Predictability of Yield Curve Inversion and Moving Average Crossover

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We take the yield curve inversion and add it to a moving average crossover strategy. This combines past prices and technical timing with macro fundamentals to see whether we can forecast historic recession periods from 1967-2019. The main technical signal is the 21 day Moving Average (MA 21) below the 200 day moving average (MA 200) following yield curve inversion periods. The inversion periods are 1 month 60 month (1,60) 12 month 60 month (12,60) 24 month 60 month (24,60) and 1month 120 month (1,120) 12 month 120 month (12,120) and 24 month 120 month (24,120). Data is obtained from the Center for Research in Security Prices (CRSP). We find that applying the moving average timing (MA TIMING) strategy following yield curve (YC) inversion has promising results for exiting the market before recession periods. We miss several of the last major recessions including the 2008-2009 recession, thus generating positive excess returns. We validate our results using CAPM, Fama and French 3 and 5 Factors, and Kolmgorov Simonoff tests.

Keywords: fundamental analysis, technical analysis, yield curve, moving averages

INTRODUCTION

Armaov, et al. (2018) show that moving averages can be predictive and profitable when explained by momentum and may be useful in similar momentum based studies. They use a 21 period and 200 period moving average which is common among practitioners. The goal of this paper is to apply interest rate inversion of several short term and long term durations to a moving average timing signal which is lacking in a fundamental only study. Neeley et al. (2013) show that combining technical indicators with fundamental ones can be powerful and that technical indicators seem to do a better job overall of predicting the market.

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It is common in trading for investors to fall in one of two camps, fundamental investors, or technical investors and is rare for investors to belong to both camps. In fact, there is no timing ability of fundamentals which is why investors that fall into a fundamental only camp are unable to time an entry signal. They can tell you when the market is over or under valued, but they cannot tell you when to enter it. Only that things will happen (eventually). Technical based camps are able to time the market however it is common that there are many false signals in technical trading and that the discretion of which signals are real and which are noise is up to the keen eye of the technical trader (Lo Mamaysky and Wang (2000)) thus making it difficult to automate technical based strategies.

It is a common belief that the yield curve inversion comes before a recession according to Fama and French (1989). Fama and French (1986) note that the changes from good times to bad times economically are accompanied by upward sloping to inverted sloping yield curves. However, there is no way to predict when a recession will occur using the yield curve on its own Fama and French (2019).

Fama and French (1986, 1989) aren't the first to discuss inverted yield curves coming before a recession period. Kessel (1965) shows that the yield curve moves with the business cycle. These early papers use fundamentals to pick up on business cycle peaks and troughs. Neely, Rapach, Tu, and Zhou (2013) show that technical indicators can also pick up on these events. Specifically they note that technical indicators pick up on business cycle peaks, while macro fundamentals pick up on business cycle troughs.

A number of studies show the predictability of stock returns including Harvey (1991), Lo and Mackinlay (1999). This is in contrast to early work by Fama (1970) which stated stock prices reflect all available information so that no abnormal returns can be made. Early technical studies are characterized by filter rules such as Fama and Blume (1966) and Sweeney (1988). Moving averages are discussed in Brock et al. (1992) who show strong evidence of moving averages for technical trading.

We create a timing signal using several interest rate term periods from the center for research in security prices (CRSP). We note that an interest rate is inverted when the short term yield is above the long term yield. Fama and French (2019) test that when this signal occurs for three consecutive months to stay out of the market for as long as yield curves stay inverted. In practice this may be an overreaction to the interest rate inversion. It is commonly held knowledge that interest rates invert up to 10 months before a recession. Their strategy is to stay out of the market for as long as the interest rates are inverted by reducing exposure up to 1/12 per consecutive month of interest rate inversion. They test their strategy using 1 year, 2 year, 3 year, and 5 year intervals. What they find is that getting out when yield curves invert doesn't predict a recession (go figure).

We hope to find that adding a timing ability to this strategy can remedy the problem of being unable to determine when a recession starts. We use a popular moving average timeframe of 21 and 200 days to pick up on the recession. In doing so we create a common entry among the yield curve inversion. We basically look for uniform inversion across the board for three consecutive months. We then wait for a moving average crossover to occur. At that point we apply the Fama and French (2019) strategy of staying out of the market for as long as interest rates are inverted. Rather than creating a separate portfolio for each inversion strategy we create a unique indicator.

DATA AND METHODOLOGY

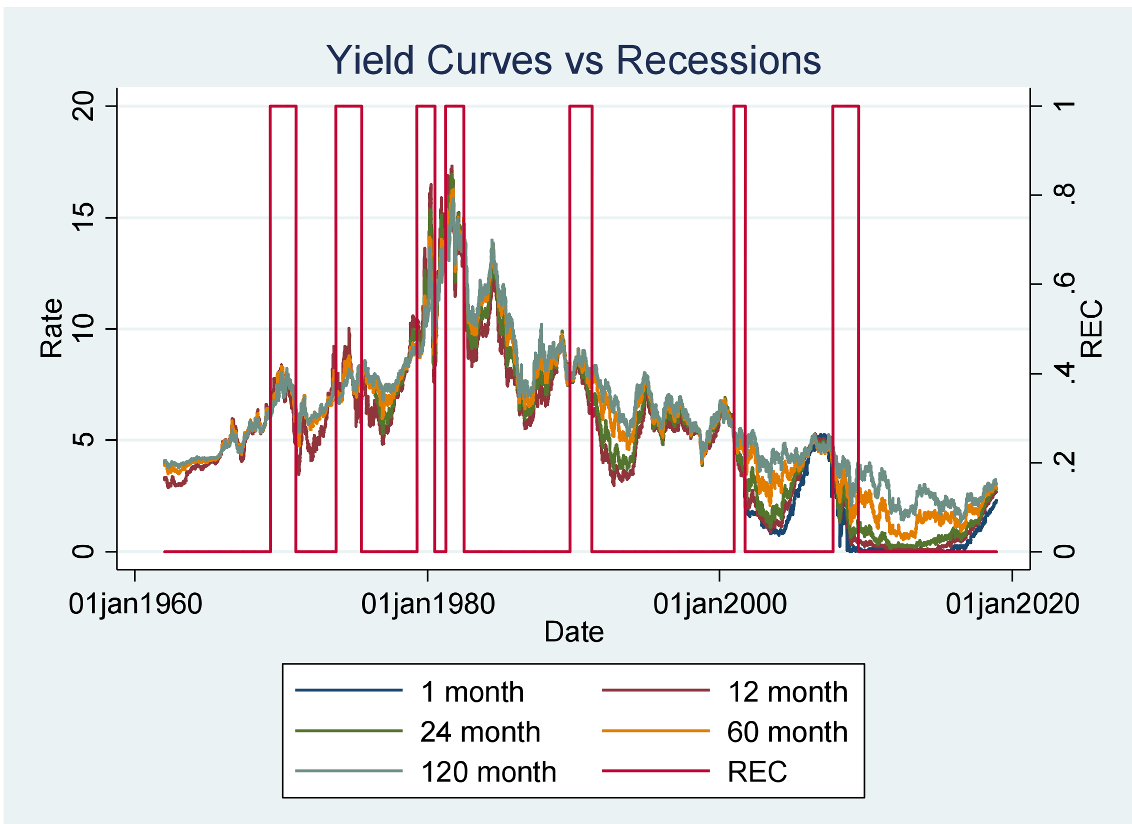
The yield curve time frames in Fama and French (2019) are in the table below. They are 1,24; 1,60; 1,120; 12,24; 12,60; 12,120.

TABLE 1
YIELD CURVE TIME FRAMES

Signal	Average Value	Std. Dev
1 month	1.25	1.51
12 month	5.15	3.40
24 month	5.36	3.77
60 month	5.85	3.10
120 month	6.19	2.87

When at least one of these are inverted over the last three days we stay out of the market. When they are no longer inverted we return to market exposure.

FIGURE 1
YIELD CURVE VS RECESSIONS



The outlined recession periods are in red above. We show all of the interest rates noting the interest rates appear to be inverted prior to a recession.

Our moving averages are outlined below. It is the simple mean of the last 21 days (one month of trading) and last 200 days (common in technical trading).

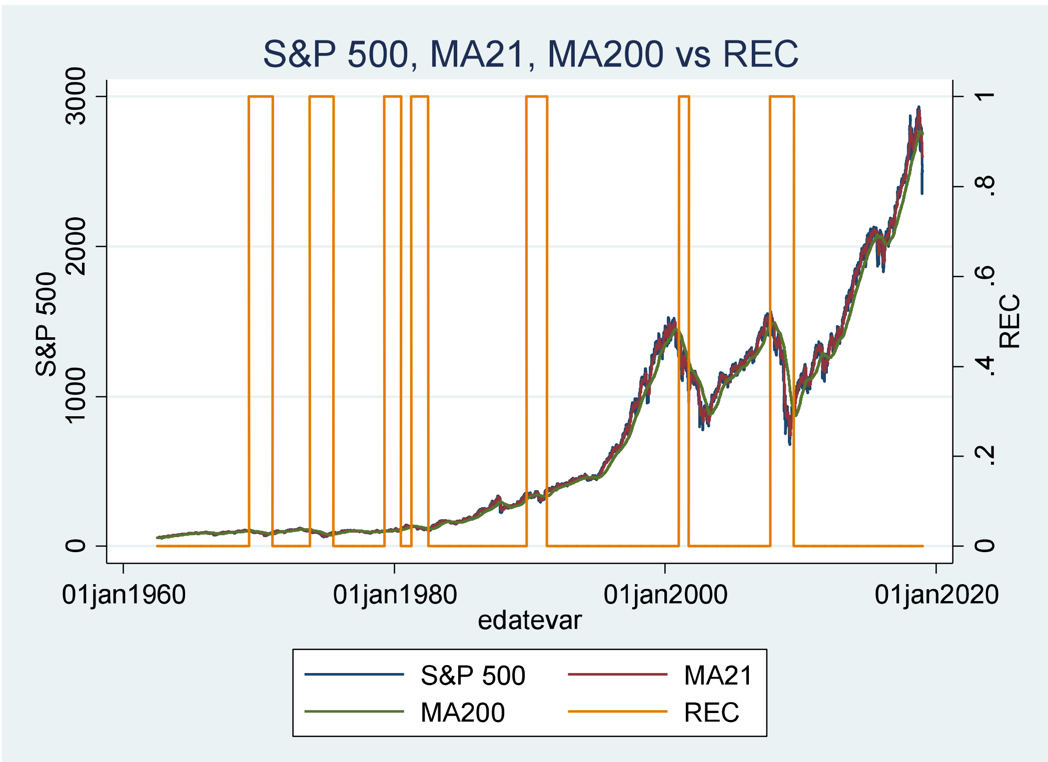
$$MA21 = \frac{1}{21}(P1 + P2+, \ldots, +P21) \quad (1)$$

$$\text{MA200} = \frac{1}{200}(\text{P1}, +\text{P2}+, \ldots, +\text{P200}) \tag{2}$$

The Signal becomes -1 when MA21 < MA 200. This suggests selling pressure in the short term. The signal alone creates too many false positives so it should be combined with the yield curve inversion.

The signal offsets interest rate inversion until MA21 < MA 200. The intuition is that the fundamental strategy ignores market timing. This combines the two.

FIGURE 2
SP 500 MA 21 MA 200 VS REC



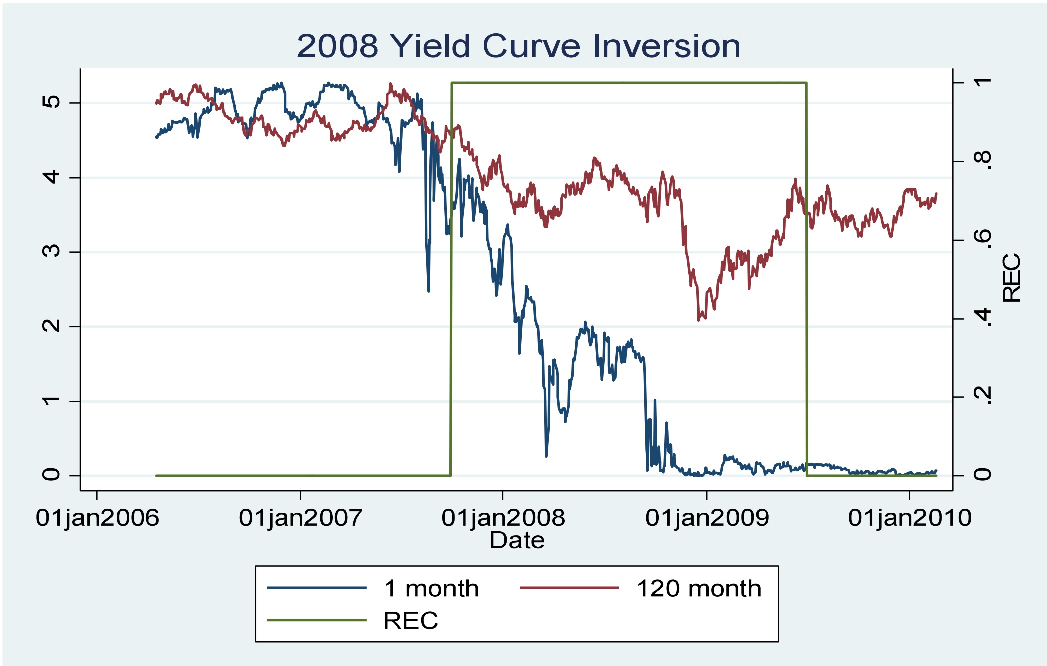
The 21 day moving average, 200 day moving average, S&P 500 index level, and recessions are shown above. It is seen that the 21 day moving average falls below the 200 day moving average during a recession.

This is significant because the yield curve by itself lacks the ability to time the market and following it alone would take an investor out immediately when the recession follows up to one year later. This isn't common in practice to exit the market immediately when interest rates invert.

This paper seeks to remedy a fundamental only strategy which by definition lacks a timing ability by providing a solution of adding moving averages. We use the time frames that are most common in literature.

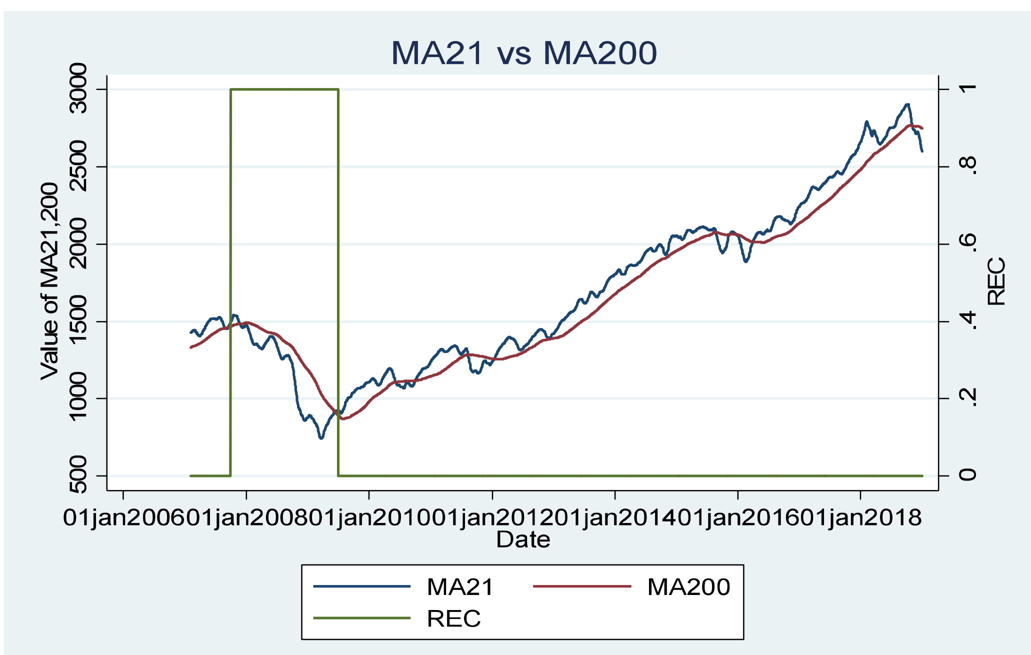
On the following page we show that the moving averages crossover at the start of the 2008 recession. We use this as an entry signal following the yield curve inversion which is shown on the following graph. We then stay out of the market for as long as the yield curves were contiguously inverted.

FIGURE 3
2008 YIELD CURVE INVERSION



Notice how on the 2008 recession the Yield Curve inverts prior to 2008 after July 2006 and goes back to normal before inverting briefly again in July 2008. Combining this with the MA21 MA200 crossover can help eliminate the false signals from both indicators.

FIGURE 4
MA21 VS MA200



One of the main problems with relying solely on technical indicators are false buy and sell signals (whipsawing). We can see how the moving averages cross over following a recession but do so at other times not during a recession giving a false signal. This is why we would like to combine it with interest rate inversion which normally doesn't happen during an expansion period.

Our recession indicator is applied to the S&P 500 index data from the Center for Research in Security Prices (CRSP). We use the index to obtain our recession signal and apply it cross sectionally to all stocks.

We create an index level for the equally weighted prices and returns for difference in mean testing and showing the equity curve of our indicator. We also test our results cross sectionally using daily returns and common asset pricing models for explaining the returns in panel data.

RESULTS

We are testing whether moving average crossovers can be used as a bearish signal preceding a recession. We use identified recessions from the Federal Reserve Bank of St. Louis (FRED).

The portfolio takes the signal on the benchmark S&P 500 index and then applies it to all listed stocks from 1967-2019. It has a dummy = -1 if out of the market and 0 otherwise. We have 10,140,062 daily price observations across all stocks.

TABLE 2
CROSS SECTIONAL OBSERVATIONS

Cross Sectional Recession Observations	10,140,062

A paired t test of the conditional distribution of returns shows conflicting results. The above regression suggests that the model predicts the one period returns. What's happening is that it is capturing a large negative return. The t test shows that the holding returns are better than getting out despite positive risk premia.

Under the null hypothesis the mean difference is equal to zero. The alternative hypothesis is that the mean difference is greater than zero.

Ho: mean(diff) = 0

Ha: mean(diff) > 0

The test statistic is tested using mean(diff) = mean (Recession Indicator – Benchmark). Where Recession Indicator is our dummy indicator outlined above. The Benchmark is all securities in the Center for Research in Security Prices (CRSP). Our sample period is from 1967-2019.

The null hypothesis shows the probability of T > t = 0.0000. Which says that there is a 100% chance the recession returns are better under the alternative hypothesis.

TABLE 3
DIFFERENCE IN MEAN TEST

Ha: mean(diff) >0
Pr(T>t) = 0.0000

T=47.8586

This test shows us that the mean return is significantly different at every level of significance. $0.00001 > \alpha$. The recession statistics are shown in the table below. Our test statistic is 47.8586 with 11,515,739 degrees of freedom. This is over 11,515,740 observations.

TABLE 4
SUMMARY STATISTICS

Portfolio	Observations	Mean	Std. Dev.	Min	Max
Short Recession	11,515,740	0.0026	.1871	-19	9
Buy and Hold	11,515,740	-0.0026	.1871	-9	19

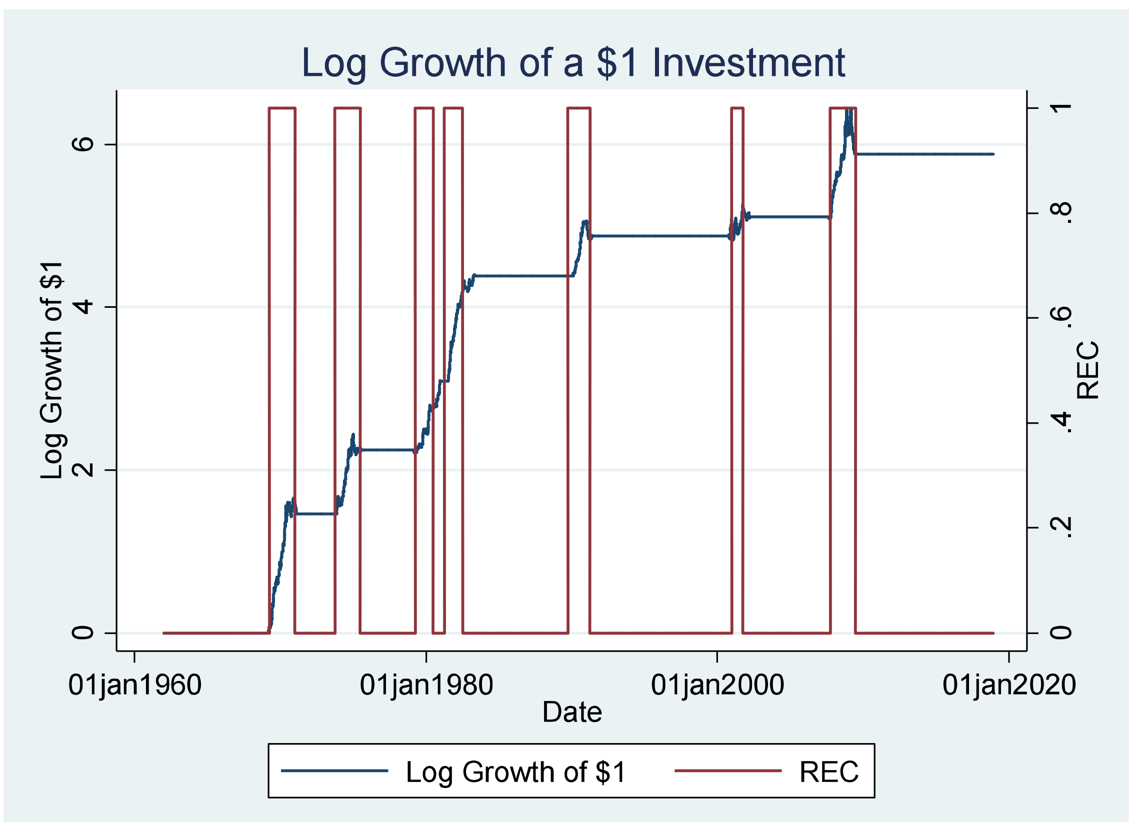
The mean return for this period is 0.0026 with a standard deviation of 0.1871. The maximum return is 9 and minimum -19. For the benchmark the mean return for this period is -0.0026 with a standard deviation of 0.1871. The maximum return is 19 and minimum -9.

We form equally weighted portfolios based on the recession signals above. We use this to further test the returns.

If we choose to invest $1 in each of the indicators we would have the following growth. Note that securities trade before 1967 but we don't take any trades until the first recession. We don't have interest rate data prior to the first 1967 recession.

We put our money where our mouth is by going short during the recessions using our signal. What we see is that even while holding out capital during expansion periods and only going short during the recessions we can gain some really significant returns. Couple that with going long during expansion periods and we have an amazing model. We want to zero in on exactly how our model does at what it is intended to do (preserve capital during a recession). So we test only those returns by giving ourselves full market exposure during them.

FIGURE 5
LOG GROWTH OF $1



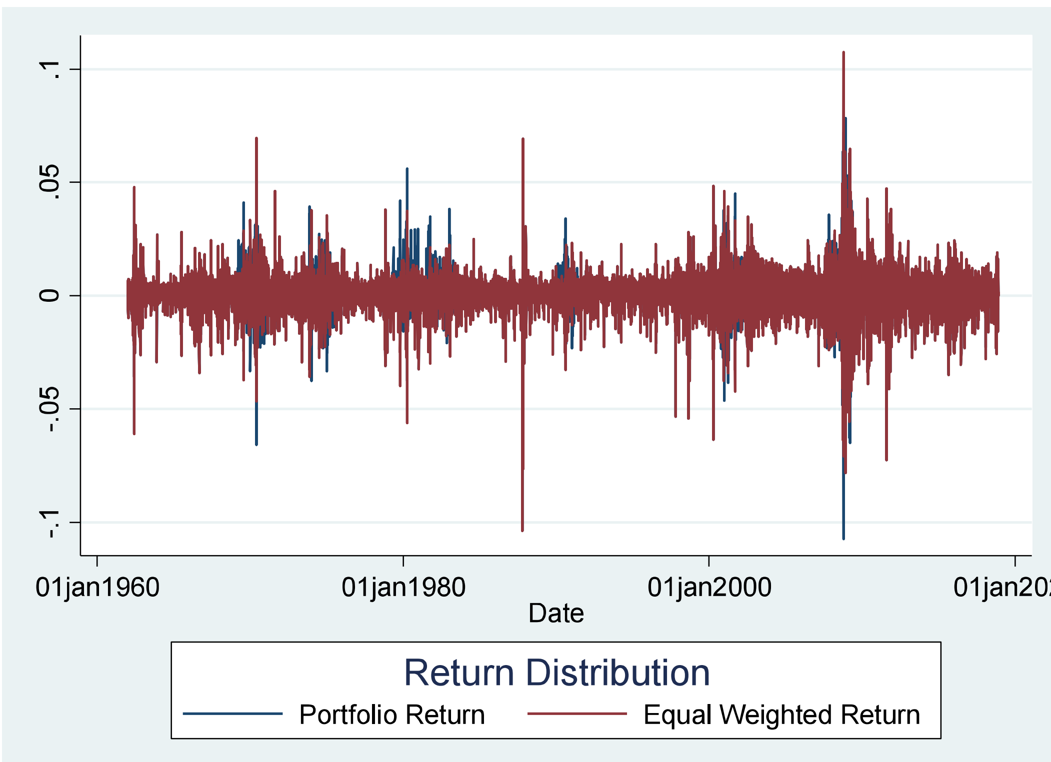
This shows the Log Growth of a $1 investment during a recession period by shorting the market using our timing signal. What this does is magnifies the result of basically holding out capital during a recession. Therefore, if the signal didn't work, we would expect to see the blue line (Log Growth of $1) slope downward between the red bars (recession periods). What we see is in fact the capital grows during a recession as a result of a proper timing signal by getting in a negative market position. Shorting is explained by borrowing a security in hopes of returning it later to the lender at a lower price. What we see is that every time there is a recession our money grows. There is no growth between recessions because we are holding out and only testing our signal in the period it is designed for.

In the next section we add in the market returns to give ourselves full exposure to the market in between recession periods. This is not forward looking, in fact we just have our strategy enter the market (instead of sitting in cash) when it isn't going short.

This is all forward looking and replicable in real time.

We next add in the returns of the equal weighted portfolio back to the inactive strategy. We compare the return distributions below.

FIGURE 6
RETURN DISTRIBUTION



We then test the difference in means of holding the equal weighted portfolio vs holding the active portfolio during our recession indicator and equal weighted portfolio otherwise. The test suggests that the mean return from our active strategy is significantly better than the equal weighted return.

We see that our strategy of going short in recessions and long in expansions has significantly better returns all around when compared with buying and holding the market.

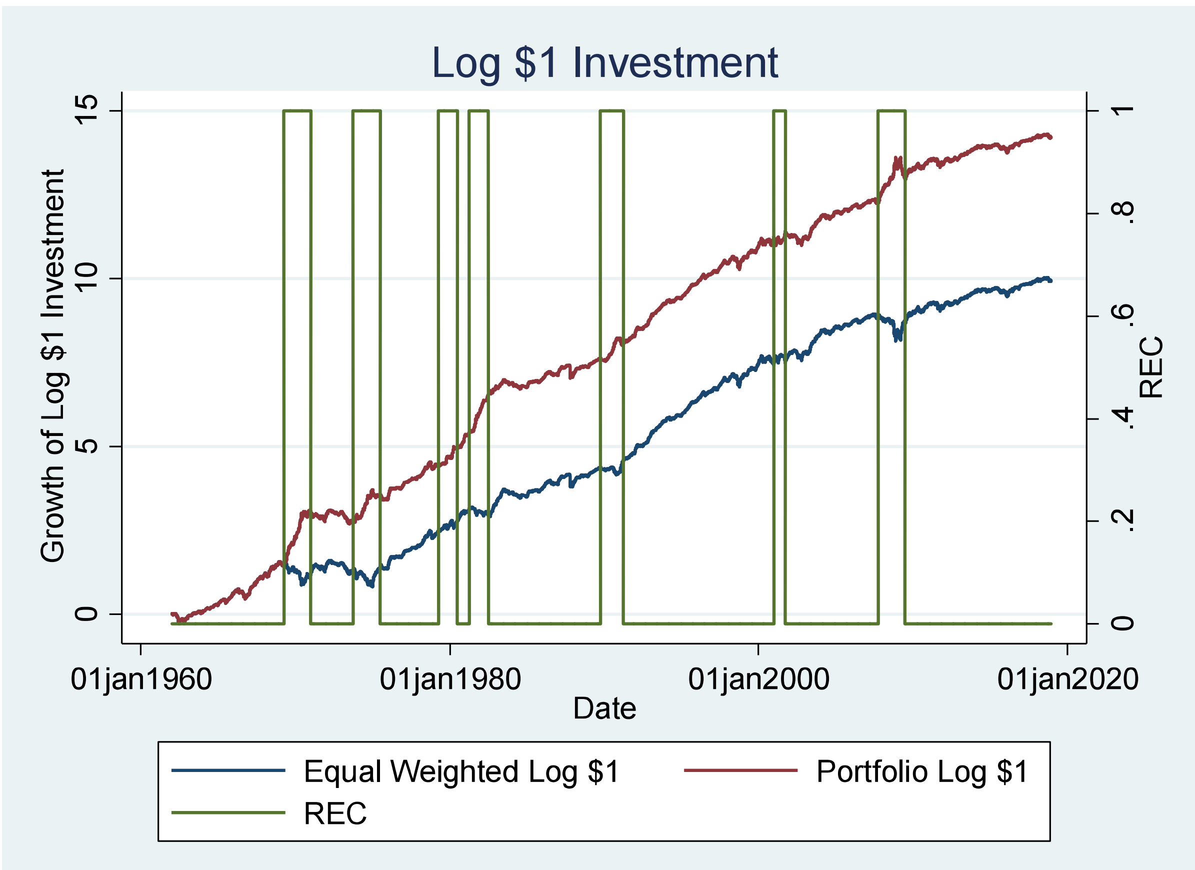
TABLE 5
RECESSION DIFFERENCE IN MEAN TEST

Ha: mean(diff) <0	Ha: mean(diff) != 0	Ha: mean(diff) >0
Pr (T < t) = 0.9996	Pr(|T|>|t|) = 0.0007	Pr(T>t) = 0.0004

t=3.3870 with 14347 degrees of freedom.

We show the detailed equity curve of our strategy, the market returns, and the recession periods below. We use log growth of a $1 investment because the returns on our strategy are parabolic.

FIGURE 7
LOG GROWTH OF $1



To cover the argument of using asset pricing models to explain away the returns we then analyze the Fama and French Portfolios and CAPM for the two investments. This is done using regression analysis for the CAPM, Three Factor, and Five Factor Model.

SINGLE FACTOR MODEL

We estimate the following regression from 1967-2019

$$\mathrm{ri}_t - \mathrm{rf}_t = \alpha + \beta_1 mktrf + \epsilon_t \quad (3)$$

Model R2 = 3.04%

TABLE 6
CAPM MODEL

Factor	Coef.	t
mktrf	20.93	0.000
α	11.73	0.000

We run a regression of the excess returns on the market excess returns. We see that the market is a contributing factor to the success of the strategy but any excess return (over the t-bill) isn't explained away. Both the market factor and the excess return are highly significant.

FAMA AND FRENCH 3 FACTORS

We estimate the following regression from 1967-2019

$$\mathrm{ri}_t - \mathrm{rf}_t = \alpha + \beta_1 mktrf + \beta_2 smb + \beta_3 hml + \epsilon_t \quad (4)$$

Model R2 = 6.04%

TABLE 7
3 FACTOR MODEL

Factor	Coef.	t
mktrf	21.57	0.000
smb	21.45	0.000
hml	-7.54	0.000
α	11.83	0.000

Since the previous model failed to explain away the returns we expand it to the Fama and French 3-Factor model. Again we see that the market factor is significant, so is the small size factor. The volatility factor is negative significant. Again we have a positive significant excess return.

FAMA AND FRENCH 5 FACTORS

We estimate the following regression from 1967-2019:

$$\mathrm{ri}_t - \mathrm{rf}_t = \alpha + \beta_1 mktrf + \beta_2 smb + \beta_3 hml + \beta_4 rmw + \beta_5 cma + \epsilon_t \quad (5)$$

Model R2 = 10.03%

TABLE 8
5 FACTOR MODEL

Factor	Coef.	t
Mktrf	26.08	0.000
Smb	20.04	0.000
Hml	-19.75	0.000
Rmw	-5.92	0.000
Cma	24.14	0.000
α	11.50	0.000

Lastly we expand to the five factor model. This is the most complete model for explaining excess returns. We show that the market factor is still a significant contributor, the size factor is significant, the volatility factor is negative significant. The momentum factor is negative significant and the consumption factor is positive significant. We still have positive significant excess returns.

KOLMOGOROV-SMIRNOV TEST

We test the distribution of our active portfolio against the theoretical distribution of the equal weighted portfolio. This is used in Lo, Mamaysky, and Wang (2000) as a study of informativeness of a technical based strategy. We use it here to test whether we can gain any information from our technical and fundamental signal.

TABLE 9
KOLMOGOROV-SMIRNOV

Smaller Group	Υ	P-value
Active Return:	1.0782	0.000
Cumulative:	-0.1074	0.000
Combined K-S:	1.0782	0.000

We can reject the hypothesis that the returns come from the same distribution. This gives us additional validation that the strategy outlined above with shorting recessions based on interest rate inversion and moving average crossovers can have both informational and practical value.

CONCLUSION

This paper tests a signal that addresses research discussing whether or not the yield curve can forecast recessions. It is widely accepted that interest rate inversion happens before a recession however there is not yet any way to time a recession using it. We know that on average it occurs 10 months before a recession. Fama and French 2019 show that it cannot be used to forecast a recession (immediately) following interest rate inversion for periods of 1 year, 2 years, 3 years and 5 years. This paper considers using the moving average crossover signal to add a timing element to the yield curve inversion prior to a recession.

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