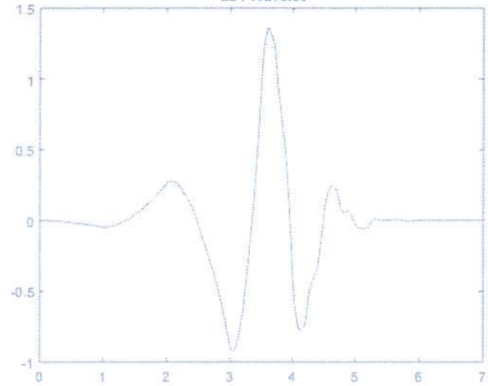

Figure 2: Db4 Wavelet

There are two types of Daubechies wavelets. The first one is extremal phase Daubechies wavelet. The second one is the least asymmetric Daubechies wavelet that is also known as symlet wavelet.

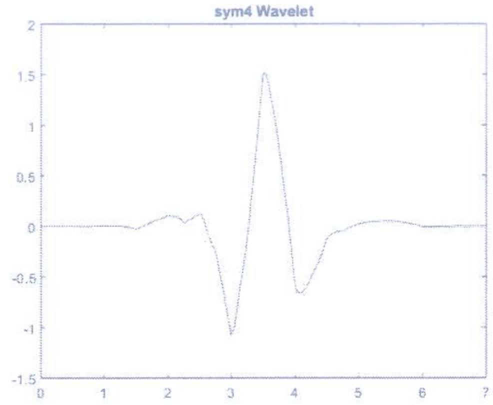

Figure 3: Sym4 Wavelet

1.1.6. Coiflet wavelet

Another type of discrete wavelet is coiflet wavelet designed by Daubechies. The coiflet wavelet near symmetric. Its wavelet function has $\frac{J}{3}$ vanishing moments and scaling function $\frac{J}{3}$-1.

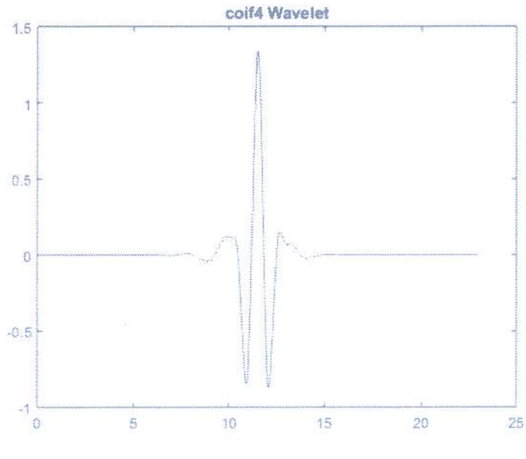

Figure 4: Coif4 Wavelet

1.1.7. The Maximal Overlap Discrete Wavelet Transformation

To model the relationship between the financial index and the probability of a future recession, the sample size of these variables has to be the same in the estimation period. However, we cannot use DWT in our analysis since it has two main problems. The first one is the dyadic length requirement that refers sample size divisible by2^J. The second one is that the wavelet and scaling coefficients in DWT are not invariant to circularly shifting the original series because of the decimation operation. For these reasons, DWT is not appropriate to filter our sample data. In contrast to the DWT, There is no decimation operation in the MODWT that is also called non-decimated DWT. Therefore, the number of scaling and wavelet coefficients at every level of the transform is the same as the number of sample observations. Although it loses orthogonality and efficiency in computation, this transform does not have any restriction on the sample size and it is shift invariant (Percival et al (2000)). In our research, we compare the performance of the filters such as Haar, Daubechies, Symlets and Coiflets wavelets to find the best among them. The mathematical details of MODWT are as in the following section.

1.1.8. MODWT

According to Gencay et al. (2002), coefficients, filters, and matrices of the MODWT are denoted by "$\widetilde{tilde}$". Hence, the central MODWT equation is rewritten in the following form

$$\widetilde{\mathrm{W}} = \widetilde{\mathcal{W}}X.$$

Where $\widetilde{\mathrm{W}}$ corresponds for vector of $(J+1)N \times 1$ and $\widetilde{\mathcal{W}}$ corresponds for matrix of $(J+1)N \times N$.

Similarly, as in the DWT:

$$\widetilde{\mathcal{W}} = [\widetilde{\mathcal{W}}_1, \widetilde{\mathcal{W}}_2, \dots, \widetilde{\mathcal{W}}_J, \widetilde{\mathcal{V}}_J].$$

Again, first J elements of $\widetilde{\mathrm{W}}$ are the matrices of wavelet filters; the last one is a matrix of scaling filters. All of them are $N \times N$ matrices (Gencay et al. 2002). The MODWT filters are a rescaled variant of the DWT filters mentioned in the previous section (Percival & Walden 2000):

$$\tilde{h}_{j,l} = \frac{h_{j,l}}{2^{j/2}},$$

$$\tilde{g}_{j,l} = \frac{g_{j,l}}{2^{j/2}},$$

where $h_{j,l}$ *and* $g_{j,l}$ are filters belonging to particula ar scale.

Similarly, as in the DWT, the pyramid algorithm will be used for computation of coefficients. First, let us define the variable

$$L_j = (2^j - 1)(L - 1) + 1\,.$$

Denoting the length of a filter on a particular scale. The first step is (Percival & Walden 2000):

$$\widetilde{w}_{1,t} = \sum_{l=0}^{L-1} \tilde{h}_{1,l} X_{2t-l} modN \;\; for\; t = 0,1,2, \dots, N-1,$$

$$\tilde{v}_{1,t} = \sum_{l=0}^{L-1} \widetilde{g_{1,l}} X_{2t-l} modN \;\; for\; t = 0,1,2, \dots, N-1.$$

Then the other steps can be written as

$$\widetilde{w}_{j,t} = \sum_{l=0}^{L-1} \tilde{h}_{2,l} v_{1,2t-l} modN \;\; for\; t = 0,1,2, \dots, N-1 \; and\; j > 1,$$

$$\tilde{v}_{j,t} = \sum_{l=0}^{L-1} \widetilde{g_{2,l}} v_{1,2t-l} modN \;\; for\; t = 0,1,2, \dots, N-1 \; and\; j > 1.$$

Similarly, all other steps are executed.

1.2. The Probit Model

After decomposing time series with MODWT to extract high-frequency fluctuations, the standard probit model is applied to evaluate the predictive power of yield curve spreads examined concerning future recessions (Estrella and Mishkin, 1998). Using probit model, a variable that predicted can only take two binary values that equal one if the economy is in recession else equals 0. Theoretically, the model that forecasts the probability of h-period ahead recession with available information at time t is defined as follows:

Let y_t^* is an unobservable recession indicator and represents the state of the economy. There is a relation between the y_t^* and x_t according to the following linear model:

$$y_{t+h}^* = \beta' x_t + \varepsilon_t.$$

We assume that y_t is an observable binary variable that 1 if the economy is in a recession or 0 if not:

$$y_t = \begin{cases} 1 \; if \; y_t^* > 0 \\ 0 \; if \; y_t^* < 0 \end{cases}.$$

Where h is forecast horizon, $\beta' = [\beta_0, \beta_1]$ is a vector of coefficients corresponding to vecthe tor of $x_t = [1, x_t]'$ predictors, including constant , ε_t is a normally distributed error term, $\varepsilon_t \sim N(0,1)$, and distributed independently .

The model is estimated with this equation:

$$Prob(y_{t+h} = 1 | x_t, \beta) = \Phi(\beta' x_t).$$

where $\Phi(.)$ is the cumulative standard normal density function corresponding ε_t , y_{t+h} is a dependent observable recession variable which determines the occurrence of a recession at time $t + h$ and using maximum likelihood, a forecasting model is estimated with the following likelihood function:

$$L(\beta) = \prod_{t=1}^{T} [\Phi(\beta' x_t)]^{y_{t+h}} [1 - \Phi(\beta' x_t)]^{1-y_{t+h}}.$$

Alternatively, the log-likelihood function is given as follows:

$$logL(\beta) = \sum_{t=1}^{T} y_{t+h} \, log \, \Phi(\beta' x_t) + \sum_{t=1}^{T} (1 - y_{t+h}) log \, (1 - \Phi(\beta' x_t)).$$

Since Φ (.) is monotonically increasing and between 0 and 1, commonly the following standard normal CDF (a probit model) function is used

$$\Phi(x) = \int_{-\infty}^{x} \frac{1}{\sqrt{2\pi}} exp\left\{-\frac{1}{2}t^2\right\} dt.$$

To empirically analyze the forecast model, the "h" parameter is set as 3, 6, 12, 24 for three, six, twelve and twenty-four-month-ahead predictions, respectively.

1.3. Yield Curve Spreads and Data

The main focus of our study is to find the best indices as a useful predictor of future recessions among more than one spread. Therefore we examine various term spreads and credit spreads that are produced using interest rates. We use monthly data ranging from January 1960 to March 2017. Table 2 shows the names, informational lags, and descriptions for all variables studied in this thesis. The sample period between January 1960 and March 2017 is selected to maximize data availability in the Federal Reserve of St. Louis and to cover as many as possible recession dates. Table 1 illustrates the National Bureau of Economic recession dates and announcement dates are used to determine the values of y, the recession dummy that equals 1 (recession) or 0 (otherwise).

However, as shown in Table 1, some variable is not declared immediately, and we need to think the information lag, in order to accurately evaluate forecasting models. For example, Federal Funds Rate (FEDFUNDS) has one month of the information lag. So, FEDFUNDS 2000:01 refers to the Federal Funds Rate data on December 1999.

Turning Point Date	Peak or Trough	Announcement Date with Link
9-Jun-19	Trough	20-Sep-10
7-Dec-19	Peak	1-Dec-08
1-Nov-19	Trough	17-Jul-03
1-Mar-19	Peak	26-Nov-01
1-Mar-91	Trough	22-Dec-92
1-Jul-90	Peak	25-Apr-91
1-Nov-82	Trough	8-Jul-83
1-Jul-81	Peak	6-Jan-82
1-Jul-80	Trough	8-Jul-81

Table 1: NBER recession

Series	Description	Lag
Interest Rates		
FEDFUNDS	Effective Federal Funds Rate	1
INTGSTUSM193N	Interest Rates, Government Securities, Treasury Bills for United States	1
AAA	Moody's Seasoned Aaa Corporate Bond Yield	1
BAA	Moody's Seasoned Baa Corporate Bond Yield	1
GS1	1-Year Treasury Constant Maturity Rate	1
GS3	3-Year Treasury Constant Maturity Rate	1
GS5	5-Year Treasury Constant Maturity Rate	1
GS10	10-Year Treasury Constant Maturity Rate	1
TB3MS	3-Month Treasury Bill	1
TB6MS	6-Month Treasury Bill	1
Term Spreads		
TB3MSMFFM	3-Month Treasury Bill - Federal Funds Rate	1
TB6MSMFFM	6-Month Treasury Bill - Federal Funds Rate	1
GS10MFFM	10-Year Treasury Constant Maturity Rate - Federal Funds Rate	1
GS5MFFM	5-Year Treasury Constant Maturity Rate - Federal Funds Rate	1
GS3MFFM	3-Year Treasury Constant Maturity Rate - Federal Funds Rate	1
GS1MFFM	1-Year Treasury Constant Maturity Rate - Federal Funds Rate	1
GS10MGS1	10-Year Treasury Constant Maturity Rate - 1-Year Treasury Constant Maturity Rate	1
GS10MGS3	10-Year Treasury Constant Maturity Rate - 3-Year Treasury Constant Maturity Rate	1
GS10MGS5	10-Year Treasury Constant Maturity Rate - 5-Year Treasury Constant Maturity Rate	1
GS10MTB3MS	5-Year Treasury Constant Maturity Rate - 3-Month Treasury Bill	1
GS10MTB6MS	5-Year Treasury Constant Maturity Rate - 6-Month Treasury Bill	1
GS5MGS1	5-Year Treasury Constant Maturity Rate - 1-Year Treasury Constant Maturity Rate	1
GS5MGS3	5-Year Treasury Constant Maturity Rate - 3-Year Treasury Constant Maturity Rate	1
GS5MTB3MS	5-Year Treasury Constant Maturity Rate - 3-Month Treasury Bill	1
GS5MTB6MS	5-Year Treasury Constant Maturity Rate - 6-Month Treasury Bill	1
GS3MGS1	3-Year Treasury Constant Maturity Rate - 1-Year Treasury Constant Maturity Rate	1
GS3MTB3MS	3-Year Treasury Constant Maturity Rate - 3-Month Treasury Bill	1
GS3MTB6MS	3-Year Treasury Constant Maturity Rate - 6-Month Treasury Bill	1
GS1MTB3MS	1-Year Treasury Constant Maturity Rate - 3-Month Treasury Bill	1
GS1MTB6MS	1-Year Treasury Constant Maturity Rate - 6-Month Treasury Bill	1
TB6MSMTB3MS	6-Month Treasury Bill - 3-Month Treasury Bill	1
Credit Spreads		
AAAMFFM	Moody's Seasoned Aaa Corporate Bond Yield - Federal Funds Rate	1
BAAMFFM	Moody's Seasoned Baa Corporate Bond Yield - Federal Funds Rate	1
AAAMGS10	Moody's Seasoned Aaa Corporate Bond Yield - 10-Year Treasury Constant Maturity Rate	1
BAAMGS10	Moody's Seasoned Baa Corporate Bond Yield - 10-Year Treasury Constant Maturity Rate	1
AAAMGS5	Moody's Seasoned Aaa Corporate Bond Yield - 5-Year Treasury Constant Maturity Rate	1
BAAMGS5	Moody's Seasoned Baa Corporate Bond Yield - 5-Year Treasury Constant Maturity Rate	1
AAAMGS3	Moody's Seasoned Aaa Corporate Bond Yield - 3-Year Treasury Constant Maturity Rate	1
BAAMGS3	Moody's Seasoned Baa Corporate Bond Yield - 3-Year Treasury Constant Maturity Rate	1
AAAMGS1	Moody's Seasoned Aaa Corporate Bond Yield - 1-Year Treasury Constant Maturity Rate	1
BAAMGS1	Moody's Seasoned Baa Corporate Bond Yield - 1-Year Treasury Constant Maturity Rate	1
AAAMTB6MS	Moody's Seasoned Aaa Corporate Bond Yield - 6-Month Treasury Bill	1
BAAMTB6MS	Moody's Seasoned Baa Corporate Bond Yield - 6-Month Treasury Bill	1
AAAMTB3MS	Moody's Seasoned Aaa Corporate Bond Yield - 3-Month Treasury Bill	1
BAAMTB3MS	Moody's Seasoned Baa Corporate Bond Yield - 3-Month Treasury Bill	1

Table 2: List of Variables

2. Empirical Results

2.1. Forecast methodology

In this study, we focused on the out-of-sample performance of the recession forecast models. The out-of-sample exercises are employed respectively for three, six, twelve and twenty-four-months ahead predictions. Our training data starts from 1960:01 to 1977:12 for three month-ahead predictions for all prediction exercises and a new observation is added each time. The out-of-sample prediction exercise starts from 1978:04 and ends at 2016:03 for three month-ahead predictions, starts from 1978:07 and ends at 2016:06 for six month-ahead-predictions, starts from 1979:01 and ends at 2016:12 for twelve month-ahead-predictions, starts from 1980:01 and ends at 2017:12 for twenty-four month-ahead-predictions.

While examining the out-of-sample performance of various interest rates and yield curve spreads as the predictor of U.S. recessions, we considered the informational lag of variables. Considering the informational lag on variables, we examined the forecasting exercises. Based on Soybilgen (2016), we initialized the prediction exercises according to the pseudo-real-time performance for all forecast horizon. Moreover, we assumed that there is no historical data revision on the sample data, and the predictions are conducted at the beginning of the month. Following these assumptions, we used the same historical data for all steps of the model estimation and prediction processes.

On the other hand, we took all of the recessions and expansions period published by NBER during the out-of-sample processes into account.The recessions can never be observed directly, and the NBER announces the date of the recession almost a year later. The NBER has historically revealed the business cycle turning points that correspond to peak or trough with a delay of 4 to 21 months for a long time. For example, the beginning of the recession that corresponds to a peak in the economic activity in December 2007 was announced in December 2008. Therefore, we make the following assumptions in order to maintain the historical data availability and update information in every step of the exercise continuously:

1. Only, the data of the turning point can be obtained after the date of turning point is announced by NBER.
2. There is a maximum of 12 months between the date of a turning point and the announcement of the peak.
3. The recession takes at least six months after the peak is announced.

In this thesis, we decided to extract high-frequency part from the original series using the maximal overlap discrete wavelet transform (MODWT) because high-frequency fluctuations on the data may lead to poor prediction performance. MODWT using four different wavelet families with a different number of vanishing moments is applied the various term spreads, credit spreads and interest rates to eliminate high-frequency fluctuations. After the transformation process, we obtain scaling coefficients correspond to low-frequency fluctuations and wavelet coefficients corresponding to high-frequency fluctuations. These scaling coefficients are used as regressors in the probit regression to forecast a recession in the U.S. The predictive power of each of these spreads are then evaluated with QPS.

As shown in the diagram below, two types forecast model is implemented in this study including pure probit regression model as well as transformed probit regression model based on MODWT.

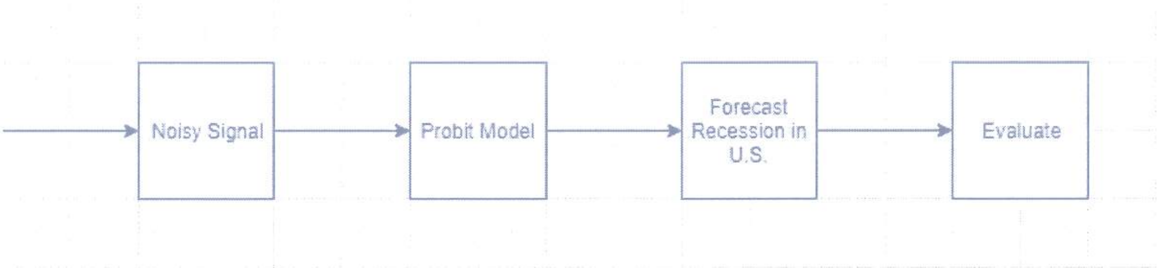

Figure 5: Standard Probit Model

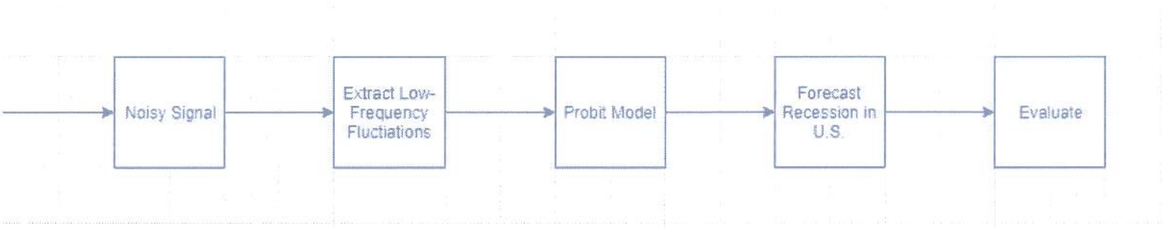

Figure 6: Wavelet Based Probit Model

In the first model, we tried to predict whether the U.S. would be in a recession using only the probit model without any noise reduction. Similar to Estrella and Mishkin (1998), the out-of-sample results are obtained in the following way for model 1. First, we estimate our model using each of the 45 variables one by one as shown in Table 2. Then these estimations are used to test for 3, 6, 12, 24 ahead forecast. After adding one more month to the estimation period, the same steps are executed for all ahead predictions. For example, we want to find an out-of-sample result that is whether the U.S. in recession or not at April 1978 using $FEDFUNDS_{1978:01}$. However, due to one-month informational lag on FEDFUNDS, we have only information from 1960:01 to December 1977:12. Therefore, considering the NBER business cycle chronology assumptions, we estimate our model-using $FEDFUNDS$ index from 1960:01 to 1977:09 and turning point information from 1960:05 to 1978:01.

Secondly, unlike model 1, we did not use the original series in model 2, on the contrary, we applied scaling (low-pass) filter to regressor shown in Table 2 to yield a set of scaling coefficients $\tilde{v}$ using MODWT. Hence, we obtained low frequency fluctuations of series rather than high frequency fluctuations. Then the decomposed series are used in the probit model in a same way as mentioned above.

In standard probit model, we model the relationship between $Prob(y_t = 1|x_{t-h})$ and x_t in a following way:

$$Prob(y_t = 1|x_{t-h}) = \Phi(\beta_0 + x'_{t-h}\beta_1),$$

$$f_{t+h} = \Phi(\hat{\beta}_0 + x_t'\hat{\beta}_1),$$

where h =3,6,12,24 Φ is standard normal CDF,f is the forecasted recession probability which is between 0 and 1 and x_t is the observed series. The coefficients β0 and β1 in are the unknown parameters and must be estimated based on the available training data and the estimates $\hat{\beta}_0$ and $\hat{\beta}_1$are chosen to maximize likelihood function.

In our wavelet-based model, the relationship between $Prob(y_t = 1|\tilde{v}_{t-h})$ and $\tilde{v}_t$ is built in a following way:

$$Prob(y_t = 1|\tilde{v}_{t-h}) = \Phi(\delta_0 + \tilde{v}'_{t-h}\delta_1),$$

$$f^w_{t+h} = \Phi(\hat{\delta}_0 + \tilde{v}_t'\hat{\delta}_1),$$

where h =3,6,12,24 Φ is standard normal CDF,f^w_{t+h} is the forecasted recession probability which is between 0 and 1 and $\tilde{v}_t$ is the transformed series. The coefficients δ_0 and δ_1 in are unknown and must be estimated based on the available training data and the estimates $\hat{\delta}_0$ and $\hat{\delta}_1$ are chosen to maximize likelihood function.

2.2. The Quadratic Probability Score

Following Katayama (2010), in order to evaluate pseudo real-time out-of-sample forecasting performance, we used the quadratic probability score that is the most commonly used measure.

$$QPS = \frac{2}{T}\sum_{t=1}^{T}(f_{t+h} - y_{t+h})^2,$$

where f_{t+h} is the h period ahead forecast probability of recession at month $t + h$ given the information up to time t, y_{t+h} is the realization of recession at month $t + h$ and T is the total number of the observations. The QPS simply compares the realization of recession and the forecast probability of recession that is represented by a binary variable 1 or 0. The range of QPS lies down between 0 and 2. The smaller values of QPS correspond to more accurate forecasts.

2.3. Out-of-sample results and performance

All QPS scores for all forecast horizons and wavelet families are shown in table 3 to table 12. Also, we choose the ones with the best performance for all models within the best of QPS scores for simplicity. Table 15 to Table 26 summarize percentage improvement of forecast performance of wavelet-based method over forecast performance of standard probit model

Table 29 to table 30 summarize best the out-of-sample forecasting performances. the first column gives rank, the second column gives the abbreviation of the index, the third column gives the QPS scores, and the fourth column gives their corresponding methods that are pure probit model or transformed model with MODWT. Also, standard means pure probit model whereas others such as haar, db2, coif3 mean transformed model with MODWT in the best of QPS scores table.

First, we will look at forecasting performance of predicting a three-month-ahead recession. According to three-month-ahead exercise results, wavelet-based approach improves the prediction power of various yield curve spread. As shown in table 13, although there is a small improvement by place, almost all of the financial indices used in the transformed model with MODWT outperform the model where the series is not filtered. For example, best predictor is GS1MFFM, spread between 1-Year Treasury Constant Maturity Rate and Federal Funds Rate, in both pure probit model and transformed model using Daubechies with ten vanishing moments according to QPS scores; however, pure model's QPS score is 0.312 whereas other is 0.123.

We used Haar, Daubechies, Symlets and Coiflets wavelets with a limited number of vanishing moments in the predict processes for comparison and found that best predictor is TB6SMFFM in the model performed with Haar, GS3MFFM in Daubechies with sixteen vanishing moments, Coiflet with two vanishing moments, Symlet with four vanishing moments. In addition, the best score among all type of wavelets is constructed by Coiflet with two vanishing moments. On the other hand, we realized that an increasing number of vanishing moments in Daubechies wavelet causes improvement in the QPS scores.

In contrast to the better performance of these term spreads, if we look at the worst-case scenario based on QPS scores, we founded that most of all credit term spreads have poor prediction performance. On the other hand, interest rates do not contain useful information for prediction in three period ahead prediction exercise. It could not even enter the top 10 QPS ranking even in all of the wavelet-based model rather than pure probit model. A similar pattern was drawn in the six months ahead prediction exercise as in the three ahead prediction.

Although QPS scores broadly show a similar pattern between three-month ahead prediction and six months ahead prediction, the best indicator for forecasting is the term spread between 3-Year Treasury Constant Maturity Rate - 1-Year Treasury Constant Maturity Rate (GS3MGS1) rather than GS3MFFM in six months ahead exercise.

GS3MFFM, GS3MGS1, GS10MTB3MS, TB3SMFFM, and GS10 also include useful information for given the forecast horizon of six months. It is important to point out that these terms spread outperform the credit spreads, Moody's Seasoned AAA Corporate Bond Yield and Moody's Seasoned Baa Corporate Bond Yield for both pure probit model and wavelet-based approach model.

Although widely used recession predictor, term spread between 10-Year Treasury Constant Maturity Rate - 3-Month Treasury Bill (GS10MTB3MS) have good QPS score, not best, it might be used for both three and six months ahead exercises because of the useful information it contains.

If we look at the performance of wavelet-based approach, term spread between 3-Year Treasury Constant Maturity Rate - Federal Funds (GS3MFFM) Rate wavelet-based model-using haar, db2 and sym2 transformations outperforms pure probit model according to QPS. Therefore, we conclude that although best predictor is GS3MFFM in both the pure probit model, the wavelet-based model-using haar, db2, and sym2 transforms, wavelet model improves prediction performance.

Now we will look at the performance of predictor between wavelet models based on QPS scores. GS3MFFM have relatively good forecasting performance and is the best predictor in all Daubechies wavelet transformed model. However, an increasing number of vanish moments on Daubechies wavelet transform cause a bad influence on QPS score. However, this pattern is not valid for other wavelet transforms. For example, although the model based on Coiflet transform with four and five vanishing moments have the same best predictor that is term spread between 3-Year Treasury Constant Maturity Rates-1-Year Treasury Constant Maturity Rate (GS3MGS1), Coiflet with five vanishing moment have better forecasting performance than another one.

The same applies to Coiflet with two and three vanishing moments. On the other hand, Symlets wavelet with two and eight have the same QPS score. However their best predictors are different. While the best predictor is the term spread between 3-Year Treasury Constant Maturity Rate - 1-Year Treasury Constant Maturity Rate in sym8, 3-Year Treasury Constant Maturity Rate – Federal Funds Rate is the best in sym2.

As in predicting three and six-month-ahead recession probabilities, the term spread between 3-Year Treasury Constant Maturity Rate - 1-Year Treasury Constant Maturity Rate (GS3MGS1) is the best predictor for twelve-month horizon prediction. In addition, the worst scenario in the twelve-month ahead exercise is for the credit spreads and bond yields. Not only credit spreads between bond yields and interest rates but also bond yields do not contain useful information for twelve-month forecast horizon. Interestingly, INTGSTUSM193N, TB3MS, TB6MS, and GS1 have good performance for twelve-month-ahead recession probabilities.

Best predictor in pure probit model and many wavelets transform based models such as Haar wavelet, Daubechies wavelet with two and three vanishing moments, Symlets wavelet with two and three vanishing moments is term spread between 3-Year Treasury Constant Maturity Rate - 1-Year Treasury Constant Maturity Rate. However, wavelet-based approach outperforms pure probit model based on QPS. Also, it can be seen on the best of QPS score table that using five to sixteen vanishing moment for Daubechies wavelet transform does not change the best predictor.

Prediction pattern and indexes for twenty four-month forecast horizons are quite different from the three, six and twelve-month forecast horizons. Although there is a bad forecasting performance using credit spread and Moody's corporate bond yield, 6-Month treasury bill - 3-month treasury bill (TB6MSMTB3MS) and 1-year treasury constant maturity rate (GS1) are the best predictor rather than 3-Month Treasury Bill - Federal Funds Rate and 3-Year Treasury Constant Maturity Rate - 1-Year Treasury Constant Maturity Rate.

Using wavelet transform based approach improves forecasting performance for the three, six and twelve-month forecast horizons. However there is no difference between the pure probit model and the wavelet-based model. Most of them have the same QPS score and the best predictor variable. The same picture is valid for all Daubechies wavelet transform with all vanishing moments. QPS score is 0.153, and best indicator is 1-Year Treasury Constant Maturity Rate (GS1) for all.

Conclusion

In this thesis, we have built a model to analyze in two concepts. The first concept is that comparing the performance of the original series with the decomposed series using MODWT. The second one is that measuring performance of different yield curve spreads. Our goal is to predict whether there will be a recession in the US by using different yield curve spreads and MODWT between three and twenty-four months in the future. As in Estrella and Mishkin (1996), we used the standard probit model to assess the relationship between recession dummy and financial index. Also, we considered the lag of information on the financial indexes and made assumptions about the announcement of the turning points by NBER in a similar way to Fossati (2015) in order to establish the model in a fair way.

Although the model we proposed has no improvement in predicting the recession for twenty-four month ahead, it works more accurate than the pure probit model in predicting U.S. recessions for three to twelve months ahead. In addition, taking the credit spreads and corporate bond yields into consideration, the model with yield curve spread remains useful in predicting U.S. recessions. When we compare the predictive performance of different yield curve spreads, we observed that the GS3MFFM and GS3MGS1 have better results in predicting a recession in the U.S.

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APPENDICES

Table 3: Forecasting NBER Recessions Over the Next 3 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$													
k=3													
Index	standard	haar	db2	db3	db4	db5	db6	db7	db8	db9	db10	db11	db12
FEDFUNDS	0.217	0.216	0.214	0.212	0.211	0.210	0.208	0.206	0.205	0.203	0.201	0.199	0.197
INTGSTUSM193N	0.234	0.232	0.230	0.227	0.225	0.222	0.219	0.217	0.214	0.211	0.209	0.206	0.204
AAA	0.185	0.183	0.182	0.181	0.180	0.179	0.178	0.177	0.176	0.174	0.173	0.172	0.171
BAA	0.168	0.167	0.166	0.166	0.165	0.165	0.164	0.164	0.163	0.163	0.163	0.162	0.162
GS1	0.257	0.255	0.252	0.249	0.245	0.242	0.239	0.235	0.232	0.228	0.225	0.222	0.218
GS3	0.253	0.248	0.244	0.240	0.237	0.233	0.229	0.224	0.220	0.217	0.213	0.209	0.206
GS5	0.241	0.235	0.232	0.228	0.224	0.221	0.217	0.213	0.209	0.205	0.202	0.198	0.195
GS10	0.213	0.209	0.206	0.204	0.201	0.198	0.195	0.192	0.189	0.186	0.184	0.181	0.179
TB3MS	0.231	0.230	0.228	0.225	0.223	0.220	0.218	0.215	0.212	0.210	0.207	0.204	0.202
TB6MS	0.234	0.233	0.230	0.227	0.225	0.222	0.219	0.216	0.213	0.210	0.208	0.205	0.202
TB3SMFFM	0.135	0.135	0.135	0.135	0.135	0.135	0.135	0.136	0.136	0.136	0.137	0.137	0.137
TB6SMFFM	0.133	0.131	0.131	0.131	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.131	0.131
GS10MFFM	0.143	0.141	0.141	0.140	0.139	0.138	0.136	0.135	0.134	0.133	0.131	0.130	0.129
GS5MFFM	0.140	0.138	0.137	0.136	0.135	0.134	0.133	0.132	0.131	0.129	0.128	0.127	0.126
GS3MFFM	0.135	0.133	0.132	0.132	0.130	0.129	0.128	0.127	0.126	0.124	0.123	0.122	0.121
GS1MFFM	0.132	0.131	0.131	0.130	0.128	0.127	0.126	0.125	0.124	0.124	0.123	0.123	0.122
AAAMFFM	0.153	0.151	0.150	0.150	0.149	0.148	0.147	0.146	0.145	0.144	0.142	0.141	0.140
BAAMFFM	0.157	0.155	0.155	0.154	0.153	0.152	0.151	0.149	0.148	0.147	0.145	0.144	0.142
AAAMGS10	0.160	0.159	0.159	0.158	0.158	0.158	0.158	0.158	0.158	0.159	0.159	0.160	0.160
BAAMGS10	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.161	0.160	0.160	0.160	0.160	0.160
GS10MGS1	0.166	0.164	0.164	0.162	0.161	0.159	0.158	0.157	0.155	0.153	0.151	0.150	0.148
GS10MGS3	0.147	0.146	0.146	0.146	0.146	0.145	0.144	0.143	0.141	0.140	0.139	0.137	0.136
GS10MGS5	0.145	0.144	0.145	0.145	0.145	0.144	0.143	0.142	0.141	0.140	0.139	0.138	0.138
GS10MTB3MS	0.159	0.155	0.155	0.154	0.152	0.150	0.149	0.147	0.145	0.143	0.141	0.140	0.138
GS10MTB6MS	0.159	0.157	0.157	0.156	0.154	0.153	0.151	0.150	0.148	0.146	0.145	0.143	0.142
AAAMGS5	0.149	0.148	0.148	0.148	0.148	0.148	0.148	0.148	0.148	0.147	0.147	0.147	0.147
BAAMGS5	0.162	0.162	0.162	0.162	0.161	0.161	0.161	0.160	0.160	0.160	0.159	0.159	0.158
GS5MGS1	0.171	0.170	0.170	0.169	0.167	0.166	0.165	0.163	0.161	0.159	0.157	0.156	0.154
GS5MGS3	0.153	0.153	0.153	0.152	0.151	0.150	0.149	0.148	0.146	0.145	0.143	0.142	0.140
GS5MTB3MS	0.155	0.153	0.152	0.151	0.150	0.148	0.147	0.145	0.143	0.142	0.140	0.138	0.136
GS5MTB6MS	0.156	0.155	0.154	0.154	0.152	0.151	0.150	0.148	0.147	0.145	0.144	0.142	0.140
AAAMGS3	0.145	0.144	0.145	0.145	0.144	0.144	0.144	0.144	0.143	0.143	0.142	0.142	0.142
BAAMGS3	0.160	0.160	0.159	0.159	0.159	0.159	0.158	0.158	0.158	0.157	0.156	0.156	0.155
GS3MGS1	0.170	0.169	0.169	0.168	0.166	0.165	0.164	0.162	0.160	0.158	0.157	0.155	0.152
GS3MTB3MS	0.155	0.152	0.151	0.150	0.149	0.147	0.146	0.144	0.142	0.141	0.139	0.137	0.135
GS3MTB6MS	0.153	0.152	0.151	0.150	0.149	0.148	0.146	0.145	0.143	0.142	0.140	0.139	0.137
AAAMGS1	0.159	0.159	0.159	0.158	0.157	0.155	0.154	0.153	0.151	0.150	0.148	0.147	0.145
BAAMGS1	0.157	0.157	0.157	0.156	0.156	0.156	0.155	0.154	0.154	0.153	0.152	0.151	0.150
GS1MTB3MS	0.162	0.162	0.162	0.162	0.162	0.162	0.161	0.161	0.161	0.161	0.160	0.160	0.160
GS1MTB6MS	0.161	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162
TB6MSMTB3MS	0.162	0.162	0.161	0.161	0.160	0.160	0.160	0.159	0.159	0.158	0.157	0.157	0.156
AAAMTB6MS	0.156	0.156	0.155	0.154	0.154	0.152	0.151	0.150	0.149	0.147	0.146	0.145	0.144
BAAMTB6MS	0.158	0.158	0.158	0.157	0.157	0.156	0.156	0.155	0.154	0.153	0.152	0.151	0.150
AAAMTB3MS	0.156	0.154	0.153	0.153	0.151	0.150	0.149	0.147	0.146	0.144	0.143	0.141	0.140
BAAMTB3MS	0.156	0.155	0.154	0.154	0.153	0.152	0.151	0.150	0.149	0.148	0.147	0.146	0.145

Table 4: Forecasting NBER Recessions Over the Next 3 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=3												
Index	db13	db14	db15	db16	sym2	sym3	sym4	sym5	sym6	sym7	sym8	sym9
FEDFUNDS	0.195	0.193	0.190	0.188	0.214	0.212	0.178	0.167	0.160	0.161	0.148	0.145
INTGSTUSM193N	0.201	0.199	0.196	0.193	0.230	0.227	0.183	0.169	0.162	0.163	0.147	0.145
AAA	0.171	0.170	0.169	0.168	0.182	0.181	0.166	0.163	0.162	0.162	0.161	0.160
BAA	0.162	0.162	0.161	0.161	0.166	0.166	0.160	0.160	0.160	0.160	0.160	0.160
GS1	0.215	0.212	0.208	0.205	0.252	0.249	0.191	0.174	0.164	0.166	0.149	0.149
GS3	0.202	0.198	0.194	0.191	0.244	0.240	0.177	0.163	0.157	0.158	0.154	0.159
GS5	0.192	0.189	0.185	0.182	0.232	0.228	0.171	0.161	0.157	0.157	0.157	0.162
GS10	0.177	0.174	0.172	0.171	0.206	0.204	0.164	0.159	0.158	0.158	0.159	0.162
TB3MS	0.199	0.197	0.194	0.192	0.228	0.225	0.182	0.168	0.162	0.163	0.147	0.145
TB6MS	0.200	0.197	0.194	0.192	0.230	0.227	0.181	0.168	0.161	0.162	0.147	0.147
TB3SMFFM	0.137	0.137	0.136	0.136	0.135	0.135	0.134	0.135	0.138	0.137	0.141	0.141
TB6SMFFM	0.131	0.131	0.131	0.131	0.131	0.131	0.129	0.131	0.135	0.133	0.137	0.137
GS10MFFM	0.128	0.127	0.126	0.125	0.141	0.140	0.119	0.117	0.120	0.118	0.119	0.119
GS5MFFM	0.125	0.124	0.123	0.122	0.137	0.136	0.117	0.115	0.119	0.117	0.119	0.119
GS3MFFM	0.121	0.120	0.120	0.119	0.132	0.132	0.115	0.116	0.120	0.118	0.122	0.122
GS1MFFM	0.123	0.123	0.123	0.124	0.131	0.130	0.123	0.126	0.129	0.128	0.132	0.132
AAAMFFM	0.139	0.138	0.137	0.136	0.150	0.150	0.130	0.126	0.126	0.125	0.124	0.124
BAAMFFM	0.141	0.139	0.138	0.137	0.155	0.154	0.133	0.130	0.129	0.129	0.128	0.129
AAAMGS10	0.160	0.161	0.162	0.162	0.159	0.158	0.166	0.174	0.181	0.180	0.221	0.251
BAAMGS10	0.160	0.160	0.160	0.159	0.161	0.161	0.159	0.160	0.162	0.161	0.174	0.186
GS10MGS1	0.146	0.144	0.143	0.141	0.164	0.162	0.134	0.126	0.125	0.123	0.120	0.120
GS10MGS3	0.135	0.133	0.132	0.131	0.146	0.146	0.128	0.125	0.125	0.124	0.129	0.135
GS10MGS5	0.137	0.136	0.135	0.135	0.145	0.145	0.133	0.132	0.132	0.132	0.139	0.150
GS10MTB3MS	0.136	0.134	0.133	0.131	0.155	0.154	0.125	0.119	0.120	0.118	0.117	0.117
GS10MTB6MS	0.140	0.138	0.137	0.136	0.157	0.156	0.131	0.126	0.125	0.125	0.122	0.122
AAAMGS5	0.147	0.147	0.147	0.147	0.148	0.148	0.146	0.148	0.151	0.150	0.189	0.233
BAAMGS5	0.158	0.157	0.157	0.156	0.162	0.162	0.155	0.153	0.153	0.153	0.167	0.186
GS5MGS1	0.152	0.150	0.148	0.146	0.170	0.169	0.138	0.129	0.128	0.126	0.121	0.118
GS5MGS3	0.139	0.137	0.135	0.134	0.153	0.152	0.129	0.123	0.123	0.121	0.121	0.123
GS5MTB3MS	0.134	0.133	0.131	0.130	0.152	0.151	0.125	0.120	0.123	0.120	0.119	0.118
GS5MTB6MS	0.139	0.137	0.136	0.135	0.154	0.154	0.132	0.127	0.128	0.126	0.125	0.123
AAAMGS3	0.141	0.141	0.141	0.140	0.145	0.145	0.140	0.141	0.142	0.141	0.160	0.185
BAAMGS3	0.155	0.154	0.154	0.153	0.159	0.159	0.151	0.149	0.149	0.148	0.156	0.170
GS3MGS1	0.150	0.149	0.147	0.145	0.169	0.168	0.137	0.128	0.127	0.126	0.122	0.119
GS3MTB3MS	0.134	0.132	0.131	0.130	0.151	0.150	0.127	0.125	0.127	0.125	0.126	0.125
GS3MTB6MS	0.136	0.135	0.134	0.134	0.151	0.150	0.132	0.130	0.132	0.130	0.131	0.130
AAAMGS1	0.144	0.143	0.141	0.140	0.159	0.158	0.136	0.132	0.131	0.131	0.133	0.140
BAAMGS1	0.149	0.148	0.147	0.146	0.157	0.156	0.144	0.141	0.140	0.140	0.140	0.144
GS1MTB3MS	0.159	0.159	0.159	0.159	0.162	0.162	0.158	0.158	0.160	0.159	0.162	0.162
GS1MTB6MS	0.162	0.162	0.162	0.162	0.162	0.162	0.163	0.164	0.167	0.165	0.171	0.173
TB6MSMTB3MS	0.156	0.155	0.155	0.155	0.161	0.161	0.155	0.154	0.156	0.155	0.152	0.151
AAAMTB6MS	0.143	0.142	0.141	0.140	0.155	0.154	0.137	0.134	0.133	0.133	0.132	0.135
BAAMTB6MS	0.150	0.149	0.148	0.148	0.158	0.157	0.145	0.143	0.141	0.141	0.139	0.141
AAAMTB3MS	0.139	0.137	0.136	0.135	0.153	0.153	0.132	0.128	0.128	0.128	0.128	0.132
BAAMTB3MS	0.144	0.143	0.142	0.142	0.154	0.154	0.139	0.137	0.136	0.136	0.136	0.139

Table 5: Forecasting NBER Recessions Over the Next 3 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=3												
Index	sym10	sym11	sym12	sym13	sym14	sym15	sym16	coif1	coif2	coif3	coif4	coif5
FEDFUNDS	0.144	0.144	0.146	0.149	0.152	0.155	0.164	0.202	0.178	0.159	0.147	0.144
INTGSTUSM193N	0.148	0.148	0.154	0.157	0.162	0.165	0.172	0.211	0.183	0.161	0.146	0.149
AAA	0.160	0.160	0.161	0.161	0.161	0.161	0.162	0.174	0.166	0.162	0.161	0.161
BAA	0.161	0.161	0.161	0.161	0.161	0.162	0.163	0.163	0.160	0.160	0.160	0.161
GS1	0.153	0.153	0.159	0.162	0.165	0.167	0.172	0.228	0.191	0.163	0.149	0.154
GS3	0.164	0.164	0.169	0.170	0.172	0.172	0.174	0.216	0.178	0.156	0.155	0.164
GS5	0.166	0.166	0.170	0.170	0.171	0.171	0.171	0.205	0.171	0.156	0.158	0.166
GS10	0.164	0.164	0.166	0.166	0.166	0.166	0.166	0.186	0.164	0.158	0.160	0.165
TB3MS	0.148	0.148	0.154	0.157	0.162	0.164	0.172	0.209	0.182	0.161	0.146	0.149
TB6MS	0.149	0.150	0.155	0.158	0.162	0.164	0.171	0.210	0.181	0.160	0.147	0.150
TB3SMFFM	0.140	0.141	0.140	0.143	0.146	0.149	0.155	0.134	0.134	0.138	0.141	0.140
TB6SMFFM	0.136	0.137	0.137	0.141	0.145	0.148	0.156	0.128	0.129	0.134	0.137	0.136
GS10MFFM	0.119	0.120	0.121	0.126	0.133	0.138	0.154	0.130	0.119	0.119	0.119	0.119
GS5MFFM	0.118	0.119	0.119	0.124	0.130	0.135	0.150	0.127	0.116	0.119	0.119	0.118
GS3MFFM	0.121	0.122	0.122	0.126	0.132	0.137	0.150	0.122	0.115	0.120	0.122	0.121
GS1MFFM	0.131	0.132	0.132	0.137	0.142	0.146	0.154	0.123	0.122	0.129	0.132	0.131
AAAMFFM	0.126	0.127	0.132	0.139	0.148	0.155	0.178	0.141	0.130	0.126	0.124	0.127
BAAMFFM	0.131	0.132	0.138	0.144	0.152	0.159	0.180	0.146	0.133	0.129	0.128	0.132
AAAMGS10	0.277	0.277	0.295	0.294	0.296	0.295	0.297	0.158	0.166	0.182	0.225	0.281
BAAMGS10	0.198	0.199	0.211	0.214	0.219	0.222	0.228	0.160	0.159	0.162	0.175	0.201
GS10MGS1	0.121	0.122	0.127	0.132	0.142	0.150	0.174	0.153	0.134	0.124	0.120	0.122
GS10MGS3	0.143	0.144	0.158	0.171	0.191	0.206	0.242	0.141	0.128	0.125	0.130	0.145
GS10MGS5	0.168	0.169	0.202	0.221	0.247	0.261	0.291	0.141	0.133	0.133	0.140	0.173
GS10MTB3MS	0.118	0.119	0.123	0.128	0.137	0.144	0.166	0.143	0.125	0.120	0.117	0.119
GS10MTB6MS	0.122	0.123	0.125	0.129	0.136	0.143	0.164	0.147	0.131	0.125	0.122	0.122
AAAMGS5	0.282	0.281	0.327	0.335	0.345	0.348	0.356	0.148	0.147	0.152	0.194	0.290
BAAMGS5	0.210	0.210	0.234	0.242	0.252	0.256	0.267	0.160	0.155	0.154	0.169	0.214
GS5MGS1	0.116	0.116	0.117	0.120	0.127	0.134	0.153	0.159	0.138	0.127	0.120	0.116
GS5MGS3	0.125	0.126	0.132	0.139	0.149	0.158	0.183	0.145	0.129	0.122	0.121	0.126
GS5MTB3MS	0.118	0.118	0.120	0.124	0.130	0.136	0.153	0.142	0.125	0.122	0.119	0.119
GS5MTB6MS	0.122	0.122	0.121	0.124	0.129	0.134	0.149	0.146	0.132	0.128	0.125	0.122
AAAMGS3	0.220	0.222	0.264	0.283	0.303	0.313	0.334	0.143	0.140	0.142	0.162	0.227
BAAMGS3	0.190	0.191	0.216	0.228	0.242	0.250	0.266	0.157	0.151	0.149	0.158	0.194
GS3MGS1	0.117	0.117	0.116	0.118	0.124	0.129	0.147	0.158	0.137	0.126	0.121	0.117
GS3MTB3MS	0.125	0.125	0.125	0.128	0.133	0.138	0.151	0.141	0.127	0.127	0.126	0.125
GS3MTB6MS	0.128	0.129	0.126	0.128	0.132	0.135	0.147	0.143	0.132	0.132	0.131	0.129
AAAMGS1	0.149	0.151	0.168	0.180	0.197	0.209	0.243	0.150	0.136	0.131	0.134	0.152
BAAMGS1	0.152	0.153	0.167	0.178	0.191	0.200	0.225	0.153	0.144	0.140	0.140	0.154
GS1MTB3MS	0.162	0.161	0.160	0.160	0.160	0.160	0.160	0.161	0.158	0.160	0.162	0.162
GS1MTB6MS	0.173	0.173	0.172	0.171	0.169	0.168	0.163	0.162	0.163	0.167	0.172	0.173
TB6MSMTB3MS	0.152	0.151	0.155	0.158	0.160	0.161	0.164	0.158	0.154	0.156	0.152	0.152
AAAMTB6MS	0.141	0.142	0.153	0.163	0.177	0.188	0.221	0.148	0.137	0.133	0.132	0.143
BAAMTB6MS	0.146	0.147	0.157	0.166	0.177	0.186	0.210	0.153	0.146	0.141	0.139	0.148
AAAMTB3MS	0.138	0.139	0.152	0.162	0.176	0.186	0.218	0.145	0.132	0.128	0.128	0.140
BAAMTB3MS	0.144	0.145	0.156	0.165	0.176	0.184	0.208	0.148	0.139	0.136	0.136	0.146

Table 6 : Forecasting NBER Recessions Over the Next 6 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$													
k=6													
Index	standard	haar	db2	db3	db4	db5	db6	db7	db8	db9	db10	db11	db12
FEDFUNDS	0.217	0.209	0.205	0.202	0.198	0.195	0.192	0.189	0.187	0.184	0.182	0.179	0.177
INTGSTUSM193N	0.243	0.237	0.233	0.230	0.226	0.222	0.219	0.215	0.211	0.208	0.204	0.201	0.198
AAA	0.186	0.183	0.182	0.181	0.180	0.179	0.178	0.177	0.175	0.174	0.173	0.172	0.171
BAA	0.167	0.166	0.166	0.165	0.165	0.165	0.164	0.164	0.163	0.163	0.162	0.162	0.162
GS1	0.269	0.262	0.256	0.251	0.246	0.242	0.237	0.232	0.227	0.222	0.218	0.213	0.209
GS3	0.269	0.260	0.254	0.248	0.242	0.237	0.231	0.225	0.219	0.214	0.209	0.204	0.199
GS5	0.255	0.245	0.240	0.235	0.229	0.224	0.219	0.213	0.208	0.203	0.198	0.193	0.189
GS10	0.227	0.219	0.215	0.211	0.207	0.203	0.200	0.196	0.192	0.189	0.186	0.183	0.180
TB3MS	0.242	0.236	0.232	0.228	0.225	0.221	0.218	0.214	0.211	0.207	0.204	0.201	0.198
TB6MS	0.245	0.239	0.234	0.230	0.227	0.223	0.219	0.215	0.211	0.208	0.205	0.201	0.198
TB3SMFFM	0.134	0.133	0.133	0.134	0.134	0.134	0.134	0.135	0.135	0.135	0.135	0.135	0.136
TB6SMFFM	0.127	0.126	0.127	0.128	0.128	0.129	0.130	0.130	0.131	0.132	0.132	0.132	0.132
GS10MFFM	0.125	0.123	0.123	0.123	0.123	0.122	0.122	0.122	0.123	0.123	0.122	0.122	0.122
GS5MFFM	0.120	0.119	0.119	0.119	0.119	0.119	0.119	0.119	0.120	0.120	0.120	0.120	0.120
GS3MFFM	0.116	0.115	0.115	0.116	0.116	0.117	0.117	0.118	0.119	0.119	0.120	0.120	0.120
GS1MFFM	0.120	0.120	0.121	0.121	0.122	0.123	0.125	0.125	0.126	0.127	0.127	0.128	0.128
AAAMFFM	0.144	0.141	0.140	0.139	0.138	0.137	0.136	0.135	0.135	0.134	0.133	0.132	0.132
BAAMFFM	0.150	0.145	0.143	0.142	0.141	0.140	0.139	0.138	0.138	0.137	0.136	0.136	0.135
AAAMGS10	0.154	0.153	0.153	0.153	0.153	0.153	0.154	0.154	0.154	0.154	0.155	0.155	0.156
BAAMGS10	0.160	0.160	0.159	0.159	0.159	0.158	0.158	0.158	0.158	0.158	0.157	0.157	0.157
GS10MGS1	0.149	0.145	0.144	0.142	0.139	0.138	0.136	0.135	0.133	0.132	0.131	0.130	0.130
GS10MGS3	0.136	0.133	0.132	0.131	0.130	0.129	0.128	0.127	0.126	0.126	0.125	0.125	0.125
GS10MGS5	0.138	0.136	0.135	0.135	0.134	0.134	0.133	0.133	0.132	0.132	0.132	0.131	0.131
GS10MTB3MS	0.136	0.131	0.130	0.129	0.128	0.127	0.126	0.126	0.125	0.125	0.124	0.124	0.123
GS10MTB6MS	0.141	0.137	0.137	0.136	0.135	0.133	0.133	0.132	0.132	0.131	0.130	0.130	0.129
AAAMGS5	0.145	0.144	0.144	0.144	0.144	0.144	0.145	0.145	0.145	0.145	0.145	0.145	0.145
BAAMGS5	0.163	0.162	0.161	0.160	0.159	0.159	0.158	0.157	0.157	0.156	0.155	0.155	0.154
GS5MGS1	0.152	0.147	0.146	0.144	0.142	0.140	0.139	0.137	0.136	0.135	0.134	0.133	0.132
GS5MGS3	0.139	0.137	0.135	0.134	0.132	0.130	0.129	0.128	0.127	0.127	0.126	0.126	0.126
GS5MTB3MS	0.134	0.129	0.128	0.127	0.126	0.125	0.125	0.125	0.125	0.125	0.124	0.124	0.123
GS5MTB6MS	0.139	0.136	0.135	0.134	0.133	0.132	0.132	0.132	0.132	0.131	0.131	0.131	0.130
AAAMGS3	0.142	0.140	0.139	0.139	0.138	0.138	0.138	0.138	0.138	0.138	0.139	0.139	0.139
BAAMGS3	0.160	0.158	0.157	0.156	0.156	0.155	0.154	0.154	0.153	0.153	0.152	0.152	0.151
GS3MGS1	0.149	0.144	0.143	0.140	0.139	0.137	0.136	0.134	0.133	0.133	0.132	0.131	0.130
GS3MTB3MS	0.133	0.128	0.128	0.127	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.126	0.125
GS3MTB6MS	0.136	0.133	0.133	0.132	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131
AAAMGS1	0.159	0.156	0.154	0.151	0.148	0.146	0.144	0.143	0.141	0.140	0.139	0.138	0.137
BAAMGS1	0.159	0.156	0.154	0.153	0.151	0.150	0.149	0.148	0.147	0.147	0.146	0.145	0.145
GS1MTB3MS	0.158	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157
GS1MTB6MS	0.161	0.161	0.161	0.161	0.161	0.162	0.162	0.162	0.163	0.163	0.163	0.164	0.164
TB6MSMTB3MS	0.153	0.152	0.151	0.151	0.151	0.151	0.151	0.152	0.152	0.152	0.152	0.152	0.152
AAAMTB6MS	0.152	0.149	0.147	0.146	0.145	0.144	0.143	0.142	0.141	0.140	0.140	0.139	0.138
BAAMTB6MS	0.155	0.154	0.153	0.152	0.151	0.151	0.150	0.150	0.149	0.149	0.148	0.148	0.147
AAAMTB3MS	0.148	0.144	0.143	0.141	0.140	0.139	0.138	0.137	0.136	0.135	0.135	0.134	0.133
BAAMTB3MS	0.148	0.145	0.144	0.144	0.143	0.142	0.142	0.142	0.141	0.141	0.141	0.140	0.140

Table 7: Forecasting NBER Recessions Over the Next 6 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=6												
Index	db13	db14	db15	db16	sym2	sym3	sym4	sym5	sym6	sym7	sym8	sym9
FEDFUNDS	0.175	0.173	0.171	0.169	0.205	0.202	0.162	0.153	0.148	0.149	0.142	0.142
INTGSTUSM193N	0.195	0.192	0.188	0.185	0.233	0.230	0.172	0.157	0.149	0.151	0.144	0.146
AAA	0.171	0.170	0.169	0.168	0.182	0.181	0.165	0.162	0.161	0.161	0.160	0.160
BAA	0.161	0.161	0.161	0.161	0.166	0.165	0.160	0.159	0.159	0.159	0.159	0.160
GS1	0.205	0.201	0.197	0.193	0.256	0.251	0.175	0.159	0.150	0.152	0.148	0.150
GS3	0.195	0.190	0.186	0.181	0.254	0.248	0.166	0.155	0.152	0.152	0.156	0.158
GS5	0.186	0.182	0.178	0.175	0.240	0.235	0.162	0.155	0.154	0.154	0.158	0.160
GS10	0.177	0.175	0.172	0.170	0.215	0.211	0.162	0.157	0.157	0.157	0.159	0.159
TB3MS	0.195	0.192	0.189	0.186	0.232	0.228	0.172	0.157	0.149	0.151	0.144	0.146
TB6MS	0.195	0.192	0.189	0.186	0.234	0.230	0.172	0.157	0.149	0.151	0.145	0.147
TB3SMFFM	0.136	0.136	0.136	0.137	0.133	0.134	0.138	0.139	0.139	0.140	0.137	0.139
TB6SMFFM	0.133	0.133	0.133	0.133	0.127	0.128	0.134	0.135	0.135	0.135	0.133	0.136
GS10MFFM	0.122	0.121	0.121	0.121	0.123	0.123	0.121	0.120	0.120	0.120	0.118	0.121
GS5MFFM	0.120	0.120	0.120	0.120	0.119	0.119	0.120	0.120	0.119	0.120	0.117	0.120
GS3MFFM	0.120	0.121	0.121	0.121	0.115	0.116	0.122	0.122	0.122	0.122	0.119	0.122
GS1MFFM	0.128	0.129	0.129	0.129	0.121	0.121	0.131	0.131	0.131	0.132	0.129	0.132
AAAMFFM	0.131	0.131	0.130	0.129	0.140	0.139	0.127	0.125	0.124	0.124	0.125	0.129
BAAMFFM	0.134	0.134	0.133	0.132	0.143	0.142	0.131	0.129	0.128	0.128	0.129	0.134
AAAMGS10	0.157	0.158	0.159	0.160	0.153	0.153	0.171	0.190	0.218	0.205	0.257	0.263
BAAMGS10	0.157	0.157	0.157	0.157	0.159	0.159	0.158	0.162	0.170	0.166	0.185	0.191
GS10MGS1	0.128	0.128	0.127	0.126	0.144	0.142	0.123	0.120	0.119	0.120	0.121	0.124
GS10MGS3	0.125	0.124	0.124	0.124	0.132	0.131	0.124	0.127	0.130	0.129	0.140	0.146
GS10MGS5	0.131	0.131	0.131	0.131	0.135	0.135	0.133	0.136	0.141	0.139	0.160	0.174
GS10MTB3MS	0.122	0.121	0.121	0.120	0.130	0.129	0.119	0.117	0.117	0.117	0.119	0.123
GS10MTB6MS	0.128	0.128	0.127	0.127	0.137	0.136	0.126	0.123	0.122	0.123	0.122	0.125
AAAMGS5	0.145	0.145	0.145	0.146	0.144	0.144	0.149	0.161	0.189	0.176	0.258	0.279
BAAMGS5	0.154	0.153	0.153	0.153	0.161	0.160	0.152	0.155	0.165	0.161	0.192	0.204
GS5MGS1	0.131	0.130	0.129	0.128	0.146	0.144	0.125	0.121	0.118	0.119	0.115	0.116
GS5MGS3	0.125	0.124	0.124	0.123	0.135	0.134	0.121	0.120	0.119	0.120	0.125	0.129
GS5MTB3MS	0.123	0.122	0.122	0.121	0.128	0.127	0.121	0.119	0.119	0.119	0.118	0.121
GS5MTB6MS	0.130	0.129	0.129	0.129	0.135	0.134	0.129	0.126	0.125	0.125	0.121	0.122
AAAMGS3	0.139	0.139	0.139	0.140	0.139	0.139	0.141	0.146	0.157	0.152	0.198	0.221
BAAMGS3	0.151	0.150	0.150	0.149	0.157	0.156	0.148	0.149	0.154	0.152	0.175	0.188
GS3MGS1	0.129	0.128	0.128	0.127	0.143	0.140	0.125	0.122	0.120	0.120	0.115	0.116
GS3MTB3MS	0.125	0.125	0.125	0.124	0.128	0.127	0.126	0.125	0.125	0.125	0.124	0.126
GS3MTB6MS	0.131	0.131	0.131	0.131	0.133	0.132	0.133	0.132	0.131	0.131	0.126	0.126
AAAMGS1	0.136	0.136	0.135	0.134	0.154	0.151	0.132	0.131	0.133	0.132	0.143	0.152
BAAMGS1	0.144	0.143	0.143	0.142	0.154	0.153	0.140	0.139	0.139	0.139	0.147	0.154
GS1MTB3MS	0.157	0.158	0.158	0.158	0.157	0.157	0.159	0.160	0.160	0.159	0.159	0.158
GS1MTB6MS	0.165	0.165	0.166	0.166	0.161	0.161	0.168	0.170	0.171	0.171	0.171	0.169
TB6MSMTB3MS	0.152	0.151	0.151	0.151	0.151	0.151	0.150	0.149	0.149	0.149	0.153	0.156
AAAMTB6MS	0.138	0.137	0.137	0.136	0.147	0.146	0.134	0.132	0.132	0.132	0.138	0.144
BAAMTB6MS	0.147	0.146	0.145	0.145	0.153	0.152	0.142	0.140	0.139	0.139	0.143	0.149
AAAMTB3MS	0.132	0.132	0.131	0.130	0.143	0.141	0.128	0.127	0.128	0.128	0.136	0.144
BAAMTB3MS	0.139	0.139	0.138	0.138	0.144	0.144	0.137	0.135	0.136	0.136	0.142	0.148

Table 8 : Forecasting NBER Recessions Over the Next 6 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=6												
Index	sym10	sym11	sym12	sym13	sym14	sym15	sym16	coif1	coif2	coif3	coif4	coif5
FEDFUNDS	0.144	0.144	0.150	0.155	0.160	0.164	0.172	0.183	0.162	0.147	0.142	0.145
INTGSTUSM193N	0.149	0.149	0.155	0.159	0.164	0.168	0.176	0.207	0.172	0.148	0.144	0.149
AAA	0.161	0.161	0.162	0.163	0.164	0.164	0.166	0.174	0.165	0.161	0.160	0.161
BAA	0.160	0.160	0.162	0.163	0.165	0.166	0.169	0.163	0.160	0.159	0.159	0.160
GS1	0.152	0.152	0.156	0.159	0.162	0.165	0.171	0.221	0.176	0.150	0.148	0.153
GS3	0.159	0.160	0.161	0.161	0.162	0.163	0.166	0.213	0.166	0.152	0.156	0.160
GS5	0.161	0.161	0.161	0.161	0.162	0.162	0.163	0.202	0.163	0.154	0.159	0.161
GS10	0.160	0.160	0.160	0.159	0.160	0.160	0.160	0.188	0.163	0.157	0.159	0.160
TB3MS	0.148	0.149	0.154	0.159	0.164	0.167	0.175	0.206	0.173	0.148	0.144	0.149
TB6MS	0.149	0.150	0.154	0.158	0.162	0.165	0.173	0.207	0.172	0.149	0.146	0.150
TB3SMFFM	0.143	0.143	0.150	0.154	0.157	0.158	0.162	0.135	0.138	0.140	0.137	0.144
TB6SMFFM	0.141	0.141	0.149	0.154	0.158	0.160	0.164	0.130	0.134	0.135	0.134	0.142
GS10MFFM	0.127	0.127	0.140	0.151	0.161	0.169	0.189	0.120	0.121	0.120	0.119	0.129
GS5MFFM	0.126	0.126	0.138	0.148	0.157	0.163	0.178	0.118	0.120	0.120	0.117	0.127
GS3MFFM	0.129	0.128	0.140	0.149	0.156	0.161	0.172	0.117	0.122	0.122	0.120	0.130
GS1MFFM	0.139	0.138	0.148	0.153	0.157	0.160	0.164	0.125	0.130	0.131	0.130	0.140
AAAMFFM	0.137	0.137	0.152	0.167	0.182	0.194	0.227	0.132	0.127	0.124	0.126	0.138
BAAMFFM	0.141	0.141	0.155	0.168	0.182	0.193	0.222	0.136	0.131	0.128	0.130	0.142
AAAMGS10	0.265	0.265	0.267	0.269	0.270	0.272	0.278	0.155	0.170	0.219	0.259	0.265
BAAMGS10	0.197	0.197	0.205	0.208	0.213	0.216	0.225	0.157	0.158	0.170	0.186	0.198
GS10MGS1	0.130	0.131	0.144	0.158	0.175	0.191	0.242	0.131	0.123	0.119	0.122	0.132
GS10MGS3	0.158	0.157	0.180	0.192	0.215	0.235	0.296	0.126	0.124	0.130	0.141	0.160
GS10MGS5	0.193	0.192	0.218	0.228	0.250	0.269	0.319	0.132	0.133	0.142	0.163	0.197
GS10MTB3MS	0.129	0.130	0.144	0.158	0.174	0.188	0.231	0.123	0.119	0.117	0.120	0.131
GS10MTB6MS	0.130	0.130	0.142	0.154	0.169	0.183	0.229	0.130	0.126	0.123	0.123	0.131
AAAMGS5	0.295	0.294	0.307	0.311	0.319	0.325	0.343	0.145	0.148	0.191	0.263	0.297
BAAMGS5	0.216	0.216	0.229	0.234	0.243	0.249	0.265	0.156	0.152	0.166	0.195	0.218
GS5MGS1	0.120	0.121	0.133	0.145	0.160	0.172	0.211	0.133	0.125	0.118	0.115	0.121
GS5MGS3	0.135	0.135	0.148	0.157	0.173	0.187	0.239	0.126	0.121	0.119	0.126	0.136
GS5MTB3MS	0.126	0.126	0.138	0.150	0.163	0.173	0.202	0.123	0.121	0.119	0.119	0.127
GS5MTB6MS	0.126	0.126	0.136	0.146	0.158	0.167	0.199	0.130	0.128	0.125	0.121	0.127
AAAMGS3	0.246	0.245	0.272	0.282	0.299	0.310	0.342	0.138	0.141	0.159	0.203	0.249
BAAMGS3	0.203	0.202	0.221	0.229	0.241	0.250	0.274	0.153	0.148	0.155	0.177	0.205
GS3MGS1	0.119	0.120	0.130	0.143	0.156	0.167	0.197	0.131	0.124	0.120	0.115	0.120
GS3MTB3MS	0.131	0.131	0.141	0.151	0.161	0.169	0.190	0.125	0.126	0.125	0.124	0.132
GS3MTB6MS	0.130	0.130	0.138	0.147	0.156	0.163	0.187	0.131	0.133	0.131	0.126	0.131
AAAMGS1	0.165	0.166	0.190	0.209	0.233	0.252	0.303	0.139	0.132	0.133	0.145	0.168
BAAMGS1	0.164	0.164	0.183	0.197	0.214	0.228	0.263	0.147	0.140	0.139	0.148	0.166
GS1MTB3MS	0.159	0.158	0.159	0.159	0.161	0.163	0.168	0.157	0.159	0.160	0.159	0.158
GS1MTB6MS	0.168	0.167	0.164	0.161	0.160	0.159	0.162	0.163	0.168	0.171	0.170	0.168
TB6MSMTB3MS	0.157	0.159	0.161	0.165	0.168	0.170	0.173	0.151	0.151	0.149	0.153	0.158
AAAMTB6MS	0.155	0.155	0.177	0.195	0.218	0.236	0.286	0.140	0.134	0.132	0.139	0.157
BAAMTB6MS	0.157	0.157	0.174	0.188	0.204	0.217	0.253	0.148	0.142	0.139	0.144	0.159
AAAMTB3MS	0.154	0.155	0.176	0.196	0.218	0.236	0.285	0.134	0.128	0.128	0.137	0.157
BAAMTB3MS	0.156	0.157	0.174	0.189	0.205	0.218	0.253	0.140	0.137	0.136	0.143	0.159

Table 9 : Forecasting NBER Recessions Over the Next 6 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$													
k=12													
Index	standard	haar	db2	db3	db4	db5	db6	db7	db8	db9	db10	db11	db12
FEDFUNDS	0.175	0.171	0.168	0.166	0.165	0.163	0.161	0.159	0.158	0.156	0.155	0.154	0.153
INTGSTUSM193N	0.220	0.210	0.204	0.200	0.196	0.193	0.189	0.187	0.184	0.181	0.179	0.176	0.174
AAA	0.198	0.194	0.193	0.191	0.190	0.189	0.188	0.188	0.187	0.186	0.185	0.185	0.184
BAA	0.174	0.172	0.172	0.171	0.171	0.171	0.170	0.170	0.170	0.169	0.169	0.169	0.169
GS1	0.237	0.223	0.217	0.212	0.207	0.203	0.200	0.197	0.194	0.191	0.188	0.185	0.182
GS3	0.246	0.229	0.221	0.215	0.210	0.206	0.202	0.199	0.196	0.193	0.190	0.187	0.185
GS5	0.238	0.222	0.214	0.208	0.204	0.200	0.197	0.194	0.191	0.188	0.186	0.184	0.182
GS10	0.236	0.223	0.216	0.212	0.208	0.205	0.202	0.199	0.197	0.195	0.193	0.191	0.189
TB3MS	0.221	0.211	0.206	0.201	0.198	0.194	0.191	0.188	0.185	0.182	0.180	0.177	0.175
TB6MS	0.226	0.215	0.209	0.204	0.200	0.197	0.194	0.191	0.188	0.185	0.183	0.180	0.178
TB3SMFFM	0.139	0.137	0.137	0.136	0.135	0.135	0.134	0.134	0.134	0.134	0.134	0.135	0.135
TB6SMFFM	0.133	0.131	0.131	0.131	0.130	0.130	0.130	0.130	0.129	0.130	0.130	0.130	0.131
GS10MFFM	0.124	0.122	0.122	0.122	0.121	0.120	0.119	0.119	0.119	0.118	0.119	0.119	0.119
GS5MFFM	0.122	0.121	0.121	0.120	0.119	0.119	0.118	0.118	0.117	0.117	0.117	0.118	0.118
GS3MFFM	0.124	0.123	0.122	0.122	0.121	0.120	0.120	0.119	0.119	0.119	0.119	0.120	0.120
GS1MFFM	0.132	0.130	0.130	0.129	0.129	0.128	0.128	0.128	0.128	0.128	0.128	0.129	0.130
AAAMFFM	0.131	0.128	0.128	0.127	0.126	0.125	0.124	0.123	0.123	0.122	0.122	0.122	0.122
BAAMFFM	0.135	0.132	0.132	0.131	0.130	0.129	0.129	0.128	0.128	0.128	0.128	0.128	0.128
AAAMGS10	0.154	0.158	0.160	0.162	0.164	0.166	0.168	0.169	0.171	0.172	0.173	0.174	0.175
BAAMGS10	0.156	0.156	0.156	0.156	0.156	0.156	0.157	0.157	0.157	0.157	0.158	0.158	0.158
GS10MGS1	0.122	0.120	0.120	0.120	0.120	0.120	0.119	0.119	0.119	0.119	0.119	0.119	0.119
GS10MGS3	0.125	0.125	0.126	0.127	0.128	0.128	0.128	0.129	0.129	0.130	0.130	0.131	0.131
GS10MGS5	0.135	0.136	0.137	0.138	0.138	0.139	0.139	0.139	0.139	0.140	0.140	0.141	0.141
GS10MTB3MS	0.122	0.120	0.121	0.121	0.120	0.120	0.119	0.119	0.119	0.119	0.119	0.120	0.120
GS10MTB6MS	0.129	0.127	0.127	0.126	0.126	0.125	0.124	0.124	0.124	0.123	0.123	0.124	0.124
AAAMGS5	0.147	0.147	0.148	0.149	0.149	0.150	0.151	0.152	0.153	0.154	0.156	0.157	0.158
BAAMGS5	0.153	0.152	0.152	0.152	0.152	0.152	0.152	0.153	0.153	0.153	0.154	0.154	0.154
GS5MGS1	0.123	0.120	0.120	0.120	0.119	0.118	0.117	0.117	0.116	0.116	0.115	0.115	0.115
GS5MGS3	0.118	0.116	0.116	0.117	0.118	0.118	0.119	0.119	0.119	0.119	0.120	0.120	0.121
GS5MTB3MS	0.122	0.121	0.121	0.121	0.121	0.120	0.120	0.119	0.119	0.119	0.119	0.120	0.120
GS5MTB6MS	0.130	0.128	0.128	0.128	0.127	0.126	0.125	0.124	0.124	0.123	0.123	0.123	0.123
AAAMGS3	0.140	0.141	0.141	0.142	0.142	0.143	0.143	0.143	0.143	0.144	0.144	0.145	0.145
BAAMGS3	0.150	0.149	0.149	0.148	0.148	0.148	0.148	0.148	0.148	0.149	0.149	0.149	0.149
GS3MGS1	0.123	0.121	0.120	0.120	0.119	0.118	0.117	0.116	0.116	0.115	0.115	0.115	0.115
GS3MTB3MS	0.127	0.126	0.126	0.126	0.125	0.125	0.124	0.124	0.124	0.124	0.125	0.125	0.126
GS3MTB6MS	0.134	0.133	0.133	0.132	0.131	0.130	0.129	0.128	0.128	0.128	0.128	0.128	0.128
AAAMGS1	0.133	0.131	0.131	0.131	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.130	0.131
BAAMGS1	0.142	0.140	0.140	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139	0.139
GS1MTB3MS	0.155	0.156	0.156	0.156	0.156	0.156	0.155	0.155	0.155	0.156	0.156	0.156	0.156
GS1MTB6MS	0.166	0.168	0.168	0.168	0.168	0.168	0.167	0.167	0.167	0.167	0.167	0.167	0.167
TB6MSMTB3MS	0.147	0.147	0.147	0.148	0.149	0.150	0.151	0.153	0.154	0.155	0.156	0.156	0.157
AAAMTB6MS	0.138	0.136	0.135	0.135	0.134	0.134	0.133	0.133	0.133	0.132	0.132	0.132	0.132
BAAMTB6MS	0.146	0.144	0.144	0.143	0.143	0.142	0.142	0.141	0.141	0.141	0.141	0.141	0.140
AAAMTB3MS	0.132	0.130	0.129	0.129	0.129	0.128	0.128	0.128	0.128	0.128	0.128	0.129	0.129
BAAMTB3MS	0.139	0.138	0.138	0.138	0.138	0.138	0.137	0.137	0.137	0.137	0.137	0.138	0.138

Table 10: Forecasting NBER Recessions Over the Next 12 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=12												
Index	db13	db14	db15	db16	sym2	sym3	sym4	sym5	sym6	sym7	sym8	sym9
FEDFUNDS	0.151	0.150	0.149	0.149	0.168	0.166	0.146	0.143	0.143	0.143	0.147	0.151
INTGSTUSM193N	0.172	0.170	0.168	0.166	0.204	0.200	0.159	0.152	0.149	0.149	0.146	0.148
AAA	0.183	0.183	0.183	0.183	0.193	0.191	0.182	0.182	0.184	0.183	0.187	0.189
BAA	0.169	0.169	0.169	0.169	0.172	0.171	0.169	0.170	0.172	0.171	0.176	0.179
GS1	0.180	0.178	0.176	0.174	0.217	0.212	0.167	0.160	0.157	0.157	0.150	0.149
GS3	0.182	0.180	0.179	0.177	0.221	0.215	0.173	0.167	0.167	0.166	0.160	0.158
GS5	0.180	0.179	0.178	0.177	0.214	0.208	0.173	0.170	0.170	0.169	0.165	0.163
GS10	0.188	0.187	0.186	0.185	0.216	0.212	0.182	0.179	0.179	0.178	0.176	0.175
TB3MS	0.173	0.171	0.169	0.167	0.206	0.201	0.160	0.153	0.150	0.150	0.146	0.148
TB6MS	0.175	0.173	0.171	0.169	0.209	0.204	0.163	0.155	0.152	0.152	0.146	0.148
TB3SMFFM	0.136	0.136	0.137	0.138	0.137	0.136	0.141	0.146	0.149	0.148	0.155	0.158
TB6SMFFM	0.132	0.132	0.133	0.135	0.131	0.131	0.139	0.144	0.149	0.148	0.157	0.160
GS10MFFM	0.120	0.120	0.121	0.122	0.122	0.122	0.127	0.134	0.140	0.138	0.159	0.169
GS5MFFM	0.119	0.120	0.121	0.122	0.121	0.120	0.127	0.134	0.141	0.139	0.158	0.167
GS3MFFM	0.121	0.122	0.123	0.124	0.122	0.122	0.129	0.137	0.143	0.141	0.158	0.165
GS1MFFM	0.131	0.132	0.133	0.134	0.130	0.129	0.139	0.145	0.149	0.148	0.158	0.161
AAAMFFM	0.123	0.123	0.124	0.125	0.128	0.127	0.129	0.136	0.143	0.141	0.167	0.183
BAAMFFM	0.128	0.129	0.129	0.130	0.132	0.131	0.133	0.139	0.145	0.143	0.165	0.179
AAAMGS10	0.176	0.177	0.179	0.180	0.160	0.162	0.183	0.188	0.192	0.191	0.204	0.211
BAAMGS10	0.158	0.159	0.159	0.159	0.156	0.156	0.161	0.163	0.165	0.165	0.172	0.178
GS10MGS1	0.119	0.120	0.120	0.121	0.120	0.120	0.124	0.130	0.136	0.134	0.159	0.178
GS10MGS3	0.132	0.132	0.133	0.133	0.126	0.127	0.136	0.140	0.142	0.143	0.159	0.175
GS10MGS5	0.142	0.142	0.143	0.143	0.137	0.138	0.145	0.149	0.150	0.151	0.169	0.183
GS10MTB3MS	0.121	0.121	0.122	0.123	0.121	0.121	0.127	0.135	0.142	0.140	0.169	0.188
GS10MTB6MS	0.124	0.125	0.125	0.126	0.127	0.126	0.129	0.134	0.139	0.138	0.162	0.181
AAAMGS5	0.160	0.161	0.163	0.165	0.148	0.149	0.171	0.182	0.186	0.187	0.215	0.232
BAAMGS5	0.155	0.155	0.156	0.156	0.152	0.152	0.158	0.163	0.165	0.165	0.179	0.190
GS5MGS1	0.115	0.115	0.116	0.116	0.120	0.120	0.119	0.126	0.132	0.131	0.156	0.173
GS5MGS3	0.121	0.122	0.123	0.123	0.116	0.117	0.127	0.132	0.136	0.135	0.149	0.163
GS5MTB3MS	0.121	0.121	0.122	0.123	0.121	0.121	0.128	0.135	0.143	0.141	0.167	0.182
GS5MTB6MS	0.124	0.124	0.124	0.125	0.128	0.128	0.128	0.134	0.139	0.138	0.160	0.175
AAAMGS3	0.146	0.147	0.147	0.148	0.141	0.142	0.152	0.161	0.166	0.166	0.198	0.220
BAAMGS3	0.149	0.150	0.150	0.150	0.149	0.148	0.152	0.157	0.159	0.159	0.176	0.189
GS3MGS1	0.115	0.115	0.116	0.116	0.120	0.120	0.120	0.127	0.134	0.132	0.159	0.174
GS3MTB3MS	0.126	0.127	0.128	0.129	0.126	0.126	0.133	0.140	0.147	0.145	0.168	0.180
GS3MTB6MS	0.129	0.129	0.129	0.130	0.133	0.132	0.133	0.138	0.143	0.142	0.162	0.174
AAAMGS1	0.131	0.131	0.132	0.133	0.131	0.131	0.136	0.142	0.148	0.147	0.180	0.206
BAAMGS1	0.139	0.139	0.139	0.140	0.140	0.139	0.141	0.146	0.150	0.149	0.171	0.188
GS1MTB3MS	0.156	0.156	0.156	0.156	0.156	0.156	0.157	0.157	0.158	0.158	0.166	0.173
GS1MTB6MS	0.167	0.167	0.166	0.166	0.168	0.168	0.164	0.161	0.159	0.159	0.160	0.164
TB6MSMTB3MS	0.157	0.157	0.157	0.157	0.147	0.148	0.160	0.162	0.164	0.163	0.171	0.174
AAAMTB6MS	0.133	0.133	0.134	0.134	0.135	0.135	0.137	0.143	0.149	0.147	0.179	0.204
BAAMTB6MS	0.141	0.141	0.141	0.141	0.144	0.143	0.142	0.146	0.150	0.149	0.171	0.188
AAAMTB3MS	0.130	0.130	0.131	0.132	0.129	0.129	0.136	0.144	0.151	0.149	0.185	0.210
BAAMTB3MS	0.138	0.138	0.139	0.139	0.138	0.138	0.142	0.147	0.152	0.151	0.175	0.193

Table 11 : Forecasting NBER Recessions Over the Next 12 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=12												
Index	sym10	sym11	sym12	sym13	sym14	sym15	sym16	coif1	coif2	coif3	coif4	coif5
FEDFUNDS	0.154	0.155	0.158	0.159	0.161	0.161	0.162	0.156	0.146	0.143	0.147	0.155
INTGSTUSM193N	0.151	0.152	0.155	0.156	0.157	0.157	0.157	0.179	0.159	0.148	0.146	0.152
AAA	0.193	0.193	0.200	0.205	0.211	0.215	0.225	0.186	0.182	0.184	0.187	0.194
BAA	0.184	0.184	0.191	0.197	0.203	0.208	0.220	0.169	0.169	0.172	0.176	0.185
GS1	0.150	0.150	0.152	0.153	0.153	0.154	0.154	0.188	0.167	0.156	0.149	0.150
GS3	0.158	0.158	0.158	0.159	0.160	0.162	0.166	0.190	0.172	0.166	0.160	0.158
GS5	0.163	0.163	0.164	0.166	0.168	0.170	0.176	0.187	0.173	0.169	0.165	0.163
GS10	0.174	0.174	0.176	0.179	0.182	0.184	0.192	0.193	0.182	0.179	0.176	0.174
TB3MS	0.151	0.151	0.154	0.156	0.157	0.157	0.157	0.181	0.160	0.149	0.146	0.151
TB6MS	0.150	0.150	0.152	0.154	0.154	0.154	0.154	0.183	0.163	0.151	0.147	0.150
TB3SMFFM	0.159	0.160	0.161	0.161	0.162	0.163	0.164	0.134	0.141	0.150	0.156	0.160
TB6SMFFM	0.162	0.162	0.163	0.163	0.164	0.165	0.168	0.130	0.138	0.150	0.158	0.162
GS10MFFM	0.178	0.180	0.192	0.200	0.211	0.219	0.243	0.119	0.126	0.141	0.160	0.180
GS5MFFM	0.173	0.175	0.184	0.191	0.200	0.207	0.231	0.118	0.126	0.141	0.159	0.175
GS3MFFM	0.170	0.171	0.176	0.180	0.186	0.191	0.208	0.120	0.129	0.144	0.159	0.171
GS1MFFM	0.163	0.163	0.164	0.165	0.167	0.169	0.175	0.128	0.138	0.150	0.158	0.163
AAAMFFM	0.198	0.201	0.221	0.235	0.249	0.258	0.279	0.123	0.128	0.144	0.169	0.201
BAAMFFM	0.192	0.195	0.211	0.222	0.234	0.242	0.259	0.128	0.133	0.145	0.167	0.195
AAAMGS10	0.219	0.218	0.224	0.226	0.224	0.222	0.213	0.174	0.183	0.192	0.204	0.220
BAAMGS10	0.184	0.185	0.191	0.193	0.195	0.195	0.194	0.158	0.161	0.165	0.173	0.186
GS10MGS1	0.195	0.200	0.225	0.243	0.252	0.252	0.246	0.120	0.124	0.136	0.161	0.199
GS10MGS3	0.191	0.194	0.217	0.229	0.228	0.222	0.203	0.130	0.136	0.143	0.161	0.195
GS10MGS5	0.192	0.194	0.196	0.190	0.184	0.178	0.168	0.140	0.145	0.150	0.170	0.194
GS10MTB3MS	0.205	0.211	0.237	0.259	0.278	0.289	0.313	0.120	0.127	0.142	0.172	0.210
GS10MTB6MS	0.197	0.202	0.228	0.246	0.261	0.267	0.276	0.124	0.128	0.140	0.164	0.202
AAAMGS5	0.245	0.245	0.252	0.252	0.246	0.241	0.223	0.155	0.171	0.187	0.217	0.247
BAAMGS5	0.199	0.200	0.208	0.210	0.210	0.209	0.204	0.154	0.159	0.165	0.181	0.201
GS5MGS1	0.189	0.193	0.220	0.242	0.256	0.261	0.265	0.117	0.119	0.133	0.159	0.193
GS5MGS3	0.181	0.185	0.228	0.269	0.285	0.285	0.267	0.120	0.127	0.136	0.151	0.186
GS5MTB3MS	0.195	0.199	0.222	0.243	0.263	0.277	0.309	0.120	0.127	0.143	0.169	0.199
GS5MTB6MS	0.189	0.193	0.216	0.237	0.255	0.265	0.285	0.124	0.128	0.140	0.162	0.193
AAAMGS3	0.240	0.241	0.260	0.268	0.264	0.258	0.238	0.144	0.152	0.167	0.200	0.243
BAAMGS3	0.202	0.203	0.216	0.222	0.224	0.222	0.215	0.149	0.152	0.160	0.177	0.204
GS3MGS1	0.186	0.189	0.207	0.220	0.231	0.236	0.245	0.116	0.120	0.135	0.161	0.189
GS3MTB3MS	0.190	0.193	0.209	0.224	0.240	0.253	0.285	0.125	0.133	0.148	0.169	0.193
GS3MTB6MS	0.185	0.189	0.205	0.219	0.235	0.245	0.270	0.129	0.133	0.144	0.163	0.188
AAAMGS1	0.228	0.232	0.259	0.273	0.277	0.274	0.261	0.131	0.136	0.149	0.183	0.233
BAAMGS1	0.204	0.207	0.225	0.235	0.240	0.240	0.236	0.139	0.141	0.151	0.174	0.207
GS1MTB3MS	0.177	0.180	0.186	0.194	0.207	0.218	0.247	0.156	0.156	0.158	0.167	0.179
GS1MTB6MS	0.169	0.171	0.177	0.184	0.196	0.206	0.236	0.167	0.164	0.159	0.160	0.171
TB6MSMTB3MS	0.176	0.177	0.178	0.182	0.186	0.191	0.205	0.154	0.160	0.164	0.172	0.176
AAAMTB6MS	0.226	0.230	0.258	0.274	0.283	0.285	0.280	0.133	0.136	0.150	0.182	0.232
BAAMTB6MS	0.203	0.206	0.225	0.236	0.244	0.246	0.248	0.141	0.142	0.151	0.173	0.207
AAAMTB3MS	0.232	0.236	0.265	0.284	0.297	0.302	0.307	0.129	0.136	0.152	0.188	0.237
BAAMTB3MS	0.208	0.211	0.231	0.244	0.254	0.259	0.266	0.138	0.142	0.152	0.178	0.212

Table 12: Forecasting NBER Recessions Over the Next 24 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$													
k=24													
Index	standard	haar	db2	db3	db4	db5	db6	db7	db8	db9	db10	db11	db12
FEDFUNDS	0.164	0.165	0.165	0.166	0.166	0.166	0.167	0.167	0.167	0.167	0.168	0.168	0.168
INTGSTUSM193N	0.161	0.162	0.162	0.162	0.163	0.163	0.162	0.162	0.162	0.162	0.161	0.161	0.161
AAA	0.201	0.205	0.205	0.206	0.208	0.209	0.211	0.212	0.214	0.215	0.217	0.218	0.220
BAA	0.189	0.193	0.194	0.195	0.197	0.198	0.200	0.202	0.203	0.205	0.207	0.208	0.210
GS1	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153
GS3	0.157	0.158	0.158	0.158	0.158	0.159	0.159	0.160	0.161	0.162	0.163	0.164	0.165
GS5	0.165	0.166	0.167	0.167	0.168	0.168	0.169	0.170	0.171	0.173	0.174	0.176	0.177
GS10	0.178	0.180	0.180	0.180	0.181	0.182	0.183	0.184	0.186	0.188	0.189	0.191	0.193
TB3MS	0.160	0.161	0.161	0.162	0.162	0.162	0.162	0.162	0.162	0.161	0.161	0.161	0.161
TB6MS	0.155	0.156	0.156	0.156	0.156	0.156	0.156	0.156	0.156	0.156	0.155	0.155	0.155
TB3SMFFM	0.161	0.162	0.162	0.162	0.162	0.162	0.162	0.163	0.163	0.163	0.164	0.164	0.164
TB6SMFFM	0.163	0.164	0.164	0.164	0.164	0.164	0.165	0.165	0.165	0.166	0.166	0.167	0.167
GS10MFFM	0.202	0.210	0.211	0.213	0.216	0.218	0.221	0.225	0.228	0.232	0.236	0.240	0.245
GS5MFFM	0.190	0.195	0.196	0.198	0.200	0.202	0.205	0.207	0.210	0.213	0.216	0.220	0.224
GS3MFFM	0.178	0.182	0.182	0.184	0.185	0.186	0.188	0.189	0.191	0.193	0.195	0.198	0.200
GS1MFFM	0.164	0.165	0.165	0.165	0.166	0.166	0.167	0.167	0.168	0.169	0.170	0.170	0.171
AAAMFFM	0.269	0.288	0.290	0.295	0.301	0.306	0.312	0.318	0.323	0.329	0.335	0.340	0.346
BAAMFFM	0.248	0.263	0.265	0.269	0.274	0.279	0.284	0.288	0.293	0.298	0.303	0.308	0.312
AAAMGS10	0.414	0.440	0.434	0.430	0.426	0.421	0.416	0.409	0.402	0.395	0.388	0.380	0.372
BAAMGS10	0.233	0.242	0.242	0.244	0.246	0.247	0.248	0.249	0.249	0.249	0.248	0.247	0.246
GS10MGS1	0.264	0.273	0.273	0.275	0.278	0.279	0.280	0.281	0.281	0.280	0.280	0.279	0.279
GS10MGS3	0.288	0.302	0.299	0.298	0.295	0.292	0.288	0.285	0.281	0.278	0.274	0.270	0.265
GS10MGS5	0.237	0.238	0.233	0.228	0.224	0.219	0.215	0.211	0.208	0.205	0.202	0.198	0.194
GS10MTB3MS	0.260	0.275	0.277	0.282	0.287	0.292	0.296	0.300	0.303	0.307	0.311	0.316	0.320
GS10MTB6MS	0.255	0.266	0.267	0.271	0.274	0.277	0.279	0.281	0.283	0.284	0.286	0.289	0.291
AAAMGS5	0.522	0.547	0.536	0.528	0.521	0.513	0.504	0.495	0.485	0.475	0.465	0.454	0.442
BAAMGS5	0.286	0.300	0.299	0.300	0.301	0.302	0.302	0.302	0.301	0.300	0.298	0.296	0.293
GS5MGS1	0.245	0.255	0.257	0.260	0.264	0.267	0.269	0.271	0.272	0.273	0.273	0.274	0.276
GS5MGS3	0.295	0.323	0.327	0.331	0.333	0.335	0.335	0.334	0.333	0.332	0.331	0.330	0.328
GS5MTB3MS	0.233	0.246	0.249	0.254	0.258	0.263	0.267	0.271	0.275	0.279	0.283	0.288	0.293
GS5MTB6MS	0.232	0.243	0.245	0.249	0.253	0.256	0.259	0.262	0.264	0.267	0.270	0.273	0.277
AAAMGS3	0.500	0.527	0.519	0.515	0.510	0.504	0.497	0.490	0.483	0.474	0.466	0.456	0.446
BAAMGS3	0.307	0.324	0.323	0.325	0.327	0.327	0.328	0.328	0.327	0.325	0.323	0.320	0.317
GS3MGS1	0.219	0.225	0.226	0.228	0.231	0.233	0.235	0.237	0.238	0.239	0.240	0.241	0.243
GS3MTB3MS	0.212	0.222	0.224	0.228	0.232	0.236	0.240	0.243	0.247	0.250	0.254	0.259	0.265
GS3MTB6MS	0.212	0.220	0.222	0.225	0.228	0.231	0.234	0.237	0.239	0.242	0.245	0.248	0.253
AAAMGS1	0.389	0.408	0.406	0.408	0.409	0.410	0.409	0.407	0.405	0.402	0.398	0.394	0.390
BAAMGS1	0.293	0.307	0.308	0.311	0.314	0.316	0.318	0.319	0.320	0.320	0.319	0.318	0.316
GS1MTB3MS	0.181	0.193	0.195	0.198	0.202	0.205	0.208	0.212	0.215	0.219	0.223	0.228	0.234
GS1MTB6MS	0.174	0.184	0.185	0.188	0.190	0.193	0.195	0.197	0.200	0.204	0.208	0.213	0.219
TB6MSMTB3MS	0.174	0.180	0.181	0.182	0.184	0.186	0.188	0.190	0.192	0.194	0.196	0.198	0.201
AAAMTB6MS	0.354	0.374	0.374	0.378	0.381	0.383	0.385	0.385	0.385	0.385	0.384	0.383	0.383
BAAMTB6MS	0.278	0.291	0.293	0.297	0.300	0.303	0.306	0.308	0.310	0.311	0.312	0.312	0.313
AAAMTB3MS	0.352	0.375	0.377	0.382	0.388	0.392	0.395	0.398	0.400	0.402	0.403	0.405	0.407
BAAMTB3MS	0.281	0.296	0.299	0.304	0.308	0.313	0.316	0.320	0.322	0.325	0.327	0.329	0.331

Table 13: Forecasting NBER Recessions Over the Next 24 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=24												
Index	db13	db14	db15	db16	sym2	sym3	sym4	sym5	sym6	sym7	sym8	sym9
FEDFUNDS	0.168	0.168	0.168	0.169	0.165	0.166	0.170	0.171	0.173	0.172	0.174	0.172
INTGSTUSM193N	0.161	0.161	0.161	0.161	0.162	0.162	0.162	0.163	0.167	0.165	0.168	0.166
AAA	0.222	0.223	0.224	0.226	0.205	0.206	0.230	0.234	0.234	0.236	0.236	0.238
BAA	0.212	0.213	0.215	0.216	0.194	0.195	0.222	0.229	0.232	0.232	0.242	0.249
GS1	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.154	0.155	0.154	0.158	0.158
GS3	0.166	0.167	0.168	0.169	0.158	0.158	0.171	0.171	0.166	0.170	0.162	0.161
GS5	0.179	0.181	0.182	0.184	0.167	0.167	0.187	0.188	0.183	0.188	0.177	0.176
GS10	0.195	0.197	0.199	0.200	0.180	0.180	0.204	0.207	0.201	0.206	0.197	0.197
TB3MS	0.161	0.160	0.160	0.161	0.161	0.162	0.161	0.163	0.167	0.165	0.168	0.166
TB6MS	0.155	0.155	0.155	0.155	0.156	0.156	0.155	0.157	0.160	0.158	0.163	0.162
TB3SMFFM	0.165	0.165	0.165	0.166	0.162	0.162	0.166	0.167	0.166	0.166	0.166	0.165
TB6SMFFM	0.167	0.168	0.168	0.169	0.164	0.164	0.169	0.170	0.169	0.170	0.167	0.165
GS10MFFM	0.249	0.254	0.259	0.264	0.211	0.213	0.286	0.321	0.340	0.338	0.382	0.374
GS5MFFM	0.228	0.232	0.237	0.241	0.196	0.198	0.260	0.289	0.301	0.303	0.321	0.314
GS3MFFM	0.203	0.207	0.210	0.213	0.182	0.184	0.225	0.242	0.247	0.250	0.250	0.243
GS1MFFM	0.173	0.174	0.175	0.176	0.165	0.165	0.179	0.182	0.180	0.182	0.176	0.171
AAAMFFM	0.351	0.356	0.361	0.367	0.290	0.295	0.392	0.423	0.449	0.438	0.473	0.452
BAAMFFM	0.316	0.321	0.325	0.330	0.265	0.269	0.350	0.378	0.400	0.392	0.437	0.435
AAAMGS10	0.364	0.356	0.349	0.342	0.434	0.430	0.324	0.303	0.309	0.297	0.289	0.272
BAAMGS10	0.245	0.244	0.243	0.242	0.242	0.244	0.243	0.245	0.254	0.247	0.261	0.261
GS10MGS1	0.279	0.279	0.279	0.280	0.273	0.275	0.291	0.315	0.357	0.336	0.427	0.440
GS10MGS3	0.259	0.253	0.248	0.243	0.299	0.298	0.243	0.252	0.285	0.263	0.374	0.387
GS10MGS5	0.189	0.184	0.180	0.176	0.233	0.228	0.172	0.171	0.177	0.171	0.213	0.224
GS10MTB3MS	0.326	0.331	0.337	0.343	0.277	0.282	0.369	0.409	0.445	0.433	0.494	0.488
GS10MTB6MS	0.294	0.297	0.300	0.304	0.267	0.271	0.325	0.360	0.403	0.385	0.473	0.482
AAAMGS5	0.429	0.417	0.405	0.395	0.536	0.528	0.369	0.343	0.355	0.337	0.347	0.327
BAAMGS5	0.289	0.286	0.283	0.280	0.299	0.300	0.278	0.278	0.291	0.280	0.306	0.305
GS5MGS1	0.277	0.279	0.282	0.285	0.257	0.260	0.301	0.331	0.373	0.354	0.432	0.445
GS5MGS3	0.327	0.326	0.325	0.325	0.327	0.331	0.339	0.372	0.427	0.398	0.520	0.531
GS5MTB3MS	0.299	0.306	0.312	0.319	0.249	0.254	0.343	0.380	0.406	0.401	0.434	0.426
GS5MTB6MS	0.281	0.286	0.291	0.297	0.245	0.249	0.320	0.357	0.394	0.382	0.446	0.454
AAAMGS3	0.436	0.426	0.416	0.407	0.519	0.515	0.390	0.375	0.398	0.374	0.407	0.388
BAAMGS3	0.314	0.310	0.307	0.304	0.323	0.325	0.304	0.307	0.327	0.312	0.352	0.352
GS3MGS1	0.245	0.247	0.250	0.253	0.226	0.228	0.267	0.290	0.319	0.307	0.353	0.361
GS3MTB3MS	0.271	0.277	0.284	0.290	0.224	0.228	0.309	0.338	0.352	0.353	0.361	0.347
GS3MTB6MS	0.258	0.263	0.268	0.274	0.222	0.225	0.295	0.327	0.352	0.346	0.383	0.385
AAAMGS1	0.386	0.382	0.379	0.377	0.406	0.408	0.379	0.387	0.422	0.398	0.448	0.438
BAAMGS1	0.315	0.314	0.313	0.313	0.308	0.311	0.319	0.332	0.360	0.343	0.396	0.399
GS1MTB3MS	0.240	0.246	0.252	0.258	0.195	0.198	0.268	0.288	0.278	0.293	0.247	0.223
GS1MTB6MS	0.226	0.233	0.240	0.246	0.185	0.188	0.263	0.287	0.290	0.297	0.283	0.264
TB6MSMTB3MS	0.203	0.205	0.208	0.211	0.181	0.182	0.212	0.214	0.205	0.211	0.175	0.166
AAAMTB6MS	0.382	0.382	0.382	0.383	0.374	0.378	0.394	0.412	0.449	0.427	0.476	0.463
BAAMTB6MS	0.314	0.315	0.316	0.318	0.293	0.297	0.330	0.349	0.379	0.363	0.417	0.421
AAAMTB3MS	0.408	0.410	0.413	0.416	0.377	0.382	0.431	0.451	0.485	0.465	0.499	0.476
BAAMTB3MS	0.333	0.336	0.338	0.341	0.299	0.304	0.356	0.377	0.406	0.392	0.436	0.433

Table 14 : Forecasting NBER Recessions Over the Next 24 Months

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=24												
Index	sym10	sym11	sym12	sym13	sym14	sym15	sym16	coif1	coif2	coif3	coif4	coif5
FEDFUNDS	0.169	0.169	0.164	0.160	0.158	0.157	0.159	0.168	0.170	0.173	0.174	0.168
INTGSTUSM193N	0.163	0.163	0.159	0.157	0.157	0.159	0.169	0.162	0.162	0.167	0.168	0.163
AAA	0.241	0.242	0.250	0.259	0.269	0.277	0.303	0.215	0.230	0.235	0.236	0.242
BAA	0.258	0.259	0.276	0.293	0.307	0.317	0.342	0.205	0.222	0.233	0.243	0.260
GS1	0.158	0.158	0.157	0.156	0.158	0.160	0.171	0.153	0.153	0.155	0.158	0.158
GS3	0.162	0.163	0.166	0.171	0.179	0.187	0.213	0.162	0.170	0.166	0.161	0.163
GS5	0.177	0.178	0.181	0.188	0.198	0.207	0.234	0.173	0.186	0.183	0.176	0.178
GS10	0.199	0.201	0.207	0.216	0.228	0.237	0.267	0.188	0.204	0.201	0.197	0.200
TB3MS	0.163	0.163	0.159	0.157	0.157	0.159	0.169	0.162	0.161	0.166	0.168	0.162
TB6MS	0.161	0.160	0.158	0.157	0.157	0.159	0.168	0.156	0.155	0.160	0.163	0.160
TB3SMFFM	0.165	0.164	0.163	0.161	0.160	0.159	0.158	0.163	0.166	0.166	0.166	0.164
TB6SMFFM	0.163	0.163	0.160	0.159	0.158	0.157	0.156	0.166	0.169	0.169	0.166	0.163
GS10MFFM	0.346	0.338	0.274	0.230	0.207	0.195	0.176	0.233	0.286	0.344	0.381	0.336
GS5MFFM	0.294	0.288	0.242	0.211	0.195	0.187	0.173	0.214	0.260	0.304	0.320	0.287
GS3MFFM	0.231	0.227	0.203	0.186	0.178	0.173	0.166	0.194	0.225	0.249	0.249	0.227
GS1MFFM	0.167	0.166	0.161	0.158	0.157	0.156	0.156	0.169	0.178	0.181	0.175	0.166
AAAMFFM	0.418	0.407	0.339	0.284	0.248	0.228	0.195	0.330	0.392	0.449	0.471	0.406
BAAMFFM	0.419	0.411	0.363	0.315	0.279	0.258	0.217	0.299	0.350	0.401	0.438	0.411
AAAMGS10	0.258	0.256	0.243	0.236	0.225	0.218	0.201	0.392	0.324	0.305	0.287	0.255
BAAMGS10	0.260	0.260	0.263	0.269	0.264	0.260	0.242	0.249	0.244	0.253	0.262	0.260
GS10MGS1	0.435	0.427	0.391	0.336	0.291	0.261	0.211	0.283	0.291	0.357	0.432	0.429
GS10MGS3	0.371	0.369	0.326	0.279	0.232	0.204	0.164	0.277	0.244	0.284	0.378	0.365
GS10MGS5	0.219	0.220	0.213	0.199	0.181	0.170	0.157	0.202	0.174	0.176	0.216	0.218
GS10MTB3MS	0.458	0.446	0.373	0.303	0.260	0.234	0.197	0.312	0.367	0.448	0.496	0.445
GS10MTB6MS	0.470	0.458	0.402	0.327	0.279	0.250	0.208	0.288	0.324	0.405	0.477	0.459
AAAMGS5	0.307	0.303	0.282	0.267	0.243	0.227	0.195	0.468	0.370	0.350	0.345	0.302
BAAMGS5	0.301	0.300	0.298	0.298	0.283	0.271	0.236	0.299	0.279	0.289	0.307	0.300
GS5MGS1	0.443	0.435	0.401	0.348	0.309	0.283	0.239	0.276	0.300	0.374	0.436	0.437
GS5MGS3	0.519	0.514	0.450	0.374	0.305	0.261	0.186	0.337	0.339	0.428	0.523	0.511
GS5MTB3MS	0.401	0.393	0.333	0.278	0.247	0.229	0.203	0.284	0.342	0.409	0.434	0.391
GS5MTB6MS	0.443	0.434	0.383	0.317	0.278	0.255	0.223	0.272	0.318	0.396	0.449	0.435
AAAMGS3	0.364	0.359	0.326	0.299	0.264	0.242	0.197	0.469	0.391	0.393	0.405	0.358
BAAMGS3	0.345	0.343	0.335	0.325	0.300	0.282	0.235	0.324	0.305	0.325	0.354	0.343
GS3MGS1	0.362	0.354	0.338	0.303	0.280	0.265	0.244	0.242	0.266	0.320	0.355	0.358
GS3MTB3MS	0.327	0.320	0.277	0.240	0.220	0.210	0.196	0.254	0.307	0.354	0.359	0.319
GS3MTB6MS	0.376	0.367	0.330	0.281	0.255	0.240	0.226	0.246	0.293	0.354	0.384	0.368
AAAMGS1	0.420	0.412	0.377	0.338	0.299	0.273	0.225	0.402	0.379	0.419	0.448	0.413
BAAMGS1	0.396	0.391	0.378	0.354	0.323	0.301	0.252	0.320	0.319	0.359	0.398	0.392
GS1MTB3MS	0.202	0.199	0.172	0.160	0.156	0.155	0.156	0.222	0.267	0.282	0.243	0.197
GS1MTB6MS	0.241	0.236	0.195	0.168	0.161	0.159	0.159	0.208	0.261	0.292	0.279	0.234
TB6MSMTB3MS	0.161	0.160	0.155	0.153	0.153	0.153	0.158	0.194	0.212	0.205	0.174	0.160
AAAMTB6MS	0.441	0.431	0.386	0.334	0.292	0.266	0.222	0.387	0.393	0.447	0.476	0.432
BAAMTB6MS	0.415	0.410	0.390	0.356	0.321	0.297	0.250	0.313	0.329	0.379	0.420	0.411
AAAMTB3MS	0.444	0.433	0.376	0.321	0.279	0.255	0.213	0.405	0.429	0.483	0.497	0.433
BAAMTB3MS	0.420	0.414	0.382	0.344	0.308	0.285	0.241	0.327	0.355	0.406	0.437	0.414

Table 15: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 3-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$											
k=3											
Index	haar	db2	db3	db4	db5	db6	db7	db8	db9	db10	db11	db12
FEDFUNDS	-0.414	-1.332	-1.967	-2.621	-3.302	-4.008	-4.762	-5.568	-6.412	-7.280	-8.179	-9.125
INTGSTUSM193N	-0.547	-1.690	-2.712	-3.768	-4.905	-6.092	-7.285	-8.462	-9.612	-10.726	-11.801	-12.854
AAA	-1.172	-1.528	-2.044	-2.628	-3.242	-3.868	-4.493	-5.107	-5.702	-6.272	-6.814	-7.326
BAA	-0.926	-1.121	-1.435	-1.763	-2.089	-2.403	-2.696	-2.965	-3.206	-3.420	-3.610	-3.779
GS1	-0.679	-1.993	-3.226	-4.475	-5.780	-7.138	-8.514	-9.869	-11.184	-12.460	-13.715	-14.968
GS3	-1.741	-3.353	-4.838	-6.359	-7.922	-9.522	-11.137	-12.732	-14.275	-15.760	-17.203	-18.633
GS5	-2.205	-3.767	-5.210	-6.710	-8.264	-9.864	-11.482	-13.078	-14.618	-16.091	-17.505	-18.886
GS10	-2.048	-3.184	-4.340	-5.598	-6.926	-8.309	-9.718	-11.113	-12.455	-13.722	-14.907	-16.021
TB3MS	-0.444	-1.536	-2.546	-3.572	-4.676	-5.853	-7.056	-8.246	-9.409	-10.539	-11.636	-12.711
TB6MS	-0.492	-1.694	-2.803	-3.920	-5.104	-6.352	-7.623	-8.874	-10.087	-11.260	-12.399	-13.521
TB3SMFFM	0.412	0.469	0.368	0.363	0.356	0.351	0.591	0.976	1.179	1.247	1.397	1.561
TB6SMFFM	-1.725	-1.894	-2.168	-2.395	-2.590	-2.729	-2.647	-2.420	-2.313	-2.305	-2.169	-1.933
GS10MFFM	-1.521	-1.959	-2.421	-3.008	-3.965	-4.937	-5.677	-6.439	-7.432	-8.497	-9.375	-10.084
GS5MFFM	-1.674	-2.077	-2.527	-3.238	-4.203	-5.062	-5.815	-6.705	-7.717	-8.676	-9.520	-10.320
GS3MFFM	-1.830	-2.162	-2.698	-3.577	-4.496	-5.258	-6.099	-7.066	-7.961	-8.728	-9.501	-10.272
GS1MFFM	-0.867	-1.161	-2.212	-3.216	-3.923	-4.753	-5.671	-6.276	-6.625	-7.067	-7.498	-7.599
AAAMFFM	-0.806	-1.386	-1.865	-2.283	-2.995	-3.842	-4.541	-5.142	-5.879	-6.749	-7.554	-8.208
BAAMFFM	-0.812	-0.962	-1.581	-2.266	-2.924	-3.715	-4.606	-5.499	-6.393	-7.323	-8.289	-9.266
AAAMGS10	-0.539	-0.602	-0.767	-0.888	-0.941	-0.913	-0.805	-0.631	-0.412	-0.172	0.078	0.337
BAAMGS10	0.069	0.063	0.062	0.047	0.014	-0.039	-0.110	-0.192	-0.280	-0.369	-0.457	-0.541
GS10MGS1	-1.237	-1.310	-2.056	-3.090	-3.944	-4.651	-5.612	-6.788	-7.891	-8.790	-9.693	-10.766
GS10MGS3	-1.002	-0.794	-0.732	-0.997	-1.629	-2.391	-3.137	-3.940	-4.859	-5.834	-6.766	-7.659
GS10MGS5	-0.559	-0.007	0.242	0.101	-0.381	-1.005	-1.650	-2.327	-3.036	-3.708	-4.288	-4.829
GS10MTB3MS	-2.178	-2.437	-3.150	-4.133	-5.131	-6.108	-7.181	-8.366	-9.582	-10.762	-11.921	-13.101
GS10MTB6MS	-1.512	-1.620	-2.147	-3.001	-3.951	-4.866	-5.823	-6.877	-7.968	-9.018	-10.027	-11.040
AAAMGS5	-0.735	-0.523	-0.488	-0.499	-0.547	-0.625	-0.719	-0.813	-0.907	-1.001	-1.100	-1.200
BAAMGS5	0.002	-0.135	-0.221	-0.326	-0.472	-0.663	-0.893	-1.147	-1.414	-1.685	-1.958	-2.235
GS5MGS1	-0.536	-0.413	-1.055	-1.947	-2.711	-3.448	-4.461	-5.665	-6.776	-7.737	-8.766	-9.944
GS5MGS3	-0.289	-0.408	-0.714	-1.148	-1.854	-2.704	-3.571	-4.448	-5.381	-6.392	-7.446	-8.501
GS5MTB3MS	-1.775	-1.992	-2.681	-3.577	-4.506	-5.451	-6.482	-7.608	-8.786	-9.983	-11.199	-12.414
GS5MTB6MS	-0.947	-0.994	-1.517	-2.276	-3.113	-3.966	-4.876	-5.864	-6.893	-7.927	-8.968	-10.009
AAAMGS3	-0.754	-0.546	-0.535	-0.594	-0.730	-0.934	-1.174	-1.425	-1.684	-1.956	-2.236	-2.515
BAAMGS3	-0.083	-0.187	-0.288	-0.421	-0.603	-0.836	-1.113	-1.421	-1.747	-2.083	-2.426	-2.775
GS3MGS1	-0.402	-0.503	-1.185	-1.817	-2.444	-3.343	-4.461	-5.561	-6.548	-7.605	-8.835	-10.109
GS3MTB3MS	-1.893	-2.235	-3.015	-3.929	-4.867	-5.830	-6.858	-7.951	-9.073	-10.206	-11.363	-12.510
GS3MTB6MS	-1.204	-1.412	-2.093	-2.933	-3.805	-4.701	-5.639	-6.602	-7.567	-8.535	-9.497	-10.409
AAAMGS1	0.086	-0.433	-0.942	-1.670	-2.514	-3.325	-4.152	-5.063	-6.023	-6.955	-7.835	-8.702
BAAMGS1	-0.019	-0.028	-0.123	-0.273	-0.528	-0.909	-1.391	-1.942	-2.537	-3.158	-3.790	-4.414
GS1MTB3MS	0.031	-0.075	-0.160	-0.248	-0.349	-0.469	-0.614	-0.784	-0.979	-1.192	-1.410	-1.615
GS1MTB6MS	0.228	0.227	0.272	0.319	0.351	0.366	0.367	0.359	0.346	0.331	0.322	0.326
TB6MSMTB3MS	-0.153	-0.480	-0.770	-1.030	-1.271	-1.515	-1.787	-2.108	-2.483	-2.900	-3.332	-3.740
AAAMTB6MS	-0.573	-0.834	-1.262	-1.847	-2.556	-3.314	-4.102	-4.926	-5.771	-6.603	-7.401	-8.160
BAAMTB6MS	-0.239	-0.362	-0.598	-0.891	-1.253	-1.688	-2.182	-2.716	-3.274	-3.842	-4.400	-4.929
AAAMTB3MS	-1.216	-1.604	-2.178	-2.912	-3.732	-4.579	-5.468	-6.416	-7.391	-8.350	-9.284	-10.195
BAAMTB3MS	-0.772	-0.985	-1.369	-1.832	-2.371	-2.982	-3.645	-4.346	-5.073	-5.807	-6.526	-7.202

Table 16 : Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 3-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=3												
Index	db13	db14	db15	db16	sym2	sym3	sym4	sym5	sym6	sym7	sym8	sym9
FEDFUNDS	-10.117	-11.140	-12.178	-13.223	-1.332	-1.967	-17.779	-23.140	-26.049	-25.551	-31.780	-33.243
INTGSTUSM193N	-13.918	-15.005	-16.100	-17.184	-1.690	-2.712	-21.830	-27.683	-30.673	-30.291	-37.170	-37.724
AAA	-7.809	-8.264	-8.692	-9.092	-1.528	-2.044	-10.498	-11.837	-12.416	-12.317	-13.194	-13.264
BAA	-3.931	-4.071	-4.199	-4.317	-1.121	-1.435	-4.712	-4.959	-5.042	-5.001	-4.903	-4.774
GS1	-16.243	-17.555	-18.898	-20.254	-1.993	-3.226	-25.689	-32.448	-36.174	-35.505	-41.945	-41.808
GS3	-20.075	-21.540	-23.019	-24.488	-3.353	-4.838	-29.765	-35.319	-37.820	-37.357	-38.869	-37.206
GS5	-20.257	-21.629	-22.994	-24.332	-3.767	-5.210	-28.929	-33.232	-34.865	-34.587	-34.567	-32.870
GS10	-17.076	-18.078	-19.028	-19.918	-3.184	-4.340	-22.822	-25.116	-25.745	-25.681	-25.110	-23.958
TB3MS	-13.784	-14.866	-15.948	-17.009	-1.536	-2.546	-21.487	-27.167	-29.916	-29.665	-36.542	-37.175
TB6MS	-14.647	-15.789	-16.941	-18.083	-1.694	-2.803	-22.667	-28.365	-31.209	-30.872	-37.016	-37.351
TB3SMFFM	1.545	1.352	1.108	0.923	0.469	0.368	-0.566	0.398	2.006	1.324	4.449	4.514
TB6SMFFM	-1.817	-1.837	-1.837	-1.743	-1.894	-2.168	-3.009	-1.817	0.819	-0.460	2.602	2.482
GS10MFFM	-10.806	-11.563	-12.220	-12.702	-1.959	-2.421	-16.897	-18.538	-16.698	-18.027	-16.990	-17.028
GS5MFFM	-11.085	-11.741	-12.242	-12.650	-2.077	-2.527	-16.675	-17.701	-15.132	-16.760	-14.743	-15.110
GS3MFFM	-10.896	-11.284	-11.507	-11.687	-2.162	-2.698	-14.876	-14.500	-11.242	-13.005	-9.822	-10.016
GS1MFFM	-7.413	-7.227	-7.055	-6.689	-1.161	-2.212	-7.325	-5.019	-2.395	-3.603	-0.313	-0.229
AAAMFFM	-8.843	-9.555	-10.282	-10.920	-1.386	-1.865	-14.967	-17.615	-17.329	-18.049	-18.834	-18.445
BAAMFFM	-10.202	-11.054	-11.805	-12.452	-0.962	-1.581	-15.188	-17.271	-17.341	-17.795	-18.533	-17.880
AAAMGS10	0.616	0.931	1.297	1.721	-0.602	-0.767	4.166	9.128	13.186	12.587	38.853	57.561
BAAMGS10	-0.621	-0.692	-0.754	-0.802	0.063	0.062	-0.811	-0.234	0.456	0.431	8.226	15.735
GS10MGS1	-11.940	-13.040	-13.981	-14.854	-1.310	-2.056	-19.455	-24.197	-24.850	-25.666	-27.924	-27.880
GS10MGS3	-8.583	-9.539	-10.426	-11.160	-0.794	-0.732	-13.340	-15.314	-14.974	-15.442	-12.239	-8.236
GS10MGS5	-5.404	-5.989	-6.501	-6.920	-0.007	0.242	-8.383	-9.055	-8.485	-8.753	-3.687	3.448
GS10MTB3MS	-14.289	-15.402	-16.358	-17.148	-2.437	-3.150	-21.216	-24.715	-24.179	-25.313	-26.452	-26.345
GS10MTB6MS	-12.046	-12.977	-13.776	-14.460	-1.620	-2.147	-17.763	-21.002	-21.144	-21.744	-23.517	-23.638
AAAMGS5	-1.299	-1.389	-1.465	-1.522	-0.523	-0.488	-1.554	-0.781	1.659	0.722	27.051	56.304
BAAMGS5	-2.519	-2.810	-3.105	-3.398	-0.135	-0.221	-4.479	-5.479	-5.247	-5.452	3.399	15.113
GS5MGS1	-11.143	-12.219	-13.173	-14.105	-0.413	-1.055	-19.003	-24.235	-25.072	-26.148	-29.197	-30.958
GS5MGS3	-9.564	-10.658	-11.747	-12.733	-0.408	-0.714	-15.693	-19.662	-19.767	-20.711	-21.143	-19.918
GS5MTB3MS	-13.574	-14.624	-15.531	-16.267	-1.992	-2.681	-19.327	-22.428	-21.088	-22.793	-23.301	-23.963
GS5MTB6MS	-10.996	-11.870	-12.607	-13.224	-0.994	-1.517	-15.637	-18.509	-17.782	-19.031	-20.027	-21.057
AAAMGS3	-2.779	-3.017	-3.214	-3.360	-0.546	-0.535	-3.475	-3.223	-2.171	-2.651	9.794	27.530
BAAMGS3	-3.126	-3.476	-3.820	-4.151	-0.187	-0.288	-5.333	-6.736	-7.042	-7.142	-2.174	6.605
GS3MGS1	-11.245	-12.238	-13.228	-14.265	-0.503	-1.185	-19.394	-24.277	-25.060	-25.796	-28.075	-29.651
GS3MTB3MS	-13.555	-14.440	-15.164	-15.738	-2.235	-3.015	-17.795	-19.547	-17.940	-19.449	-18.787	-19.045
GS3MTB6MS	-11.207	-11.857	-12.369	-12.782	-1.412	-2.093	-14.145	-15.377	-14.082	-15.313	-14.387	-14.956
AAAMGS1	-9.589	-10.470	-11.291	-12.022	-0.433	-0.942	-14.526	-17.029	-17.450	-17.701	-16.294	-12.290
BAAMGS1	-5.009	-5.564	-6.077	-6.547	-0.028	-0.123	-8.077	-9.979	-10.696	-10.760	-10.735	-7.755
GS1MTB3MS	-1.792	-1.928	-2.021	-2.071	-0.075	-0.160	-2.450	-2.614	-1.102	-2.220	-0.103	-0.191
GS1MTB6MS	0.350	0.400	0.480	0.588	0.227	0.272	0.979	1.766	3.521	2.555	6.292	7.012
TB6MSMTB3MS	-4.080	-4.316	-4.426	-4.405	-0.480	-0.770	-4.664	-4.872	-3.636	-4.519	-6.132	-6.767
AAAMTB6MS	-8.875	-9.529	-10.109	-10.614	-0.834	-1.262	-12.539	-14.529	-15.083	-15.192	-15.643	-13.596
BAAMTB6MS	-5.417	-5.858	-6.254	-6.610	-0.362	-0.598	-8.062	-9.844	-10.627	-10.644	-11.988	-10.603
AAAMTB3MS	-11.067	-11.863	-12.553	-13.133	-1.604	-2.178	-15.429	-17.636	-17.861	-18.180	-18.037	-15.473
BAAMTB3MS	-7.811	-8.340	-8.787	-9.163	-0.985	-1.369	-10.663	-12.199	-12.560	-12.724	-12.876	-10.911

Table 17: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 3-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=3												
Index	sym10	sym11	sym12	sym13	sym14	sym15	sym16	coif1	coif2	coif3	coif4	coif5
FEDFUNDS	-33.497	-33.445	-32.542	-31.444	-29.630	-28.300	-24.405	-6.821	-17.638	-26.427	-32.096	-33.431
INTGSTUSM193N	-36.592	-36.476	-34.001	-32.588	-30.646	-29.458	-26.251	-9.715	-21.843	-31.152	-37.367	-36.263
AAA	-13.226	-13.230	-13.145	-13.094	-13.020	-12.945	-12.646	-5.713	-10.467	-12.481	-13.210	-13.217
BAA	-4.661	-4.654	-4.517	-4.377	-4.182	-3.986	-3.292	-3.211	-4.711	-5.035	-4.885	-4.641
GS1	-40.400	-40.253	-38.068	-37.056	-35.656	-34.872	-32.851	-11.208	-25.616	-36.652	-42.035	-40.055
GS3	-35.252	-35.145	-33.205	-32.732	-32.026	-31.775	-31.238	-14.396	-29.661	-38.054	-38.695	-34.897
GS5	-31.093	-31.054	-29.479	-29.358	-28.984	-28.937	-28.818	-14.741	-28.828	-34.993	-34.366	-30.804
GS10	-22.832	-22.822	-21.896	-21.959	-21.852	-21.917	-22.026	-12.440	-22.765	-25.796	-24.968	-22.660
TB3MS	-36.076	-35.956	-33.493	-32.036	-30.100	-28.923	-25.820	-9.506	-21.514	-30.403	-36.743	-35.749
TB6MS	-36.218	-36.089	-33.871	-32.630	-30.882	-29.805	-26.980	-10.130	-22.661	-31.668	-37.168	-35.898
TB3SMFFM	3.597	4.552	3.759	6.090	8.618	10.621	15.189	-0.971	-0.742	2.054	4.417	3.779
TB6SMFFM	1.861	2.635	2.515	5.339	8.452	10.880	16.533	-3.992	-3.395	0.789	2.581	2.054
GS10MFFM	-17.026	-16.361	-15.493	-12.239	-7.506	-3.648	7.588	-9.108	-17.113	-16.917	-17.026	-16.713
GS5MFFM	-15.684	-14.978	-14.953	-11.555	-7.062	-3.339	6.915	-9.314	-16.881	-15.335	-14.806	-15.468
GS3MFFM	-10.788	-9.902	-10.141	-6.583	-2.222	1.349	10.717	-9.445	-15.155	-11.351	-9.834	-10.542
GS1MFFM	-1.062	0.012	-0.250	3.448	7.098	9.963	16.365	-7.512	-7.770	-2.335	-0.237	-0.756
AAAMFFM	-17.185	-16.616	-13.177	-9.148	-3.191	1.466	16.401	-7.325	-15.085	-17.577	-18.850	-16.649
BAAMFFM	-16.331	-15.865	-12.134	-8.213	-2.795	1.407	14.678	-6.709	-15.162	-17.517	-18.484	-15.795
AAAMGS10	73.884	73.588	84.991	84.305	85.270	84.875	86.428	-0.663	4.137	14.141	40.869	75.952
BAAMGS10	23.447	23.726	31.074	33.204	36.253	37.771	41.933	-0.290	-0.805	0.688	9.010	24.772
GS10MGS1	-26.929	-26.348	-23.556	-20.176	-14.511	-9.880	4.807	-7.988	-19.348	-25.194	-27.911	-26.443
GS10MGS3	-3.005	-2.100	7.210	16.373	30.113	40.128	64.412	-4.486	-13.259	-14.997	-11.736	-1.605
GS10MGS5	16.141	16.977	39.785	52.424	70.817	80.619	101.047	-2.397	-8.279	-8.361	-2.934	19.297
GS10MTB3MS	-25.434	-25.037	-22.611	-19.095	-13.668	-9.228	4.568	-9.645	-21.122	-24.438	-26.434	-25.015
GS10MTB6MS	-23.396	-22.825	-21.533	-18.971	-14.334	-10.294	3.031	-7.811	-17.715	-21.352	-23.520	-23.038
AAAMGS5	89.621	89.045	119.633	125.117	132.206	134.000	139.272	-0.848	-1.526	2.135	30.270	94.624
BAAMGS5	29.376	29.712	44.746	49.408	55.480	58.230	64.809	-1.388	-4.448	-5.145	4.629	31.914
GS5MGS1	-31.782	-31.691	-31.368	-29.414	-25.336	-21.711	-10.227	-6.735	-18.843	-25.520	-29.472	-31.800
GS5MGS3	-18.212	-17.447	-13.771	-9.164	-2.651	3.034	19.371	-5.135	-15.631	-20.140	-20.935	-17.550
GS5MTB3MS	-23.762	-23.750	-23.000	-20.402	-16.179	-12.560	-1.757	-8.547	-19.246	-21.413	-23.370	-23.605
GS5MTB6MS	-21.956	-21.549	-22.229	-20.674	-17.256	-14.138	-4.223	-6.512	-15.625	-18.081	-20.145	-21.835
AAAMGS3	51.430	52.728	81.582	94.783	108.723	115.361	129.566	-1.494	-3.409	-2.011	11.564	56.195
BAAMGS3	18.624	19.513	35.040	42.782	51.525	56.181	66.536	-1.648	-5.291	-7.066	-1.317	21.177
GS3MGS1	-30.937	-30.864	-31.668	-30.306	-26.961	-23.843	-13.595	-6.877	-19.305	-25.472	-28.374	-31.097
GS3MTB3MS	-19.086	-18.986	-19.166	-17.149	-13.906	-11.057	-2.636	-8.705	-17.770	-18.107	-18.747	-18.934
GS3MTB6MS	-16.343	-15.721	-17.713	-16.784	-14.212	-11.792	-4.195	-7.018	-14.196	-14.211	-14.392	-16.212
AAAMGS1	-6.188	-5.275	5.256	12.901	23.687	31.125	52.465	-5.919	-14.474	-17.574	-15.896	-4.609
BAAMGS1	-2.798	-2.089	6.786	13.343	21.844	27.618	43.454	-2.071	-7.986	-10.830	-10.469	-1.505
GS1MTB3MS	0.044	-0.496	-1.075	-1.106	-1.460	-1.489	-1.412	-0.940	-2.509	-1.214	-0.140	-0.130
GS1MTB6MS	7.192	7.112	6.640	6.168	5.053	4.080	1.086	0.414	0.909	3.544	6.503	7.150
TB6MSMTB3MS	-6.350	-6.632	-4.624	-2.627	-1.275	-0.626	0.938	-2.503	-4.801	-3.751	-6.206	-6.333
AAAMTB6MS	-9.914	-9.274	-1.983	4.246	13.444	20.392	41.491	-5.459	-12.519	-15.210	-15.487	-8.867
BAAMTB6MS	-7.589	-7.104	-0.797	4.627	11.936	17.315	32.838	-2.991	-8.035	-10.786	-11.917	-6.725
AAAMTB3MS	-11.308	-10.641	-2.684	3.924	12.950	19.543	39.618	-7.179	-15.424	-18.001	-17.803	-10.188
BAAMTB3MS	-7.477	-6.968	-0.136	5.604	12.923	18.186	33.522	-4.804	-10.642	-12.676	-12.713	-6.552

Table 18: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 6-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=6												
Index	haar	db2	db3	db4	db5	db6	db7	db8	db9	db10	db11	db12
FEDFUNDS	-3.456	-5.247	-6.880	-8.456	-9.950	-11.348	-12.661	-13.908	-15.094	-16.217	-17.288	-18.317
INTGSTUSM193N	-2.376	-4.020	-5.540	-7.040	-8.579	-10.136	-11.674	-13.179	-14.647	-16.060	-17.405	-18.698
AAA	-1.506	-1.976	-2.540	-3.119	-3.694	-4.267	-4.842	-5.417	-5.987	-6.543	-7.080	-7.595
BAA	-0.680	-0.768	-0.972	-1.195	-1.428	-1.670	-1.917	-2.166	-2.408	-2.640	-2.856	-3.057
GS1	-2.921	-4.856	-6.717	-8.523	-10.346	-12.197	-14.047	-15.856	-17.600	-19.269	-20.864	-22.399
GS3	-3.536	-5.699	-7.790	-9.889	-12.018	-14.186	-16.365	-18.507	-20.562	-22.500	-24.317	-26.035
GS5	-3.827	-5.925	-7.958	-10.025	-12.127	-14.269	-16.417	-18.518	-20.520	-22.387	-24.113	-25.717
GS10	-3.650	-5.414	-7.088	-8.732	-10.353	-11.975	-13.591	-15.174	-16.686	-18.104	-19.424	-20.657
TB3MS	-2.571	-4.219	-5.706	-7.128	-8.583	-10.072	-11.549	-12.982	-14.369	-15.709	-16.999	-18.252
TB6MS	-2.623	-4.405	-6.018	-7.548	-9.094	-10.670	-12.233	-13.743	-15.188	-16.565	-17.877	-19.138
TB3SMFFM	-0.832	-0.439	-0.333	-0.113	0.161	0.363	0.569	0.779	0.920	1.002	1.087	1.210
TB6SMFFM	-0.760	-0.200	0.159	0.580	1.131	1.701	2.271	2.811	3.225	3.480	3.655	3.833
GS10MFFM	-1.257	-1.549	-1.695	-1.712	-1.913	-2.026	-1.850	-1.644	-1.682	-1.892	-2.081	-2.218
GS5MFFM	-1.277	-1.390	-1.303	-1.247	-1.283	-1.070	-0.582	-0.194	-0.083	-0.072	-0.014	0.025
GS3MFFM	-0.902	-0.589	-0.183	0.115	0.506	1.182	1.946	2.495	2.827	3.127	3.431	3.646
GS1MFFM	0.027	0.888	1.318	2.015	3.012	3.916	4.627	5.229	5.765	6.210	6.545	6.809
AAAMFFM	-1.873	-2.931	-3.799	-4.407	-5.129	-5.813	-6.251	-6.566	-7.000	-7.556	-8.100	-8.574
BAAMFFM	-3.335	-4.183	-5.247	-6.045	-6.565	-7.058	-7.566	-8.031	-8.445	-8.857	-9.306	-9.775
AAAMGS10	-0.239	-0.214	-0.208	-0.193	-0.160	-0.089	0.037	0.223	0.470	0.771	1.124	1.539
BAAMGS10	-0.430	-0.683	-0.874	-1.043	-1.199	-1.345	-1.483	-1.609	-1.722	-1.820	-1.905	-1.978
GS10MGS1	-3.123	-3.603	-5.124	-6.815	-8.019	-8.801	-9.749	-10.806	-11.674	-12.236	-12.728	-13.345
GS10MGS3	-2.568	-3.187	-3.809	-4.648	-5.636	-6.469	-7.001	-7.377	-7.725	-8.037	-8.268	-8.452
GS10MGS5	-1.912	-2.172	-2.481	-2.910	-3.436	-3.910	-4.263	-4.550	-4.810	-5.017	-5.156	-5.260
GS10MTB3MS	-3.839	-4.227	-5.175	-6.247	-6.921	-7.209	-7.487	-7.891	-8.344	-8.740	-9.146	-9.660
GS10MTB6MS	-3.055	-3.332	-3.949	-4.839	-5.586	-5.999	-6.339	-6.788	-7.295	-7.749	-8.169	-8.630
AAAMGS5	-0.943	-0.900	-0.847	-0.775	-0.700	-0.629	-0.555	-0.475	-0.395	-0.318	-0.249	-0.186
BAAMGS5	-0.636	-1.180	-1.604	-2.011	-2.418	-2.830	-3.240	-3.638	-4.015	-4.367	-4.696	-5.007
GS5MGS1	-3.183	-3.859	-5.450	-7.052	-8.134	-8.922	-9.874	-10.882	-11.627	-12.083	-12.628	-13.392
GS5MGS3	-1.831	-2.852	-3.890	-4.985	-6.256	-7.359	-8.076	-8.480	-8.785	-9.116	-9.458	-9.782
GS5MTB3MS	-3.844	-4.349	-5.162	-6.005	-6.472	-6.589	-6.662	-6.819	-7.007	-7.215	-7.522	-7.942
GS5MTB6MS	-2.719	-3.161	-3.803	-4.501	-5.003	-5.230	-5.379	-5.586	-5.817	-6.029	-6.291	-6.639
AAAMGS3	-1.485	-1.976	-2.308	-2.523	-2.678	-2.772	-2.785	-2.720	-2.606	-2.472	-2.338	-2.214
BAAMGS3	-0.845	-1.468	-1.948	-2.388	-2.808	-3.211	-3.595	-3.957	-4.293	-4.607	-4.908	-5.207
GS3MGS1	-3.003	-4.183	-5.734	-6.846	-7.689	-8.656	-9.636	-10.392	-10.875	-11.385	-12.093	-12.863
GS3MTB3MS	-3.463	-3.897	-4.562	-5.131	-5.375	-5.380	-5.371	-5.416	-5.426	-5.421	-5.555	-5.840
GS3MTB6MS	-2.109	-2.433	-2.951	-3.374	-3.565	-3.627	-3.680	-3.718	-3.718	-3.736	-3.829	-3.954
AAAMGS1	-2.042	-3.543	-5.078	-6.755	-8.272	-9.436	-10.395	-11.286	-12.092	-12.763	-13.314	-13.816
BAAMGS1	-1.516	-2.799	-3.800	-4.576	-5.271	-5.924	-6.509	-7.017	-7.466	-7.878	-8.280	-8.684
GS1MTB3MS	-0.334	-0.476	-0.605	-0.698	-0.735	-0.716	-0.649	-0.551	-0.441	-0.336	-0.249	-0.182
GS1MTB6MS	0.261	0.255	0.346	0.478	0.641	0.831	1.046	1.281	1.530	1.783	2.034	2.282
TB6MSMTB3MS	-0.768	-1.018	-1.187	-1.245	-1.170	-0.983	-0.735	-0.484	-0.283	-0.183	-0.210	-0.347
AAAMTB6MS	-1.961	-2.932	-3.743	-4.578	-5.387	-6.048	-6.577	-7.066	-7.550	-8.013	-8.444	-8.861
BAAMTB6MS	-0.769	-1.488	-2.043	-2.477	-2.860	-3.231	-3.587	-3.919	-4.241	-4.567	-4.906	-5.260
AAAMTB3MS	-2.538	-3.503	-4.490	-5.531	-6.434	-7.086	-7.609	-8.131	-8.655	-9.146	-9.621	-10.113
BAAMTB3MS	-1.567	-2.229	-2.756	-3.144	-3.470	-3.766	-4.023	-4.247	-4.467	-4.707	-4.976	-5.270

Table 19: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 6-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=6												
Index	db13	db14	db15	db16	sym2	sym3	sym4	sym5	sym6	sym7	sym8	sym9
FEDFUNDS	-19.310	-20.261	-21.163	-22.019	-5.247	-6.880	-25.438	-29.553	-31.798	-31.379	-34.662	-34.526
INTGSTUSM193N	-19.977	-21.271	-22.583	-23.904	-4.020	-5.540	-29.432	-35.472	-38.846	-38.036	-40.769	-40.053
AAA	-8.091	-8.569	-9.032	-9.477	-1.976	-2.540	-11.044	-12.461	-13.179	-12.993	-13.698	-13.641
BAA	-3.243	-3.415	-3.575	-3.722	-0.768	-0.972	-4.196	-4.508	-4.594	-4.575	-4.505	-4.300
GS1	-23.905	-25.421	-26.968	-28.549	-4.856	-6.717	-34.890	-41.156	-44.245	-43.499	-45.078	-44.422
GS3	-27.691	-29.319	-30.941	-32.555	-5.699	-7.790	-38.370	-42.475	-43.474	-43.352	-42.123	-41.372
GS5	-27.235	-28.699	-30.128	-31.522	-5.925	-7.958	-36.310	-39.160	-39.501	-39.548	-37.958	-37.376
GS10	-21.823	-22.942	-24.022	-25.061	-5.414	-7.088	-28.518	-30.618	-30.982	-30.966	-30.118	-29.811
TB3MS	-19.502	-20.779	-22.092	-23.432	-4.219	-5.706	-28.921	-35.024	-38.572	-37.688	-40.541	-39.851
TB6MS	-20.385	-21.654	-22.963	-24.308	-4.405	-6.018	-29.885	-35.802	-39.114	-38.268	-40.741	-40.145
TB3SMFFM	1.378	1.599	1.879	2.218	-0.439	-0.333	3.161	3.875	4.034	4.267	2.108	3.587
TB6SMFFM	4.030	4.234	4.451	4.703	-0.200	0.159	5.497	5.987	5.902	6.196	4.484	6.539
GS10MFFM	-2.372	-2.550	-2.700	-2.798	-1.549	-1.695	-3.169	-3.856	-3.924	-3.933	-5.215	-2.790
GS5MFFM	-0.015	-0.067	-0.052	0.015	-1.390	-1.303	-0.001	-0.422	-0.608	-0.497	-2.891	-0.556
GS3MFFM	3.771	3.902	4.096	4.322	-0.589	-0.183	4.877	5.066	5.007	5.193	2.614	5.134
GS1MFFM	7.054	7.286	7.504	7.741	0.888	1.318	8.918	9.685	9.479	9.900	7.856	10.497
AAAMFFM	-9.017	-9.463	-9.900	-10.307	-2.931	-3.799	-11.774	-13.448	-13.870	-13.832	-13.501	-10.452
BAAMFFM	-10.224	-10.645	-11.052	-11.455	-4.183	-5.247	-12.684	-14.061	-14.468	-14.359	-13.415	-10.559
AAAMGS10	2.038	2.654	3.427	4.397	-0.214	-0.208	11.006	23.823	41.633	33.604	66.911	70.977
BAAMGS10	-2.036	-2.077	-2.092	-2.069	-0.683	-0.874	-1.374	1.146	5.710	3.737	15.331	19.303
GS10MGS1	-14.043	-14.672	-15.160	-15.597	-3.603	-5.124	-17.613	-19.553	-20.495	-20.052	-19.193	-16.886
GS10MGS3	-8.668	-8.931	-9.186	-9.387	-3.187	-3.809	-8.778	-7.128	-4.793	-5.606	2.389	7.269
GS10MGS5	-5.360	-5.443	-5.477	-5.453	-2.172	-2.481	-4.177	-1.741	2.014	0.401	15.597	25.524
GS10MTB3MS	-10.252	-10.787	-11.199	-11.557	-4.227	-5.175	-12.333	-13.667	-13.788	-13.845	-12.612	-9.782
GS10MTB6MS	-9.123	-9.570	-9.938	-10.279	-3.332	-3.949	-11.186	-12.725	-13.385	-13.091	-13.637	-11.846
AAAMGS5	-0.126	-0.058	0.035	0.183	-0.900	-0.847	2.238	10.898	29.697	21.050	77.205	92.029
BAAMGS5	-5.309	-5.604	-5.886	-6.144	-1.180	-1.604	-6.458	-4.376	1.297	-1.267	18.029	25.684
GS5MGS1	-14.206	-14.857	-15.311	-15.698	-3.859	-5.450	-17.858	-20.526	-22.194	-21.770	-24.446	-23.504
GS5MGS3	-10.146	-10.624	-11.211	-11.830	-2.852	-3.890	-13.099	-14.051	-14.412	-13.955	-10.231	-7.214
GS5MTB3MS	-8.400	-8.823	-9.195	-9.514	-4.349	-5.162	-9.384	-11.003	-11.116	-11.343	-11.882	-9.993
GS5MTB6MS	-6.988	-7.250	-7.461	-7.694	-3.161	-3.803	-7.729	-9.689	-10.561	-10.308	-13.387	-12.573
AAAMGS3	-2.106	-2.013	-1.921	-1.812	-1.976	-2.308	-0.689	2.719	10.744	7.122	39.350	55.507
BAAMGS3	-5.512	-5.829	-6.153	-6.473	-1.468	-1.948	-7.256	-6.659	-3.356	-4.887	9.440	17.558
GS3MGS1	-13.466	-13.843	-14.123	-14.414	-4.183	-5.734	-16.242	-18.220	-19.384	-19.246	-22.858	-22.237
GS3MTB3MS	-6.104	-6.261	-6.403	-6.586	-3.897	-4.562	-5.292	-5.962	-5.758	-6.084	-7.013	-5.494
GS3MTB6MS	-4.016	-3.987	-3.940	-3.928	-2.433	-2.951	-2.312	-3.062	-3.585	-3.452	-7.439	-7.052
AAAMGS1	-14.328	-14.860	-15.386	-15.893	-3.543	-5.078	-17.228	-17.703	-16.550	-17.049	-9.859	-4.338
BAAMGS1	-9.096	-9.520	-9.956	-10.396	-2.799	-3.800	-11.679	-12.613	-12.198	-12.454	-7.363	-2.962
GS1MTB3MS	-0.129	-0.072	0.011	0.128	-0.476	-0.605	1.008	1.162	1.528	1.052	0.637	0.164
GS1MTB6MS	2.531	2.789	3.061	3.352	0.255	0.346	4.780	6.071	6.399	6.463	6.164	5.443
TB6MSMTB3MS	-0.555	-0.794	-1.036	-1.256	-1.018	-1.187	-1.431	-2.132	-2.590	-2.494	-0.030	2.271
AAAMTB6MS	-9.285	-9.719	-10.152	-10.583	-2.932	-3.743	-11.867	-13.072	-12.917	-13.115	-9.150	-4.896
BAAMTB6MS	-5.633	-6.025	-6.432	-6.851	-1.488	-2.043	-8.347	-9.893	-10.263	-10.281	-7.722	-4.361
AAAMTB3MS	-10.628	-11.142	-11.638	-12.112	-3.503	-4.490	-13.276	-14.158	-13.447	-13.866	-8.020	-2.870
BAAMTB3MS	-5.587	-5.917	-6.248	-6.571	-2.229	-2.756	-7.469	-8.214	-7.874	-8.128	-3.840	0.260

Table 20: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 6-month-ahead prediction exercise

$P(R_{t+k} = 1) = F(\beta_0 + \beta_t x_t)$												
k=6												
Index	sym10	sym11	sym12	sym13	sym14	sym15	sym16	coif1	coif2	coif3	coif4	coif5
FEDFUNDS	-33.519	-33.430	-30.828	-28.434	-26.150	-24.514	-20.783	-15.545	-25.359	-32.037	-34.639	-33.250
INTGSTUSM193N	-38.903	-38.671	-36.425	-34.443	-32.411	-30.929	-27.538	-15.033	-29.256	-39.092	-40.652	-38.590
AAA	-13.455	-13.446	-12.869	-12.306	-11.845	-11.530	-10.647	-6.141	-10.961	-13.225	-13.699	-13.402
BAA	-3.948	-3.940	-3.015	-2.131	-1.293	-0.679	1.090	-2.419	-4.167	-4.596	-4.477	-3.862
GS1	-43.569	-43.445	-42.017	-40.981	-39.712	-38.758	-36.367	-17.905	-34.664	-44.417	-44.958	-43.366
GS3	-40.761	-40.722	-40.181	-40.068	-39.646	-39.330	-38.417	-20.818	-38.157	-43.478	-41.951	-40.665
GS5	-37.015	-36.976	-36.791	-36.836	-36.647	-36.494	-36.043	-20.727	-36.142	-39.473	-37.809	-36.966
GS10	-29.686	-29.647	-29.659	-29.728	-29.685	-29.649	-29.521	-17.028	-28.374	-30.971	-30.037	-29.668
TB3MS	-38.716	-38.500	-36.313	-34.461	-32.494	-31.053	-27.656	-14.841	-28.729	-38.821	-40.434	-38.411
TB6MS	-39.143	-39.007	-37.084	-35.623	-33.937	-32.689	-29.566	-15.551	-29.707	-39.326	-40.642	-38.893
TB3SMFFM	7.083	6.553	11.898	14.774	16.856	18.143	20.677	0.407	3.037	4.156	2.415	7.545
TB6SMFFM	10.740	10.374	17.042	21.118	23.889	25.569	28.430	1.988	5.414	6.017	4.883	11.396
GS10MFFM	2.250	2.221	12.227	20.802	28.968	35.250	51.839	-3.632	-3.232	-3.888	-4.666	3.286
GS5MFFM	4.924	4.612	14.961	23.155	30.392	35.639	48.192	-2.207	-0.088	-0.564	-2.385	5.936
GS3MFFM	10.958	10.490	20.770	28.371	34.647	39.013	48.435	0.887	4.792	5.108	3.147	11.949
GS1MFFM	16.083	15.296	23.529	28.060	31.341	33.342	36.915	4.619	8.869	9.686	8.350	16.818
AAAMFFM	-5.301	-4.929	5.688	15.837	26.224	34.486	57.581	-8.539	-11.787	-13.853	-12.909	-4.112
BAAMFFM	-6.023	-5.644	3.693	12.631	21.735	28.867	48.248	-9.213	-12.653	-14.421	-12.890	-4.959
AAAMGS10	72.703	72.170	73.486	74.947	75.887	77.006	81.163	0.614	10.448	42.307	68.351	72.491
BAAMGS10	22.927	22.997	27.554	29.807	32.528	34.440	40.050	-1.794	-1.456	6.036	16.231	23.490
GS10MGS1	-13.066	-12.645	-3.495	5.533	17.339	28.011	62.008	-12.218	-17.530	-20.393	-18.655	-12.031
GS10MGS3	15.630	15.314	31.590	40.408	57.663	71.972	116.793	-7.951	-8.744	-4.483	3.323	17.343
GS10MGS5	39.604	38.940	57.626	64.465	80.773	94.113	130.215	-4.684	-4.160	2.366	17.572	41.939
GS10MTB3MS	-5.193	-4.641	5.509	15.907	27.917	38.310	69.808	-9.731	-12.248	-13.730	-12.004	-3.991
GS10MTB6MS	-8.312	-8.124	0.412	8.899	19.815	29.600	61.677	-8.029	-11.173	-13.310	-13.158	-7.432
AAAMGS5	103.168	102.021	110.837	114.094	119.362	123.606	135.548	-0.366	2.050	31.111	80.936	103.998
BAAMGS5	32.899	32.870	40.927	44.241	49.279	52.902	63.057	-4.114	-6.493	1.811	19.715	33.952
GS5MGS1	-21.097	-20.530	-12.812	-4.512	4.988	13.191	38.522	-12.442	-17.829	-22.314	-24.220	-20.218
GS5MGS3	-2.967	-2.809	6.567	13.150	24.528	34.404	71.969	-9.673	-13.094	-14.144	-9.634	-1.947
GS5MTB3MS	-6.020	-5.662	3.372	12.375	21.643	29.258	51.135	-8.379	-9.353	-11.134	-11.460	-4.997
GS5MTB6MS	-9.712	-9.657	-2.349	4.757	13.024	20.139	42.825	-6.529	-7.866	-10.574	-13.071	-8.994
AAAMGS3	73.099	72.120	91.567	98.766	110.277	118.419	140.809	-2.562	-0.782	11.579	42.607	75.483
BAAMGS3	26.943	26.757	38.692	43.702	51.251	56.594	71.792	-4.399	-7.259	-2.986	11.005	28.442
GS3MGS1	-20.110	-19.550	-12.296	-3.781	5.038	12.420	32.509	-12.125	-16.337	-19.556	-22.701	-19.293
GS3MTB3MS	-1.831	-1.748	5.986	13.607	20.926	26.877	42.856	-6.183	-5.275	-5.743	-6.651	-1.011
GS3MTB6MS	-4.383	-4.593	1.713	7.704	14.340	20.032	37.301	-3.776	-2.512	-3.549	-7.158	-3.829
AAAMGS1	3.619	4.066	19.097	31.413	46.483	58.361	90.094	-12.384	-17.184	-16.322	-8.846	5.390
BAAMGS1	3.376	3.716	15.444	24.492	35.245	43.518	65.901	-7.586	-11.617	-12.062	-6.601	4.773
GS1MTB3MS	0.588	0.003	0.518	0.938	2.075	3.299	6.829	-0.753	0.907	1.394	0.532	0.431
GS1MTB6MS	4.669	4.195	2.052	0.096	-0.658	-0.765	0.613	1.437	4.685	6.470	6.063	4.328
TB6MSMTB3MS	3.152	4.427	5.434	8.176	9.761	11.038	13.179	-1.115	-1.322	-2.616	0.172	3.730
AAAMTB6MS	1.805	2.199	16.184	28.367	43.183	55.013	88.512	-7.852	-11.834	-12.820	-8.392	3.362
BAAMTB6MS	0.956	1.263	12.104	21.076	31.599	39.788	62.790	-4.457	-8.302	-10.232	-7.166	2.185
AAAMTB3MS	4.214	5.023	18.937	32.077	47.124	59.184	92.279	-9.257	-13.236	-13.306	-7.130	5.942
BAAMTB3MS	5.996	6.607	17.802	27.866	39.087	47.845	71.625	-4.838	-7.440	-7.787	-3.172	7.384

Table 21: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 12-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=12												
Index	haar	db2	db3	db4	db5	db6	db7	db8	db9	db10	db11	db12
FEDFUNDS	-2.470	-3.758	-4.918	-6.021	-7.065	-8.047	-8.967	-9.830	-10.648	-11.426	-12.166	-12.862
INTGSTUSM193N	-4.843	-7.200	-9.212	-10.957	-12.510	-13.939	-15.273	-16.534	-17.743	-18.909	-20.025	-21.081
AAA	-1.787	-2.580	-3.215	-3.774	-4.261	-4.699	-5.114	-5.520	-5.920	-6.304	-6.659	-6.973
BAA	-0.851	-1.080	-1.326	-1.540	-1.726	-1.895	-2.056	-2.214	-2.366	-2.503	-2.618	-2.705
GS1	-5.573	-8.276	-10.501	-12.393	-14.031	-15.504	-16.878	-18.192	-19.459	-20.678	-21.837	-22.926
GS3	-6.650	-10.026	-12.486	-14.507	-16.206	-17.699	-19.074	-20.377	-21.618	-22.788	-23.872	-24.857
GS5	-6.640	-9.985	-12.336	-14.253	-15.842	-17.218	-18.465	-19.624	-20.704	-21.700	-22.600	-23.400
GS10	-5.649	-8.498	-10.480	-12.126	-13.508	-14.707	-15.782	-16.763	-17.661	-18.479	-19.218	-19.884
TB3MS	-4.742	-7.014	-8.997	-10.736	-12.292	-13.730	-15.084	-16.369	-17.602	-18.790	-19.928	-21.008
TB6MS	-5.028	-7.474	-9.547	-11.320	-12.866	-14.268	-15.579	-16.828	-18.030	-19.193	-20.314	-21.385
TB3SMFFM	-1.487	-1.742	-2.174	-2.626	-3.023	-3.328	-3.522	-3.598	-3.556	-3.403	-3.152	-2.812
TB6SMFFM	-1.359	-1.420	-1.742	-2.105	-2.438	-2.697	-2.848	-2.875	-2.778	-2.560	-2.229	-1.792
GS10MFFM	-1.357	-1.396	-1.946	-2.585	-3.169	-3.691	-4.105	-4.359	-4.450	-4.398	-4.208	-3.875
GS5MFFM	-1.235	-1.269	-1.850	-2.486	-3.086	-3.633	-4.044	-4.275	-4.338	-4.244	-3.994	-3.587
GS3MFFM	-1.188	-1.318	-1.877	-2.447	-2.990	-3.466	-3.786	-3.930	-3.915	-3.744	-3.416	-2.938
GS1MFFM	-1.520	-1.716	-2.174	-2.637	-3.035	-3.306	-3.425	-3.395	-3.216	-2.891	-2.441	-1.878
AAAMFFM	-2.058	-2.399	-3.147	-3.958	-4.690	-5.330	-5.859	-6.245	-6.484	-6.590	-6.569	-6.413
BAAMFFM	-2.086	-2.453	-2.979	-3.594	-4.163	-4.631	-5.000	-5.265	-5.422	-5.473	-5.423	-5.273
AAAMGS10	2.394	4.190	5.590	6.853	8.001	9.064	10.058	10.979	11.815	12.567	13.257	13.917
BAAMGS10	-0.017	0.144	0.284	0.432	0.581	0.730	0.881	1.035	1.191	1.349	1.511	1.682
GS10MGS1	-1.391	-1.341	-1.348	-1.544	-1.845	-2.100	-2.278	-2.422	-2.538	-2.580	-2.516	-2.350
GS10MGS3	0.411	1.138	1.824	2.382	2.789	3.095	3.375	3.672	4.004	4.378	4.796	5.247
GS10MGS5	0.667	1.364	1.885	2.268	2.546	2.770	2.990	3.237	3.529	3.865	4.232	4.609
GS10MTB3MS	-1.208	-0.994	-0.975	-1.298	-1.722	-2.025	-2.198	-2.279	-2.249	-2.084	-1.795	-1.401
GS10MTB6MS	-1.481	-1.675	-1.897	-2.328	-2.876	-3.345	-3.674	-3.906	-4.053	-4.087	-4.000	-3.813
AAAMGS5	0.286	0.810	1.327	1.864	2.414	2.998	3.649	4.391	5.224	6.133	7.094	8.088
BAAMGS5	-0.489	-0.536	-0.501	-0.424	-0.323	-0.204	-0.062	0.108	0.309	0.540	0.797	1.075
GS5MGS1	-2.251	-2.154	-2.462	-3.114	-3.820	-4.351	-4.764	-5.166	-5.546	-5.832	-5.993	-6.042
GS5MGS3	-1.356	-1.112	-0.632	-0.019	0.460	0.731	0.932	1.167	1.436	1.738	2.095	2.521
GS5MTB3MS	-1.190	-0.762	-0.749	-1.226	-1.809	-2.218	-2.481	-2.628	-2.616	-2.446	-2.166	-1.789
GS5MTB6MS	-1.496	-1.587	-1.916	-2.571	-3.384	-4.076	-4.585	-4.960	-5.208	-5.316	-5.299	-5.181
AAAMGS3	0.242	0.696	1.056	1.356	1.610	1.837	2.058	2.294	2.562	2.874	3.233	3.641
BAAMGS3	-0.623	-0.802	-0.887	-0.925	-0.939	-0.938	-0.927	-0.902	-0.854	-0.776	-0.666	-0.521
GS3MGS1	-1.907	-1.986	-2.634	-3.487	-4.203	-4.742	-5.223	-5.674	-6.030	-6.255	-6.364	-6.373
GS3MTB3MS	-0.954	-0.611	-0.762	-1.265	-1.758	-2.083	-2.261	-2.279	-2.116	-1.818	-1.435	-0.981
GS3MTB6MS	-1.125	-1.225	-1.725	-2.511	-3.322	-3.973	-4.448	-4.756	-4.891	-4.875	-4.751	-4.551
AAAMGS1	-1.591	-1.844	-1.979	-2.069	-2.156	-2.236	-2.298	-2.334	-2.333	-2.278	-2.154	-1.957
BAAMGS1	-1.241	-1.553	-1.736	-1.843	-1.916	-1.984	-2.056	-2.127	-2.184	-2.214	-2.206	-2.154
GS1MTB3MS	0.592	0.595	0.518	0.366	0.203	0.078	0.019	0.026	0.082	0.170	0.271	0.372
GS1MTB6MS	0.962	0.895	0.863	0.792	0.693	0.594	0.513	0.458	0.429	0.412	0.388	0.339
TB6MSMTB3MS	-0.196	0.153	0.650	1.281	2.041	2.875	3.712	4.492	5.173	5.731	6.161	6.475
AAAMTB6MS	-1.901	-2.406	-2.802	-3.166	-3.516	-3.818	-4.056	-4.235	-4.353	-4.402	-4.373	-4.266
BAAMTB6MS	-1.389	-1.930	-2.337	-2.670	-2.961	-3.221	-3.454	-3.656	-3.826	-3.956	-4.040	-4.076
AAAMTB3MS	-1.786	-1.983	-2.164	-2.382	-2.597	-2.751	-2.828	-2.834	-2.764	-2.611	-2.371	-2.045
BAAMTB3MS	-0.801	-1.006	-1.132	-1.238	-1.338	-1.422	-1.481	-1.509	-1.499	-1.447	-1.347	-1.198

Table 22: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 12-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=12												
Index	db13	db14	db15	db16	sym2	sym3	sym4	sym5	sym6	sym7	sym8	sym9
FEDFUNDS	-13.511	-14.105	-14.641	-15.114	-3.758	-4.918	-16.637	-18.044	-18.113	-18.188	-16.320	-13.976
INTGSTUSM193N	-22.068	-22.985	-23.834	-24.622	-7.200	-9.212	-27.618	-31.116	-32.473	-32.306	-33.836	-32.568
AAA	-7.234	-7.440	-7.590	-7.688	-2.580	-3.215	-7.884	-7.776	-6.775	-7.308	-5.530	-4.281
BAA	-2.759	-2.780	-2.769	-2.729	-1.080	-1.326	-2.535	-1.900	-0.933	-1.262	1.342	3.310
GS1	-23.934	-24.858	-25.700	-26.467	-8.276	-10.501	-29.194	-32.511	-33.620	-33.685	-36.792	-36.988
GS3	-25.742	-26.529	-27.225	-27.838	-10.026	-12.486	-29.699	-31.886	-32.143	-32.517	-34.700	-35.533
GS5	-24.105	-24.724	-25.266	-25.739	-9.985	-12.336	-27.099	-28.678	-28.686	-29.053	-30.633	-31.305
GS10	-20.483	-21.025	-21.515	-21.954	-8.498	-10.480	-23.087	-24.404	-24.390	-24.716	-25.614	-26.153
TB3MS	-22.018	-22.952	-23.813	-24.605	-7.014	-8.997	-27.585	-31.086	-32.389	-32.278	-34.183	-33.113
TB6MS	-22.395	-23.339	-24.215	-25.027	-7.474	-9.547	-27.921	-31.435	-32.771	-32.698	-35.196	-34.692
TB3SMFFM	-2.384	-1.869	-1.281	-0.635	-1.742	-2.174	1.789	4.913	7.471	6.777	11.620	13.472
TB6SMFFM	-1.248	-0.601	0.137	0.942	-1.420	-1.742	4.076	8.303	11.872	10.836	17.775	20.012
GS10MFFM	-3.405	-2.810	-2.106	-1.313	-1.396	-1.946	2.225	7.772	13.005	11.535	27.883	36.576
GS5MFFM	-3.031	-2.338	-1.527	-0.623	-1.269	-1.850	3.300	9.230	14.798	13.204	28.750	36.064
GS3MFFM	-2.318	-1.564	-0.693	0.268	-1.318	-1.877	4.320	10.128	15.435	13.892	27.567	33.189
GS1MFFM	-1.197	-0.400	0.489	1.434	-1.716	-2.174	5.014	9.556	13.176	12.207	19.540	21.892
AAAMFFM	-6.122	-5.701	-5.165	-4.531	-2.399	-3.147	-1.639	3.627	9.103	7.513	27.346	39.755
BAAMFFM	-5.021	-4.669	-4.226	-3.706	-2.453	-2.979	-1.390	2.844	7.178	5.949	22.255	32.777
AAAMGS10	14.587	15.292	16.041	16.823	4.190	5.590	18.941	22.363	24.703	24.201	32.324	37.415
BAAMGS10	1.865	2.066	2.285	2.522	0.144	0.284	3.306	4.919	5.942	5.924	10.812	14.692
GS10MGS1	-2.099	-1.771	-1.365	-0.888	-1.341	-1.348	1.937	6.933	11.244	10.265	30.548	45.913
GS10MGS3	5.712	6.176	6.631	7.075	1.138	1.824	9.163	12.602	14.410	14.487	27.770	40.653
GS10MGS5	4.976	5.321	5.637	5.926	1.364	1.885	7.427	10.353	10.989	11.610	25.070	35.626
GS10MTB3MS	-0.913	-0.339	0.313	1.026	-0.994	-0.975	4.542	10.732	16.166	14.795	38.681	54.563
GS10MTB6MS	-3.545	-3.205	-2.799	-2.339	-1.675	-1.897	-0.021	4.283	8.152	7.288	26.057	40.331
AAAMGS5	9.102	10.136	11.188	12.252	0.810	1.327	16.508	23.927	26.826	27.330	47.019	58.367
BAAMGS5	1.371	1.683	2.010	2.349	-0.536	-0.501	3.714	6.546	7.834	8.104	17.517	24.471
GS5MGS1	-5.992	-5.841	-5.583	-5.221	-2.154	-2.462	-2.535	2.657	7.872	6.494	27.483	41.502
GS5MGS3	3.009	3.545	4.107	4.686	-1.112	-0.632	7.659	12.164	15.165	14.809	26.895	38.619
GS5MTB3MS	-1.309	-0.732	-0.070	0.666	-0.762	-0.749	4.285	10.659	16.482	14.876	36.165	48.634
GS5MTB6MS	-4.978	-4.693	-4.330	-3.899	-1.587	-1.916	-1.611	2.833	7.016	5.988	23.062	34.695
AAAMGS3	4.098	4.600	5.146	5.731	0.696	1.056	8.559	14.888	18.382	18.684	41.076	57.006
BAAMGS3	-0.343	-0.136	0.098	0.355	-0.802	-0.887	1.594	4.518	6.136	6.345	17.489	26.400
GS3MGS1	-6.276	-6.065	-5.742	-5.317	-1.986	-2.634	-2.484	2.962	8.789	7.042	29.242	41.674
GS3MTB3MS	-0.458	0.128	0.778	1.486	-0.611	-0.762	4.838	10.432	15.641	14.074	32.003	41.669
GS3MTB6MS	-4.290	-3.969	-3.591	-3.165	-1.225	-1.725	-1.025	2.886	6.648	5.637	20.445	29.839
AAAMGS1	-1.687	-1.352	-0.958	-0.513	-1.844	-1.979	1.761	6.732	11.297	10.345	35.309	54.337
BAAMGS1	-2.057	-1.917	-1.739	-1.524	-1.553	-1.736	-0.283	2.784	5.616	5.094	20.841	32.833
GS1MTB3MS	0.462	0.540	0.608	0.666	0.595	0.518	0.777	1.093	1.745	1.449	7.145	11.180
GS1MTB6MS	0.250	0.114	-0.068	-0.290	0.895	0.863	-1.186	-3.096	-4.631	-4.215	-4.084	-1.352
TB6MSMTB3MS	6.692	6.843	6.959	7.071	0.153	0.650	8.523	9.936	11.366	10.543	16.557	18.525
AAAMTB6MS	-4.083	-3.833	-3.522	-3.161	-2.406	-2.802	-1.346	2.966	7.344	6.347	29.574	47.174
BAAMTB6MS	-4.062	-4.001	-3.897	-3.753	-1.930	-2.337	-2.835	-0.184	2.570	1.999	16.962	28.278
AAAMTB3MS	-1.637	-1.155	-0.609	-0.008	-1.983	-2.164	2.919	8.836	14.442	13.024	40.286	59.051
BAAMTB3MS	-1.000	-0.757	-0.473	-0.151	-1.006	-1.132	1.542	5.276	8.847	8.009	25.872	38.271

Table 23: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 12-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=12												
Index	sym10	sym11	sym12	sym13	sym14	sym15	sym16	coif1	coif2	coif3	coif4	coif5
FEDFUNDS	-12.019	-11.649	-9.842	-8.959	-8.176	-7.841	-7.198	-10.977	-16.713	-18.093	-15.981	-11.609
INTGSTUSM193N	-31.275	-31.016	-29.648	-29.011	-28.611	-28.549	-28.639	-18.605	-27.703	-32.632	-33.680	-30.981
AAA	-2.421	-2.413	1.041	3.812	6.482	8.530	13.823	-6.076	-7.932	-6.749	-5.293	-2.056
BAA	5.859	5.966	10.299	13.724	17.169	19.752	26.509	-2.377	-2.570	-0.834	1.631	6.388
GS1	-36.592	-36.559	-35.784	-35.366	-35.146	-35.070	-34.887	-20.350	-29.271	-33.852	-36.827	-36.489
GS3	-35.840	-35.884	-35.673	-35.218	-34.751	-34.242	-32.593	-22.495	-29.789	-32.336	-34.770	-35.883
GS5	-31.519	-31.520	-30.956	-30.004	-29.132	-28.287	-25.788	-21.488	-27.212	-28.829	-30.662	-31.530
GS10	-26.390	-26.313	-25.589	-24.379	-23.211	-22.117	-18.809	-18.338	-23.191	-24.506	-25.619	-26.382
TB3MS	-31.881	-31.655	-30.283	-29.623	-29.188	-29.087	-29.094	-18.410	-27.672	-32.566	-34.054	-31.601
TB6MS	-33.800	-33.675	-32.551	-32.035	-31.731	-31.682	-31.706	-18.934	-27.979	-32.977	-35.145	-33.597
TB3SMFFM	14.643	14.888	15.592	15.987	16.543	16.950	18.306	-3.315	1.477	7.708	11.948	14.853
TB6SMFFM	21.164	21.491	22.077	22.559	23.246	23.859	25.845	-2.539	3.733	12.174	18.192	21.383
GS10MFFM	43.515	45.473	54.517	61.692	70.500	76.599	96.260	-3.811	1.890	13.577	29.154	45.281
GS5MFFM	41.576	43.052	50.051	56.031	63.498	69.243	88.774	-3.820	2.896	15.377	29.892	42.924
GS3MFFM	36.977	38.002	42.070	45.478	50.121	53.989	67.972	-3.442	3.904	15.962	28.484	37.854
GS1MFFM	23.117	23.465	24.226	25.108	26.414	27.724	32.423	-2.905	4.594	13.521	19.966	23.358
AAAMFFM	51.035	53.586	68.496	79.364	90.527	97.069	112.949	-5.953	-1.892	9.734	29.059	53.808
BAAMFFM	42.277	44.361	56.379	64.875	73.777	79.066	91.874	-4.991	-1.576	7.695	23.678	44.575
AAAMGS10	42.217	41.823	45.368	46.792	45.633	44.241	38.504	12.841	19.133	25.039	32.854	42.882
BAAMGS10	18.610	18.738	22.490	24.102	25.165	25.444	24.827	1.377	3.350	6.191	11.241	19.338
GS10MGS1	59.627	63.680	84.758	98.958	106.326	106.397	101.779	-1.690	1.861	11.837	32.444	63.499
GS10MGS3	53.017	56.020	74.373	83.704	83.300	77.883	62.887	4.785	9.142	14.830	29.125	56.379
GS10MGS5	41.958	43.824	45.009	40.346	35.936	31.704	24.095	3.985	7.516	11.393	25.999	43.401
GS10MTB3MS	68.419	72.759	94.443	112.125	128.425	137.283	156.674	-1.457	4.390	16.869	40.741	72.356
GS10MTB6MS	53.422	57.243	77.016	91.561	103.184	107.475	114.246	-3.284	-0.157	8.721	27.812	57.076
AAAMGS5	67.116	66.876	71.901	72.018	68.166	64.102	52.371	6.068	16.821	27.737	48.173	68.352
BAAMGS5	30.564	30.960	35.915	37.219	37.436	36.653	33.290	0.543	3.806	8.274	18.250	31.701
GS5MGS1	54.000	57.628	79.151	97.186	109.004	112.957	116.142	-4.864	-2.650	8.523	29.379	57.555
GS5MGS3	53.454	56.820	93.655	128.312	141.972	141.854	127.229	2.283	7.539	15.638	28.324	57.969
GS5MTB3MS	59.499	62.877	81.171	98.393	115.364	126.485	152.692	-1.973	4.069	17.156	37.891	62.591
GS5MTB6MS	45.448	48.549	66.355	82.108	96.234	103.793	119.269	-4.573	-1.792	7.586	24.591	48.465
AAAMGS3	70.970	71.687	85.443	90.929	88.554	84.134	69.888	2.939	8.647	19.351	42.952	73.568
BAAMGS3	34.777	35.538	44.439	48.317	49.279	48.330	43.609	-0.722	1.638	6.622	18.487	36.502
GS3MGS1	51.216	54.191	68.131	79.218	88.150	92.255	99.375	-5.370	-2.612	9.448	31.012	53.847
GS3MTB3MS	49.606	52.248	64.404	76.053	89.152	98.851	124.372	-1.549	4.625	16.184	33.361	51.834
GS3MTB6MS	38.022	40.543	52.696	63.406	74.994	82.372	100.916	-4.217	-1.213	7.131	21.695	40.284
AAAMGS1	71.284	74.198	94.392	105.069	107.907	105.953	96.190	-1.793	1.758	12.030	37.687	75.220
BAAMGS1	43.704	45.577	58.598	65.666	69.119	69.181	66.074	-1.934	-0.272	6.106	22.302	46.243
GS1MTB3MS	14.223	15.795	19.634	25.151	33.179	40.319	59.150	0.190	0.713	1.821	7.734	15.141
GS1MTB6MS	1.698	2.887	6.420	10.643	17.956	24.060	42.019	0.568	-1.168	-4.723	-3.791	2.564
TB6MSMTB3MS	19.386	20.152	21.001	23.526	26.680	30.107	39.718	4.634	8.728	11.356	16.815	19.693
AAAMTB6MS	63.443	66.367	86.456	98.288	104.680	105.568	102.584	-3.927	-1.401	8.033	31.766	67.284
BAAMTB6MS	38.764	40.662	53.526	61.261	66.606	68.285	69.289	-3.674	-2.856	3.035	18.343	41.246
AAAMTB3MS	75.864	79.235	100.935	115.379	125.058	128.803	132.431	-2.253	2.871	15.225	42.710	79.937
BAAMTB3MS	49.383	51.620	65.690	75.107	82.462	85.869	91.058	-1.247	1.524	9.382	27.438	52.074

Table 24: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 24-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=24												
Index	haar	db2	db3	db4	db5	db6	db7	db8	db9	db10	db11	db12
FEDFUNDS	0.815	0.984	1.198	1.390	1.566	1.733	1.890	2.036	2.168	2.284	2.383	2.471
INTGSTUSM193N	0.508	0.688	0.853	0.945	0.954	0.890	0.769	0.616	0.449	0.287	0.140	0.018
AAA	1.575	1.953	2.531	3.170	3.846	4.553	5.290	6.055	6.845	7.650	8.456	9.248
BAA	1.877	2.386	3.120	3.910	4.732	5.579	6.444	7.323	8.210	9.097	9.976	10.839
GS1	0.140	0.244	0.317	0.359	0.371	0.352	0.312	0.260	0.208	0.162	0.129	0.110
GS3	0.541	0.563	0.736	0.984	1.289	1.644	2.050	2.511	3.033	3.624	4.284	5.003
GS5	0.988	1.071	1.378	1.786	2.265	2.807	3.411	4.086	4.841	5.686	6.621	7.629
GS10	0.995	1.055	1.381	1.817	2.334	2.939	3.640	4.445	5.356	6.366	7.455	8.586
TB3MS	0.541	0.759	0.975	1.125	1.192	1.180	1.105	0.987	0.848	0.706	0.576	0.467
TB6MS	0.226	0.363	0.475	0.533	0.531	0.473	0.373	0.249	0.116	-0.015	-0.134	-0.238
TB3SMFFM	0.462	0.448	0.484	0.544	0.638	0.770	0.935	1.123	1.327	1.538	1.750	1.960
TB6SMFFM	0.590	0.584	0.659	0.767	0.910	1.086	1.285	1.500	1.727	1.966	2.218	2.483
GS10MFFM	3.820	4.325	5.462	6.713	8.055	9.507	11.089	12.813	14.679	16.668	18.763	20.956
GS5MFFM	3.072	3.547	4.500	5.569	6.729	7.979	9.325	10.783	12.364	14.076	15.938	17.967
GS3MFFM	2.008	2.260	2.852	3.543	4.314	5.159	6.080	7.089	8.192	9.408	10.769	12.290
GS1MFFM	0.817	0.892	1.079	1.307	1.575	1.885	2.233	2.621	3.054	3.546	4.109	4.742
AAAMFFM	7.088	7.834	9.722	11.715	13.748	15.818	17.922	20.059	22.207	24.325	26.384	28.383
BAAMFFM	6.085	6.915	8.727	10.627	12.554	14.508	16.478	18.451	20.408	22.325	24.184	25.982
AAAMGS10	6.340	4.859	3.896	2.890	1.744	0.401	-1.116	-2.756	-4.495	-6.326	-8.234	-10.180
BAAMGS10	3.812	4.103	4.809	5.472	6.042	6.481	6.766	6.881	6.818	6.582	6.198	5.714
GS10MGS1	3.631	3.672	4.483	5.336	6.001	6.401	6.551	6.516	6.371	6.177	5.981	5.814
GS10MGS3	4.742	3.908	3.418	2.552	1.383	0.101	-1.149	-2.332	-3.513	-4.805	-6.303	-8.042
GS10MGS5	0.187	-2.035	-3.852	-5.819	-7.794	-9.596	-11.141	-12.473	-13.728	-15.069	-16.614	-18.392
GS10MTB3MS	5.558	6.575	8.489	10.423	12.175	13.739	15.178	16.576	18.022	19.588	21.311	23.187
GS10MTB6MS	4.352	4.852	6.173	7.499	8.619	9.511	10.240	10.900	11.581	12.346	13.225	14.219
AAAMGS5	4.818	2.723	1.282	-0.174	-1.727	-3.401	-5.163	-6.984	-8.887	-10.913	-13.079	-15.366
BAAMGS5	4.660	4.413	4.839	5.181	5.395	5.472	5.404	5.170	4.736	4.072	3.181	2.109
GS5MGS1	4.266	4.885	6.220	7.664	8.950	9.942	10.619	11.049	11.349	11.642	12.022	12.546
GS5MGS3	9.581	10.677	12.031	12.941	13.362	13.406	13.216	12.900	12.516	12.090	11.636	11.175
GS5MTB3MS	5.500	6.739	8.769	10.868	12.837	14.644	16.319	17.941	19.624	21.480	23.574	25.922
GS5MTB6MS	4.674	5.550	7.191	8.895	10.440	11.765	12.902	13.947	15.023	16.241	17.671	19.332
AAAMGS3	5.351	3.823	2.915	1.922	0.766	-0.549	-1.980	-3.496	-5.113	-6.862	-8.752	-10.758
BAAMGS3	5.507	5.443	6.047	6.512	6.789	6.885	6.810	6.558	6.102	5.417	4.509	3.426
GS3MGS1	2.865	3.184	4.202	5.426	6.612	7.604	8.343	8.871	9.297	9.741	10.296	11.016
GS3MTB3MS	4.715	5.678	7.418	9.282	11.099	12.830	14.481	16.120	17.867	19.834	22.096	24.668
GS3MTB6MS	3.961	4.591	6.016	7.583	9.083	10.441	11.665	12.839	14.089	15.536	17.259	19.279
AAAMGS1	5.065	4.535	4.883	5.246	5.402	5.264	4.838	4.176	3.331	2.355	1.303	0.235
BAAMGS1	4.821	5.031	6.041	7.058	7.918	8.544	8.917	9.054	8.982	8.732	8.346	7.886
GS1MTB3MS	6.649	7.599	9.418	11.332	13.173	14.993	16.866	18.828	20.929	23.283	25.998	29.059
GS1MTB6MS	5.618	6.213	7.664	9.115	10.439	11.725	13.115	14.757	16.771	19.244	22.215	25.659
TB6MSMTB3MS	3.358	3.911	5.016	6.186	7.237	8.360	9.609	10.722	11.649	12.690	14.081	15.567
AAAMTB6MS	5.473	5.600	6.562	7.485	8.164	8.551	8.688	8.652	8.510	8.312	8.100	7.909
BAAMTB6MS	4.846	5.441	6.766	8.068	9.200	10.118	10.832	11.384	11.812	12.146	12.416	12.660
AAAMTB3MS	6.354	7.041	8.581	10.076	11.321	12.289	13.024	13.597	14.076	14.516	14.960	15.434
BAAMTB3MS	5.466	6.417	8.112	9.788	11.298	12.603	13.721	14.695	15.566	16.369	17.133	17.888

Table 25: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 24-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=24												
Index	db13	db14	db15	db16	sym2	sym3	sym4	sym5	sym6	sym7	sym8	sym9
FEDFUNDS	2.554	2.642	2.744	2.867	0.984	1.198	3.620	4.455	5.584	4.921	6.004	4.902
INTGSTUSM193N	-0.073	-0.128	-0.142	-0.108	0.688	0.853	0.475	1.510	3.741	2.427	4.321	3.097
AAA	10.010	10.728	11.392	11.999	1.953	2.531	14.175	16.422	16.374	17.095	17.221	18.047
BAA	11.680	12.495	13.282	14.042	2.386	3.120	17.015	20.795	22.363	22.551	27.599	31.403
GS1	0.105	0.111	0.125	0.143	0.244	0.317	0.280	0.580	1.346	0.863	3.227	3.524
GS3	5.757	6.510	7.220	7.843	0.563	0.736	8.761	8.962	5.952	8.158	3.004	2.818
GS5	8.677	9.719	10.702	11.574	1.071	1.378	13.213	14.332	11.088	13.818	7.303	6.879
GS10	9.714	10.788	11.758	12.583	1.055	1.381	14.504	16.008	12.806	15.594	10.706	10.949
TB3MS	0.387	0.342	0.335	0.372	0.759	0.975	0.925	1.951	4.156	2.856	4.854	3.697
TB6MS	-0.323	-0.386	-0.424	-0.432	0.363	0.475	-0.067	0.787	2.722	1.602	4.622	4.341
TB3SMFFM	2.162	2.353	2.527	2.682	0.448	0.484	3.103	3.322	3.028	3.228	2.942	2.594
TB6SMFFM	2.757	3.032	3.292	3.521	0.584	0.659	3.989	4.201	3.753	4.044	2.206	1.059
GS10MFFM	23.235	25.581	27.985	30.448	4.325	5.462	41.666	58.647	68.389	67.294	88.752	85.028
GS5MFFM	20.152	22.467	24.885	27.374	3.547	4.500	37.378	52.517	59.039	59.928	69.598	65.488
GS3MFFM	13.958	15.749	17.627	19.530	2.260	2.852	26.224	35.795	38.315	39.942	40.277	36.031
GS1MFFM	5.443	6.196	6.953	7.655	0.892	1.079	9.180	11.129	10.220	11.443	7.248	4.543
AAAMFFM	30.336	32.264	34.202	36.198	7.834	9.722	45.608	57.171	66.708	62.682	75.688	67.718
BAAMFFM	27.738	29.483	31.252	33.078	6.915	8.727	41.476	52.809	61.417	58.477	76.479	75.445
AAAMGS10	-12.115	-13.981	-15.718	-17.272	4.859	3.896	-21.715	-26.706	-25.424	-28.154	-30.102	-34.211
BAAMGS10	5.195	4.710	4.321	4.070	4.103	4.809	4.393	5.126	9.033	6.216	12.186	12.106
GS10MGS1	5.703	5.682	5.793	6.095	3.672	4.483	10.452	19.631	35.470	27.301	62.111	67.087
GS10MGS3	-9.980	-12.007	-13.979	-15.746	3.908	3.418	-15.740	-12.385	-1.015	-8.617	29.790	34.344
GS10MGS5	-20.336	-22.317	-24.195	-25.858	-2.035	-3.852	-27.364	-28.128	-25.571	-28.001	-10.080	-5.839
GS10MTB3MS	25.186	27.285	29.467	31.728	6.575	8.489	41.777	57.091	71.140	66.448	90.055	87.474
GS10MTB6MS	15.319	16.517	17.825	19.271	4.852	6.173	27.506	41.360	58.100	51.050	85.451	89.258
AAAMGS5	-17.726	-20.078	-22.325	-24.370	2.723	1.282	-29.245	-34.222	-31.948	-35.464	-33.494	-37.331
BAAMGS5	0.938	-0.229	-1.293	-2.174	4.413	4.839	-2.853	-3.023	1.535	-2.168	6.720	6.372
GS5MGS1	13.245	14.133	15.221	16.523	4.885	6.220	23.084	35.241	52.203	44.616	76.248	81.614
GS5MGS3	10.739	10.381	10.172	10.198	10.677	12.031	14.896	26.179	44.821	34.997	76.031	80.068
GS5MTB3MS	28.490	31.225	34.066	36.949	6.739	8.769	47.282	63.190	74.185	72.192	86.391	82.759
GS5MTB6MS	21.210	23.270	25.482	27.827	5.550	7.191	37.827	54.027	69.681	64.593	92.188	95.736
AAAMGS3	-12.827	-14.878	-16.814	-18.538	3.823	2.915	-22.040	-25.057	-20.493	-25.135	-18.602	-22.349
BAAMGS3	2.254	1.098	0.062	-0.768	5.443	6.047	-0.952	0.010	6.573	1.748	14.893	14.697
GS3MGS1	11.924	13.020	14.298	15.750	3.184	4.202	21.920	32.379	45.759	40.241	61.347	64.964
GS3MTB3MS	27.507	30.528	33.610	36.633	5.678	7.418	45.533	59.220	65.799	66.065	69.993	63.586
GS3MTB6MS	21.563	24.044	26.645	29.312	4.591	6.016	39.245	54.442	66.124	63.512	80.973	81.693
AAAMGS1	-0.791	-1.713	-2.466	-2.990	4.535	4.883	-2.591	-0.552	8.520	2.355	15.333	12.597
BAAMGS1	7.422	7.030	6.779	6.730	5.031	6.041	8.832	13.174	22.843	17.082	35.014	36.217
GS1MTB3MS	32.356	35.781	39.171	42.270	7.599	9.418	48.033	58.644	53.503	61.620	36.279	23.199
GS1MTB6MS	29.468	33.443	37.350	41.003	6.213	7.664	50.719	64.662	66.119	70.352	62.059	51.086
TB6MSMTB3MS	16.861	18.140	19.741	21.474	3.911	5.016	22.106	23.114	17.749	21.290	0.995	-4.231
AAAMTB6MS	7.771	7.723	7.811	8.082	5.600	6.562	11.214	16.175	26.649	20.396	34.391	30.653
BAAMTB6MS	12.919	13.242	13.676	14.270	5.441	6.766	18.597	25.520	36.334	30.643	50.210	51.492
AAAMTB3MS	15.956	16.546	17.236	18.054	7.041	8.581	22.338	28.060	37.615	32.175	41.642	35.076
BAAMTB3MS	18.664	19.492	20.405	21.436	6.417	8.112	26.699	34.327	44.368	39.400	55.187	54.076

Table 26: Percentage improvement of forecast performance of wavelet based method over forecast performance of standard probit model for 24-month-ahead prediction exercise

$P(R_t + k = 1) = F(\beta_0 + \beta_t x_t)$												
k=24												
Index	sym10	sym11	sym12	sym13	sym14	sym15	sym16	coif1	coif2	coif3	coif4	coif5
FEDFUNDS	3.213	2.864	-0.177	-2.459	-3.652	-4.051	-3.182	2.240	3.587	5.550	5.892	2.742
INTGSTUSM193N	1.401	1.045	-1.359	-2.571	-2.208	-0.993	5.027	0.761	0.410	3.666	4.268	0.940
AAA	19.646	20.022	24.062	28.449	33.566	37.760	50.232	6.907	14.112	16.594	17.348	20.118
BAA	36.179	36.838	45.960	54.495	61.990	67.512	80.530	8.323	16.989	22.745	28.188	37.360
GS1	3.259	3.156	2.535	2.380	3.260	4.767	11.843	0.259	0.299	1.346	3.350	3.139
GS3	3.401	3.645	5.592	9.095	14.275	19.320	36.055	3.069	8.609	6.128	2.851	3.656
GS5	7.482	7.986	10.162	14.397	20.354	25.750	42.260	4.985	13.002	11.376	7.027	7.852
GS10	11.989	12.785	16.123	21.285	27.889	33.389	49.754	5.412	14.333	13.142	10.515	12.537
TB3MS	2.009	1.686	-0.733	-1.928	-1.590	-0.395	5.709	1.154	0.876	4.084	4.804	1.559
TB6MS	3.419	3.165	1.586	0.707	1.137	2.298	7.900	0.298	-0.074	2.697	4.700	3.115
TB3SMFFM	2.140	1.989	0.830	-0.089	-0.819	-1.265	-2.159	1.226	3.066	3.044	2.839	1.990
TB6SMFFM	0.081	-0.136	-1.582	-2.503	-3.177	-3.542	-4.074	1.693	3.923	3.747	2.002	-0.166
GS10MFFM	71.358	67.041	35.563	13.979	2.341	-3.691	-13.014	15.272	41.351	69.954	88.498	66.182
GS5MFFM	55.158	51.993	27.759	11.431	2.830	-1.543	-8.545	13.017	37.015	60.621	69.006	51.353
GS3MFFM	29.468	27.334	13.601	4.400	-0.482	-2.937	-6.851	8.628	25.860	39.298	39.466	27.121
GS1MFFM	2.068	1.664	-1.702	-3.266	-4.099	-4.457	-4.862	3.112	9.023	10.395	6.700	1.443
AAAMFFM	55.358	51.159	25.831	5.445	-7.835	-15.159	-27.403	22.714	45.411	66.885	74.746	50.953
BAAMFFM	69.159	66.012	46.577	27.315	12.811	4.133	-12.188	20.887	41.470	61.945	76.681	66.112
AAAMGS10	-37.575	-38.235	-41.362	-42.897	-45.651	-47.335	-51.386	-5.231	-21.638	-26.339	-30.627	-38.352
BAAMGS10	11.736	11.645	12.768	15.665	13.539	11.804	4.019	6.847	4.593	8.721	12.513	11.656
GS10MGS1	65.122	61.986	48.387	27.528	10.404	-0.902	-20.009	7.210	10.357	35.593	63.791	62.599
GS10MGS3	28.903	28.197	13.332	-3.169	-19.318	-29.228	-42.924	-3.871	-15.192	-1.344	31.326	26.860
GS10MGS5	-7.750	-7.394	-10.213	-16.247	-23.780	-28.419	-33.810	-15.001	-26.908	-25.833	-8.802	-8.282
GS10MTB3MS	76.090	71.580	43.384	16.629	-0.194	-9.861	-24.361	19.917	41.151	72.043	90.549	71.168
GS10MTB6MS	84.246	79.572	57.680	28.435	9.514	-1.940	-18.481	13.174	26.995	58.752	87.000	80.217
AAAMGS5	-41.227	-41.995	-45.980	-48.912	-53.439	-56.436	-62.598	-10.304	-29.034	-32.924	-33.871	-42.191
BAAMGS5	5.004	4.654	4.063	4.011	-1.308	-5.468	-17.514	4.275	-2.498	1.040	7.127	4.601
GS5MGS1	80.751	77.489	63.855	42.012	26.039	15.656	-2.411	12.808	22.704	52.696	77.912	78.369
GS5MGS3	75.703	74.056	52.490	26.680	3.462	-11.581	-36.977	14.319	15.015	44.995	77.274	73.247
GS5MTB3MS	72.201	68.452	42.658	19.435	5.980	-1.609	-13.044	21.659	46.568	75.430	86.381	67.848
GS5MTB6MS	91.155	87.107	65.276	36.644	19.980	10.058	-3.675	17.027	37.089	70.760	93.441	87.493
AAAMGS3	-27.139	-28.206	-34.758	-40.232	-47.153	-51.692	-60.557	-6.120	-21.853	-21.439	-18.932	-28.479
BAAMGS3	12.671	11.937	9.088	5.916	-2.129	-8.126	-23.315	5.787	-0.613	6.054	15.374	11.920
GS3MGS1	65.588	61.887	54.461	38.411	27.798	21.092	11.467	10.484	21.405	46.224	62.451	63.571
GS3MTB3MS	54.170	50.496	30.527	13.117	3.787	-1.240	-7.517	19.485	44.749	66.907	69.071	50.309
GS3MTB6MS	77.330	73.121	55.954	32.702	20.506	13.472	6.619	15.914	38.348	67.207	81.331	73.910
AAAMGS1	8.056	5.956	-2.977	-12.994	-23.112	-29.744	-42.187	3.415	-2.605	7.845	15.362	6.153
BAAMGS1	34.954	33.371	28.777	20.901	10.216	2.634	-13.981	9.214	8.961	22.547	35.820	33.817
GS1MTB3MS	11.379	10.029	-4.963	-11.951	-13.905	-14.285	-14.067	22.285	47.572	55.335	34.317	8.732
GS1MTB6MS	38.107	35.037	11.716	-3.959	-7.835	-9.075	-8.888	19.153	49.563	67.666	59.905	33.884
TB6MSMTB3MS	-7.420	-7.870	-10.891	-12.144	-12.029	-11.676	-9.148	11.797	22.130	18.061	0.120	-8.035
AAAMTB6MS	24.486	21.577	8.892	-5.739	-17.648	-25.064	-37.386	9.283	10.940	26.177	34.391	21.864
BAAMTB6MS	49.463	47.436	40.169	27.993	15.336	6.751	-9.921	12.533	18.499	36.272	51.110	47.914
AAAMTB3MS	26.174	23.048	6.636	-8.912	-20.641	-27.650	-39.395	15.137	21.954	37.208	41.171	23.023
BAAMTB3MS	49.552	47.329	36.081	22.283	9.736	1.581	-14.261	16.476	26.504	44.368	55.663	47.487

Table 27:Best QPS Scores for 3-month-ahead prediction exercise[1]

Best Scores			
RANK	INDEX	QPS SCORE	METHOD
1	GS3MFFM	0.115	coif2
2	GS3MFFM	0.115	sym4
3	GS5MFFM	0.115	sym5
4	GS3MGS1	0.116	sym12
5	GS5MGS1	0.116	coif5
6	GS5MGS1	0.116	sym10
7	GS5MGS1	0.116	sym11
8	GS5MFFM	0.117	sym7
9	GS10MTB3MS	0.117	sym8
10	GS10MTB3MS	0.117	coif4
11	GS10MTB3MS	0.117	sym9
12	GS3MGS1	0.118	sym13
13	GS5MFFM	0.119	coif3
14	GS5MFFM	0.119	sym6
15	GS3MFFM	0.119	db16
16	GS3MFFM	0.120	db15
17	GS3MFFM	0.120	db14
18	GS3MFFM	0.121	db13
19	GS3MFFM	0.121	db12
20	GS3MFFM	0.122	db11
21	GS3MFFM	0.122	coif1
22	GS1MFFM	0.123	db10
23	GS1MFFM	0.124	db9
24	GS3MGS1	0.124	sym14
25	GS1MFFM	0.124	db8
26	GS1MFFM	0.125	db7
27	GS1MFFM	0.126	db6
28	GS1MFFM	0.127	db5
29	GS1MFFM	0.128	db4
30	GS3MGS1	0.129	sym15
31	GS1MFFM	0.130	db3
32	GS1MFFM	0.130	sym3
33	TB6SMFFM	0.131	db2
34	TB6SMFFM	0.131	sym2
35	TB6SMFFM	0.131	haar
36	GS1MFFM	0.132	standard
37	GS3MGS1	0.147	sym16

[1] Firstly, the best indexes in the wavelet and probit model in each QPS table is determined and then these best scores are ranked in their own.

Table 28:Best QPS Scores for 6-month-ahead prediction exercise[2]

Best Scores			
RANK	INDEX	QPS SCORE	METHOD
1	GS3MGS1	0.115	sym8
2	GS3MGS1	0.115	coif4
3	GS3MFFM	0.115	haar
4	GS3MFFM	0.115	db2
5	GS3MFFM	0.115	sym2
6	GS3MGS1	0.116	sym9
7	GS3MFFM	0.116	db3
8	GS3MFFM	0.116	sym3
9	GS3MFFM	0.116	standard
10	GS3MFFM	0.116	db4
11	GS3MFFM	0.117	db5
12	GS3MFFM	0.117	coif1
13	GS10MTB3MS	0.117	sym7
14	GS10MTB3MS	0.117	sym6
15	GS10MTB3MS	0.117	coif3
16	GS10MTB3MS	0.117	sym5
17	GS3MFFM	0.117	db6
18	GS3MFFM	0.118	db7
19	GS3MGS1	0.119	sym10
20	GS3MFFM	0.119	db8
21	GS10MTB3MS	0.119	sym4
22	GS3MFFM	0.119	db9
23	GS10MTB3MS	0.119	coif2
24	GS3MGS1	0.120	sym11
25	GS3MFFM	0.120	db10
26	GS3MGS1	0.120	coif5
27	GS3MFFM	0.120	db11
28	GS5MFFM	0.120	db13
29	GS5MFFM	0.120	db14
30	GS5MFFM	0.120	db15
31	GS5MFFM	0.120	db16
32	GS5MFFM	0.120	db12
33	GS3MGS1	0.130	sym12
34	GS3MGS1	0.143	sym13
35	GS3MTB6MS	0.156	sym14
36	TB3SMFFM	0.158	sym15
37	GS10	0.160	sym16

[2] Firstly, the best indexes in the wavelet and probit model in each QPS table is determined and then these best scores are ranked in their own.

Table 29:Best QPS Scores for 12-month-ahead prediction exercise[3]

Best Scores			
RANK	INDEX	QPS SCORE	METHOD
1	GS3MGS1	0.115	db9
2	GS3MGS1	0.115	db10
3	GS3MGS1	0.115	db11
4	GS3MGS1	0.115	db12
5	GS3MGS1	0.115	db13
6	GS5MGS1	0.115	db14
7	GS5MGS3	0.116	haar
8	GS5MGS3	0.116	db2
9	GS3MGS1	0.116	db7
10	GS3MGS1	0.116	db8
11	GS5MGS1	0.116	db15
12	GS5MGS1	0.116	db16
13	GS5MGS3	0.116	sym2
14	GS3MGS1	0.116	coif1
15	GS5MGS3	0.117	db3
16	GS3MGS1	0.117	db6
17	GS5MGS3	0.117	sym3
18	GS5MGS3	0.118	standard
19	GS5MGS3	0.118	db4
20	GS3MGS1	0.118	db5
21	GS5MGS1	0.119	sym4
22	GS5MGS1	0.119	coif2
23	GS5MGS1	0.126	sym5
24	GS5MGS1	0.131	sym7
25	GS5MGS1	0.132	sym6
26	GS5MGS1	0.133	coif3
27	INTGSTUSM193N	0.146	sym8
28	TB3MS	0.146	coif4
29	TB6MS	0.148	sym9
30	TB6MS	0.150	sym10
31	TB6MS	0.150	sym11
32	TB6MS	0.150	coif5
33	GS1	0.152	sym12
34	GS1	0.153	sym13
35	GS1	0.153	sym14
36	GS1	0.154	sym15
37	GS1	0.154	sym16

[3] Firstly, the best indexes in the wavelet and probit model in each QPS table is determined and then these best scores are ranked in their own.

Table 30:Best QPS Scores for24-month-ahead prediction exercise[4]

Best Scores			
RANK	INDEX	QPS SCORE	METHOD
1	TB6MSMTB3MS	0.153	sym13
2	TB6MSMTB3MS	0.153	sym14
3	TB6MSMTB3MS	0.153	sym15
4	GS1	0.153	standard
5	GS1	0.153	db13
6	GS1	0.153	db12
7	GS1	0.153	db14
8	GS1	0.153	db15
9	GS1	0.153	db11
10	GS1	0.153	haar
11	GS1	0.153	db16
12	GS1	0.153	db10
13	GS1	0.153	db9
14	GS1	0.153	db2
15	GS1	0.153	sym2
16	GS1	0.153	coif1
17	GS1	0.153	db8
18	GS1	0.153	sym4
19	GS1	0.153	coif2
20	GS1	0.153	db7
21	GS1	0.153	db3
22	GS1	0.153	sym3
23	GS1	0.153	db6
24	GS1	0.153	db4
25	GS1	0.153	db5
26	GS1	0.154	sym5
27	GS1	0.154	sym7
28	TB6MSMTB3MS	0.155	sym12
29	GS1	0.155	sym6
30	GS1	0.155	coif3
31	GS1MTB3MS	0.156	sym16
32	GS1	0.158	coif5
33	GS1	0.158	sym11
34	GS1	0.158	sym8
35	GS1	0.158	sym10
36	GS1	0.158	coif4
37	GS1	0.158	sym9

[4] Firstly, the best indexes in the wavelet and probit model in each QPS table is determined and then these best scores are ranked in their own.