Can We Predict Recessions? Evidence from the Term Spread

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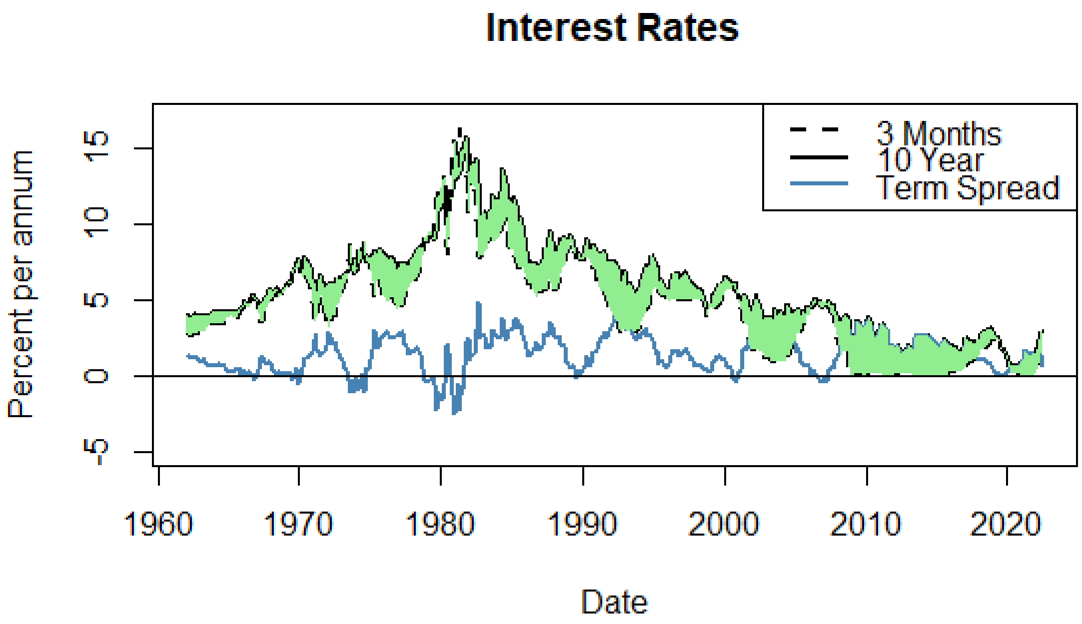
The US economy is in a technical recession because in the last two quarters of 2022, the economy shrank 1,6% and 0,9%, respectively. We call it a technical recession (two quarters of negative real growth) because the National Bureau of Economic Research (NBER) has not called it a recession yet, and moreover, there has not been an increase in the unemployment rate. In this paper, we would like to identify two main relationships. Firstly, can we predict recessions dated by the NBER via term spread, that is the difference between short- and long-term government bond yields? Secondly, is there a relationship between term spread and GDP growth rates? In this paper, we find that, yes, we can predict recessions using term spread, and that there is a positive relationship between term spread and real GDP growth.

Estrella and Mishkin (1996, 1) note that "the yield curve—specifically, the spread between the interest rates on the ten-year Treasury note and the three-month Treasury bill—is a valuable forecasting tool. It is simple to use and significantly outperforms other financial and macroeconomic indicators in predicting recessions two to six quarters ahead." Although many empirical studies find that the term spread predicts future economic activity, there is no universally agreed-upon theory as to why a relationship between the term spread and economic activity should exist. To a large extent, the usefulness of the spread for forecasting economic activity remains a "stylized fact in search of a theory" (Benati and Goodhart 2008). The expectations hypothesis of the term structure is the foundation of many explanations of the term spread's usefulness in forecasting output growth and recessions. The expectations hypothesis holds that long-term interest rates equal the sum of current and expected future short-term interest rates plus a term premium. The term premium explains why the yield curve usually slopes upward—that is, why the yields on long-term securities usually exceed those on short-term securities. However, the yield curve flattens or inverts—slopes downward—if the public expects short-term interest rates to fall. In that case, investors bid up the prices of longer-term securities, which causes their yields to fall relative to current yields on short-term securities.

The term structure of interest is regarded as an important indicator of financial activity. The yield curve can be drawn according to the maturity of Treasury bonds. The different shapes of the yield curve represent different economic implications. Under normal circumstances, the yield curve is upwards, indicating that yields on long-term bonds are higher than those on short-term ones. Conversely, if the interest rate on a short-term bond is higher than that on a long-term bond, it will be an inverted shape, indicating a recession; a flat yield curve shows that interest rates on long-term and short-term bonds are closely correlated. By studying the relationship between term structure of interest rate and economic growth, we can further predict the ability of yield curve to predict economic activity.

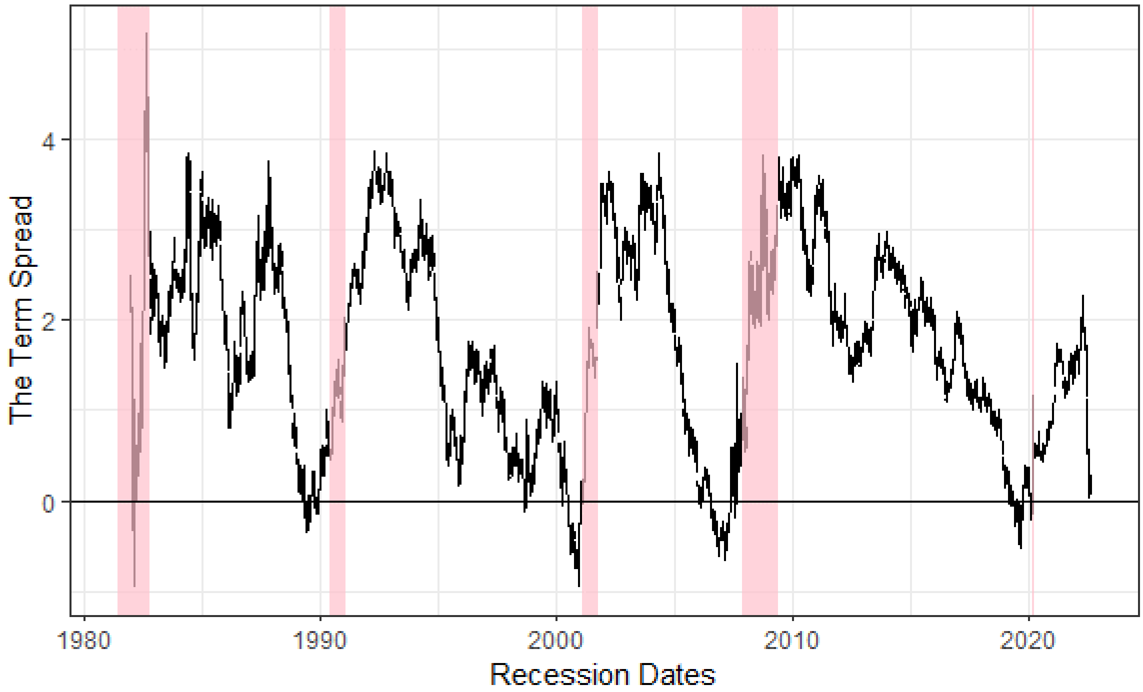
As mentioned above, we have two main goals in this paper: Predicting recession probabilities via the term spread and identifying relationship between economic growth and the term spread if any.

Graph 1. The Term Spread



Above is a graph of annualized three-month Treasury Bill rates, 10-year Treasury Note rates and their difference, namely the term spread proxy. We can observe that there are times when the term spread falls below zero. Our expectation is that sometime after those reversions a recession starts. This year in 2022 the term spread fell below zero briefly in April. We could have used the difference between the ten-year Treasury note rate and the two-year treasury note, but the convention is to use three-months' Treasury bill instead. It appears to be a better predictor of recessions.

Graph 2. The Term Spread versus Recession Dates



Above is a graph showing the initial relationship between the term spread and the recessions. The shaded areas in pink are recession times as dated by the NBER. The last recession was the “corona” recession. Observe that before each recession after the 1990s the term spread inverts and goes below zero as opposed to non-recession times. In times of growth, long-term yields are larger than short-term yields. The question is how many quarters prior to a recession can we reliably predict recessions and what is the relationship between the economic activity (namely real GDP growth) and the spread?

The convention is to use the probit (nonlinear classification) model to predict recessions. However, we will use other models as well to compare the results. Let’s start with the probit model.

Table 1. Probit Estimation Results

variables	estimate	standard error	z value	p value
intercept	0.43	0.46	0.94	0.34
second lag	-0.18	0.32	-0.56	0.57
fourth lag	-0.88	0.49	-1.76	0.07
sixth lag	-0.14	0.51	-0.28	0.77
eighth lag	-0.96	0.46	-2.06	0.03

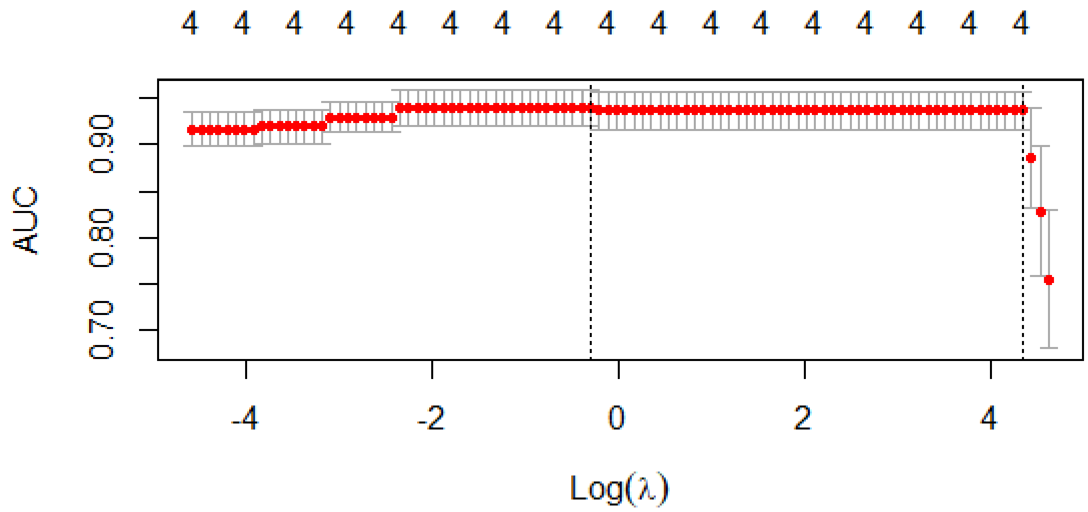
Above are the results from the probit model. We estimate recession probabilities from the term spread. If we take the significance level at 10%, the fourth and the eighth lags are significant statistically. If we use a more conservative approach and take the significance level at 5%, only the eighth lag is statistically significant. The sign of the estimate is negative, as we expected. It means that if the spread is negative, it increases the probability of a recession. The results also depict that we can predict recessions eight quarters before it occurs. The McFadden R^2 of the model is 0.45 which is quite high for these kinds of models, and it implies a good fit. After this, we tried a logit model with the same logic but obtained undesired results. First, the lags became insignificant statistically at the 5% level and the pseudo-R^2 of the model decreased.

Table 2. Logit Estimation Results

variables	estimate	standard error	z value	p value
intercept	0.86	0.78	1.09	0.27
second lag	-0.39	0.56	-0.70	0.57
fourth lag	-1.69	1.91	-1.77	0.08
sixth lag	-0.29	0.86	-0.29	0.79
eighth lag	-1.67	0.46	-1.90	0.06

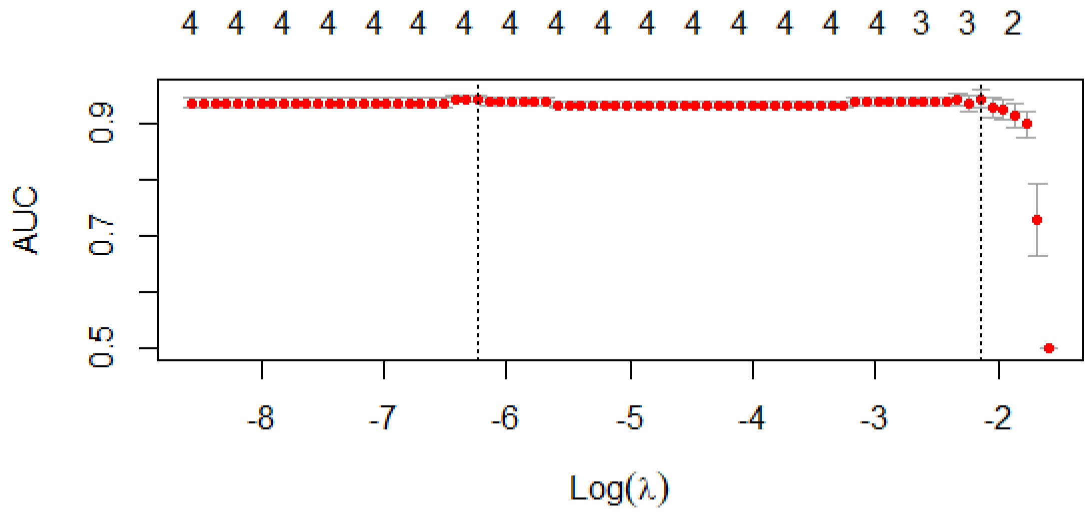
As our main problem of predicting recessions is a classification procedure, we can also apply glmnet models here. Let's look at how these models behave under this context. In short, we will only employ three main models: Ridge, Elastic-Net and Lasso.

Graph 3. Area Under Curves (AUCs) of Ridge Model



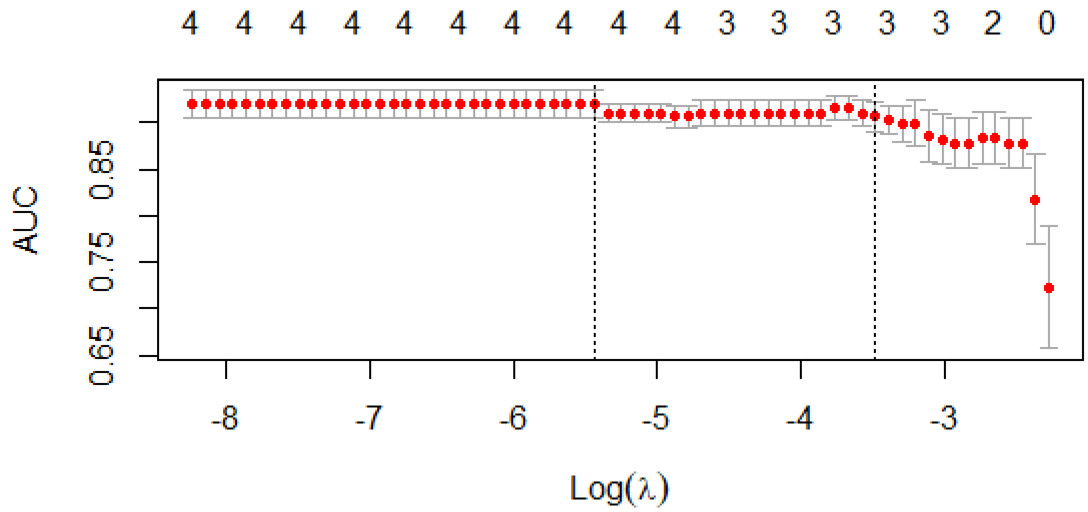
As we know the Ridge estimation keeps all possible variables in the model. The area under the curve reaches a maximum of 0.94 for this model, which is high, considering that it is a binary classification problem.

Graph 4. Area Under Curves (AUCs) of Elastic-Net Model



The Elastic-net model yields a slightly higher area under curve. It keeps the fourth, the sixth and the eighth lags of the spread and all of them are negative.

Graph 5. Area Under Curves (AUCs) of Lasso Model



The Lasso model keeps three variables as does the Elastic-net but yields an area under the curve less than that of the Elastic-net and the Ridge (0.92). Overall, these models, other than probit, show that we can predict recessions beforehand via the term spread. To rephrase, the term spread is a good predictor of recessions.

Next, we want to identify whether we can predict real GDP growth with term spread. For that reason, we transform quarterly data from 1987 to 2018 so that it reflects growth for 1, 4, 8, 12, 16 periods. Below are the results for these regressions. The ordinary least squares is used for this purpose.

Table 3. OLS Regression Results

k quarters	intercept	coefficients	R squared
1	2.15	0.24	0.01
4	2.03	0.29	0.03
8	1.97	0.37	0.09
12	2.09	0.33	0.11
16	2.11	0.31	0.08

Above is the table for the OLS results obtained from regressions with different lags. All coefficients are statistically significant. R squares are very low with the highest being with 12 lags. From these results we can claim that the spread is a predictor of real GDP growth, but it is weak predictor. If we add three months' Treasury bill rate to the regression, its R square increases substantially. We can conclude that the rates themselves together with the spread are good predictors of economic activity rather than the spread alone. In this paper, we checked the results of previous literature and obtained close results to those via our statistical models. Moreover, we found that different regressions like logistic regression or penalized regressions might improve the power of the term spread to predict recessions. We used different methods than the previous literature additionally and found stronger results: we found a relationship between term spread and recessions and between the term spread and economic activity.

References:

1. Benati, Luca & Goodhart, Charles, 2008. "**Investigating time-variation in the marginal predictive power of the yield spread**," Journal of Economic Dynamics and Control, Elsevier, vol. 32(4), pages 1236-1272, April.
2. Estrella, Arturo and Mishkin, Frederic S., The Yield Curve as a Predictor of U.S. Recessions (June 1996). Current Issues in Economics and Finance, Vol. 2, No. 7, June 1996, Available at SSRN: https://ssrn.com/abstract=1001228 or http://dx.doi.org/10.2139/ssrn.1001228