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ABSTRACT

Using positions data on bond futures, I document that speculators' spread trades contain private information about future economic activities and asset prices. Strong steepening trades are associated with negative payroll surprises in subsequent months and can predict asset markets' reaction to future payroll releases, suggesting that speculators hold superior information about future payrolls. Steepening trades can also predict the rise of stock prices within a few hours before subsequent FOMC announcements, implying that the pre-FOMC stock drift is driven by informed speculation. Overall, evidence highlights spread traders' superior information and its important role in explaining announcement returns and pre-announcement drifts.

JEL Classification: E32; E43; G12; G14

Keywords: informed trading; term structure; business cycle; pre-FOMC; macroeconomic announcements

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Do sophisticated investors have superior information acquisition and processing ability? How does private information, if any, get incorporated into asset prices? These long-lasting questions in finance have received more attention as investors have increasingly relied on data-crunching technologies and alternative data sources, such as satellite images, traffic data, shipping data, mobile devices data, internet search data, social media data, and credit card transactions. Alternative data are used to analyze not only firm-specific information but also macroeconomic activities. For example, Henderson, Storeygard, and Weil (2012) show that satellite images on night lights can be useful for measuring economic growth when traditional data are of low quality or unavailable. Orbital Insight, a big-data firm in Palo Alto, claims that it has predicted retail sales better than Bloomberg consensus forecasts.¹

This paper studies the macroeconomic information contained in investors' yield spread trading—a purchase of one bond and a simultaneous sale of another bond with a different maturity. The idea is motivated by the well-established macroeconomic fact that the slope of the yield curve has a close relationship to economic activity and monetary policy.² Curve-steepening trades can be useful right before or during a recession in which short-term rates tend to drop faster than long-term rates. Curve-flattening trades can be useful at the peak of the business cycle or during a monetary tightening in which short-term rates tend to rise faster than long-term rates.

From an informed trading perspective, spread trading has two appealing features compared to outright trading: low cost and low risk. Spread trading requires a smaller margin than outright trading, facilitating informed traders to take higher leverage. Black (1975) and Easley, O'Hara, and Srinivas (1998) show that leverage is a crucial determinant of informed trading. Moreover, spread trading is viewed as a low-risk strategy because it is largely shielded from a parallel shift in the term structure of interest rates. Duration-matched spread trading, in particular, can be useful when investors are informed about economic activity but uncertain about more permanent shocks, such as inflation shock, which tend to affect yields more evenly across all maturities.

A casual observation suggests that speculators in bond futures may have some

¹ See the article at <https://orbitalinsight.com/orbital-insight-correctly-predicts-retail-sales-miss-hit-rate-grows-78>.

² See Diebold, Rudebusch, and Aruoba (2006), Gürkaynak, Sack, and Swanson (2005), and Rudebusch and Wu (2008).

information associated with the slope of the yield curve. Figure 1 shows the excess net number of speculators in bond futures using the Commitments-of-Traders (COT) report published by the Commodity Futures Trading Commission. With the average net number of speculators removed, the excess net number is intended to measure abnormal trading activity in short-term bond markets relative to long-term ones. The figure shows remarkable divergences in abnormal trading activity between Eurodollar futures and 30-year Treasury futures during all of the recession periods. In particular, speculators took a bullish (bearish) view on short-term (long-term) bond markets relative to long-term (short-term) bond markets during all of the recession periods. Such empirical regularity hints at the possibility that speculators (but not hedgers and small retail investors) have been good at timing the slope of the yield curve along business cycle fluctuations.

By introducing some indicators mimicking speculators' spread trading, I find that the indicators have predictive power for future economic activity. Probit regression analysis shows that speculators' stronger steepening (flattening) is associated with a higher (lower) probability of subsequent recessions. In addition, stronger steepening (flattening) is associated with lower (higher) non-farm payroll growth rates in subsequent months. The predictive power of the spreading indicators cannot be spanned by other business-cycle indicators such as term spreads and bond excess premiums as introduced by Gilchrist and Zakrajšek (2012).

To understand the source of the predictive power of spreading indicators, I compare speculators' ability to forecast future payrolls to that of professional forecasters.³ I find that strong steepening (flattening) is associated with negative (positive) payroll surprises in subsequent months, suggesting that spread traders hold some information that is not accounted for by professional forecasters. Furthermore, spreading indicators can forecast financial markets' response to future payroll announcements. Specifically, strong steepening is followed by positive returns on short-term bonds and depreciations of the U.S. dollar against the British pound and Swiss franc at the times of future payroll releases. Overall, I argue that speculators have a superior ability to analyze future payrolls and that such information manifests itself into their betting on the slope of the yield curve.

³ Among various macroeconomic announcements, payrolls are known as “the king of announcements” (see Andersen and Bollerslev 1998).

I also show that the information in spread trades can explain the otherwise puzzling pre-Federal Open Market Committee (FOMC) stock drift, the fact that a large fraction of excess stock returns have materialized during a few trading hours immediately preceding scheduled FOMC announcements (see Lucca and Moench 2015). Specifically, I find that speculators' stronger steepening is followed by larger increases in stock prices during same-day trading hours before subsequent FOMC announcements. After the information in steepening trades is accounted for, the pre-FOMC same-day stock drift is no longer statistically significant. An active pre-FOMC timing strategy conditioned on the information in steepening trades would have delivered a Sharpe ratio gain of 0.34 relative to a naive pre-FOMC buy-and-sell strategy. Overall, information held by speculators has been incorporated into stock prices through pre-FOMC same-day trading.

Why is it that steepening trades are positively (but not negatively) associated with future stock returns? The positive relationship is at first surprising because steepening trades are related to low levels of future economic activities, which may signal low corporate earnings in the future. However, stock markets sometimes interpret economic news upside down if the news is expected to affect the future course of monetary policy. In light of the positive relationship, speculators with bad economic news appear to have anticipated an easing policy and have engaged in informed trading during a few hours before the FOMC announcements. This interpretation is broadly consistent with empirical research showing that stock prices tend to increase following easing monetary policies (see Rigobon and Sack 2004; and Bernanke and Kuttner 2005).

Related literature: This paper contributes to the finance and macroeconomic literature in three ways. First, my findings have an implication for the literature studying asset returns on days of macroeconomic announcements or during a few hours before macroeconomic announcements. Following Lucca and Moench (2015), Cieslak, Morse, and Vissing-Jorgensen (2018) find the cyclical pattern of stock returns over the FOMC cycle. Kurov, Sancetta, Strasser, and Wolfe (2017) discover pre-announcement drifts for several macroeconomic announcements. Savor and Wilson (2013) find that stock returns and Sharpe ratios are higher on days of major macroeconomic announcements. Mueller, Tahbaz-Salehi, and Vedolin (2017) find that the U.S. dollar tends to depreciate relative to other currencies on days of sched-

uled FOMC announcements. Ai and Bansal (2018) develop revealed preference theory for macroeconomic announcement premiums. My paper contributes to this literature as it shows that macroeconomic announcement returns and pre-announcement drifts may be explained by speculators' superior information and strategic informed trading.

Second, this paper contributes to the literature documenting biases in professional forecasts. Coibion and Gorodnichenko (2012, 2015) provide a methodology for imputing consensus forecast errors to information rigidities. Andrade and Le Bihan (2013) relate the predictability of forecast errors to agents' inattention to new information. Campbell and Sharpe (2009) and Bordalo, Gennaioli, Ma, and Shleifer (2018) provide behavioral explanations for forecast biases. Froot and Frankel (1989) and Bacchetta, Mertens, and Van Wincoop (2009) document the empirical relationship between the predictability of excess returns and forecast errors. My paper provides new evidence that forecast biases can arise from forecasters' limited capacity to process macroeconomic information relative to some sophisticated investors.

Third, there is a vast literature identifying business-cycle indicators from financial markets. For example, Estrella and Hardouvelis (1991) and Estrella and Mishkin (1998) find that the slope of the yield curve is a harbinger of recessions; Gilchrist and Zakrajšek (2012) document that credit spreads are a leading indicator of the business cycle; and Ang, Piazzesi, and Wei (2006) argue that short-term rates are more informative about gross domestic product (GDP) growth than term spreads. While this line of research typically focuses on asset prices to study macroeconomic expectations, I show that informed traders' strategies and positions can carry macroeconomic information that can help policymakers and practitioners understand the future state of the economy.

The rest of the paper is organized as follows: Section 1 introduces spread trading in bond futures, examines speculators' spread trading behavior, and defines spreading indicators; Section 2 examines the predictive power of spread trading for economic activity; Section 3 provides an explanation for the pre-FOMC stock drift using the information contained in spread trading; and Section 4 concludes.

1 Yield spread trading

Motivation: Spread trading, in a more general form, refers to a purchase of one security and a sale of another related security. Sophisticated investors often engage in such a package deal in order to construct a portfolio that is most sensitive to the information they have. For example, suppose that you have a good ability to forecast whether a Category-five hurricane will hit the Gulf of Mexico. Given such an ability, you might consider taking a direct position in the West Texas Intermediate (WTI) crude oil futures, but the position would expose you to the risks that have little to do with the hurricane, such as political uncertainty in the Middle East. Instead, spread trading between the WTI and Brent crude oil futures just before the arrival of a hurricane would allow you to purely bet on the hurricane risk, eliminating other risks that are common to both oil prices.

I conjecture that the market's information about economic activity may manifest itself into spread trading in bond futures. This conjecture is based on the stylized macroeconomic fact that the slope of the yield curve is closely linked to real economic activity (see Diebold, Rudebusch, and Aruoba 2006). Figure 2 illustrates the tight relationship between the non-farm payroll growth rate and the slope factor in the Treasury yield curve, where the slope factor is the second principal component of a cross-section of Treasury yields with maturities of 1 to 30 years. Furthermore, the slope sharply responds to monetary policy shocks (see Gürkaynak, Sack, and Swanson 2005; Rigobon and Sack 2004; and Rudebusch and Wu 2008). For example, a policy rate cut is typically accompanied by a further steepening of the yield curve.

Given the stylized fact, investors may profit from playing the slope of the yield curve if informed about future economic activity. For example, increasing holdings of short-term bonds relative to long-term bonds (curve steepening) can be useful right before or during a recession or a monetary easing. Conversely, reducing holdings of short-term bonds relative to long-term bonds (curve flattening) can be useful at the peak of the business cycle or ahead of a monetary tightening. A zero-duration spread trade, in particular, can be useful when investors are uncertain about permanent shocks, such as inflation and productivity shocks, which tend to affect yields more evenly across all maturities.

In addition, the existing literature shows that leverage is an important factor in

informed trading (see Black 1975; and Easley, O’Hara, and Srinivas 1998). While required margins are very small for bond futures, spread trading requires an even smaller margin than outright trading. For example, in March 2018, margins were set at \$1,600 for ten-year Treasury futures and \$3,100 for 30-year Treasury futures. Meanwhile, the Chicago Mercantile Exchange allows for a 70% margin credit for a three-to-two-ratio spread trade between ten- and 30-year Treasury futures. Under this margin setting, a purchase of three ten-year Treasury futures and a sale of two 30-year Treasury futures would require margins of \$4,800 and \$6,200, respectively, but their combined trade would require a margin of only \$2,840.⁴ Note that the margin for spread trading is much smaller than that for each of the two legs. Ultimately, low margins on spread trading would help informed traders lever their informational advantage.

Overall, the market’s information about economic activity can be revealed through spread trading in bond futures. Admittedly, the slope of the yield curve is affected by many other factors such as inflation expectations and Treasury demand/supply shocks. For example, when inflation expectations pick up, the curve can steepen as long-term rates rise faster than short-term rates, which is called a “bear steepener.” For another example, if incoming data suggest a further deepening of the recession that the economy has already been in, the curve can flatten because of safe-haven demand or reach-for-yield demand for long-term Treasury bonds, which is called a “bull flattener.” Furthermore, in the past decade, central banks have increasingly relied on forward guidance and quantitative easing, and non-conventional monetary policies may have different implications for the slope of the yield curve than conventional ones. Nevertheless, other factors generally have less of an influence on the slope of the yield curve than expectations on economic activities.

Data and stylized facts: To study the information content of yield spread trading, I make use of the legacy (futures-only) COT data over the period from July 1986 to July 2017.⁵ The data set contains information on the number of traders who are short and long for each futures contract, broken down into three investor groups: commercial, non-commercial, and non-reportable. The first two groups are considered to be large hedgers and speculators, whereas the last group represents small players

⁴ $\$6,200 - 0.7 \times \$4,800 = \$2,840$.

⁵ The futures-and-options-combined data have a shorter time-series span than the futures-only data.

whose open interest levels are below a certain threshold level.

I particularly use the data on the net number of speculators (the difference between the numbers of long and short speculators) in the most liquid bond futures: Eurodollar (ticker=ED), ten-year Treasury (TY), and 30-year Treasury (US).⁶ An issue in using the net number of speculators is that it is driven by not only spread trading but also outright trading, so the net number itself is not ideal for capturing speculators' view on the slope of the yield curve.

Instead, I introduce the excess net number of speculators as follows. Let SP_t^i denote the net number of speculators for a future contract $i \in \{3M, 10Y, 30Y\}$ at time t , where $3M$, $10Y$, and $30Y$ refer to Eurodollar futures, ten-year Treasury futures, and 30-year Treasury futures, respectively. I compute an equally-weighted average of the net speculators over the three selected futures: $\overline{SP}_t = \frac{1}{3} \sum_{i \in \{3M, 10Y, 30Y\}} SP_t^i$. The excess net number of speculators in each futures market is obtained by subtracting the average net number of speculators from the market's net number:

$$EXSP_t^i = SP_t^i - \overline{SP}_t, \quad (1)$$

where $EXSP_t^i$ denotes the excess net number of speculators for a future contract i at time t . With the average net number of speculators across different maturities removed, the excess net number is intended to measure abnormal trading activity in each futures market. For example, a positive value of $EXSP_t^{3M}$ means that speculators are expecting Eurodollar futures to outperform the other bond futures overall.

Figure 1 shows the excess net number of speculators in Eurodollar futures (the solid line) and 30-year Treasury futures (the dotted line). The shaded areas refer to the three National Bureau of Economic Research (NBER)-designated recessions included in my sample period. The figure shows several stylized facts associated with speculators' bond trading behavior over business cycles. Specifically, the excess net number of speculators in Eurodollar futures began to rise before the start of all the recessions and stayed at positive levels throughout the recession periods. In contrast, the excess net number of speculators in 30-year Treasury futures began to

⁶ I do not use two-year (TU) and five-year (FV) Treasury futures because the COT data on these bond futures are unavailable in the beginning of the sample period. In addition, as Eurodollar futures have maturities up to ten years, their term structure information overlaps that of two- and five-year Treasury futures. Similarly, I do not include federal funds futures because their trading volume is still one-order-of-magnitude smaller than that of Eurodollar futures.

fall before the start of all the recessions and stayed at negative levels during all of the recession periods. That is, throughout the recession periods, speculators took a bullish (bearish) view on short-term (long-term) bond markets relative to long-term (short-term) ones. Importantly, the slope trading pattern started even before the start of recessions, suggesting that speculators might have had some macroeconomic information associated with the slope of the yield curve before the economy turned around.

Steepening indicators: To mimic speculators' spread trading behavior, I introduce a steepening indicator based on the signs of the excess net numbers. Specifically, I define a binary variable that equals one if the excess net number is positive in Eurodollar futures and negative in 30-year Treasury futures and zero otherwise. The steepening indicator is then defined as a quarterly moving average of the binary variable:

$$\text{STEEP}_t \equiv \frac{1}{N_t} \sum_{t-q < \tau \leq t} \mathbb{1}_{\text{EXSP}_\tau^{3M} > 0} \mathbb{1}_{\text{EXSP}_\tau^{30Y} < 0}, \quad (2)$$

where STEEP_t denotes the steepening indicator at time t , q stands for a quarter, and N_t denotes the number of observations over the past quarter. A high value of STEEP_t is associated with speculators' expectations that the yield curve will become steeper in subsequent periods.

Similarly, I introduce another binary variable that equals one if the excess net number is negative in Eurodollar futures and positive in 30-year Treasury futures and zero otherwise. A flattening indicator is then defined as a quarterly moving average of the binary variable:

$$\text{FLAT}_t \equiv \frac{1}{N_t} \sum_{t-q < \tau \leq t} \mathbb{1}_{\text{EXSP}_\tau^{3M} < 0} \mathbb{1}_{\text{EXSP}_\tau^{30Y} > 0}, \quad (3)$$

where FLAT_t denotes the flattening indicator at time t . A high value of FLAT_t is associated with speculators' expectations that the yield curve will become flatter in subsequent periods.

The top panel of Figure 3 shows the time-evolution of the steepening indicator, where the shaded areas refer to the four easing episodes included in my sample period. Note that the steepening indicator stood at very high levels during most of the easing periods, except for the very brief easing period beginning in September 1998. Furthermore, the steepening indicator reached its peaks before the start of the two

easing cycles that began in January 2001 and September 2007.

The bottom panel of Figure 3 shows the time-evolution of the flattening indicator, where the shaded areas refer to the five tightening episodes included in my sample period. While the flattening indicator was not turned on as frequently as the steepening indicator, speculators appear to have expected a further flattening of the yield curve during the three tightening episodes that started in February 1994, June 2004, and December 2015. In particular, speculators turned to and maintained the strongest flattening view after former Chairman Ben Bernanke first indicated a slowdown of quantitative easing in May 2013, a bond market turmoil called the taper tantrum.

Table 1 provides the summary statistics of the spreading indicators and their correlations with other business-cycle variables. Term spreads (TMSP) are defined as quarterly moving averages of the yield spreads between ten-year Treasury bonds and three-month Treasury bills; bond excess premiums (EBP) are a measure of credit risk premiums provided by Gilchrist and Zakrajšek (2012); and real federal fund rates (FFR) are defined as the differences between the effective federal fund rates and the inflation rates as implied by the core PCE (personal consumer expenditures) price index. An interesting feature emerging from the table is that both STEEP and FLAT are little correlated with TMSP. Similarly, correlations of STEEP and FLAT with EBP are modest at 0.37 and -0.25 , respectively. Overall, the low-to-moderate correlations imply that spreading indicators may have very different information about future economic activity than TMSP and EBP.

2 Information content for economic activities

This section studies the predictive power of speculators' spread trading for future economic activities. I also compare the predictive power of spread trading to that of outright trading in various futures markets and discuss the private nature of the information contained in spread trading.

2.1 Forecasting recession probabilities

I start by looking at whether spreading indicators have predictive information about recession probabilities because the slope of the yield curve is known as a harbinger of recessions. Let SPRD_t denote a spreading indicator, which refers to either STEEP_t or FLAT_t . I then estimate a Probit regression model for h -month-ahead recession probabilities as follows:

$$\text{Prob}(\text{rec}_{t+h} = 1) = \Phi(\alpha + \beta \text{SPRD}_t + \gamma' z_t), \quad (4)$$

where rec_{t+h} denotes a dummy variable that equals one if the $t+h$ month is declared to be a recession month and zero otherwise and z_t denotes a vector of control variables.

Panel A of Table 2 shows in-sample Probit regression results. The panel shows that a higher value of STEEP is associated with a higher probability of recession in subsequent months. The statistical significance of STEEP is obtained at the 1% level in three- and six-month-ahead forecasting and at the 5% level in 12-month-ahead forecasting. A higher value of FLAT is associated with a lower probability of recession in subsequent months. The statistical significance of FLAT is obtained at the 5% level in three- and six-month-ahead forecasting. Note that these results survive the inclusion of control variables, suggesting that the spreading indicators contain distinct information about future recession probabilities from traditional predictors.

To assess out-of-sample forecasting power, I divide the entire sample period into two subperiods: the first in-sample estimation period (July 1986 to December 1999) and the out-of-sample evaluation period (January 2000 to July 2017). Here, I am interested in measuring the incremental forecasting power of spreading indicators beyond the well-known predictors. An out-of-sample R^2 measure is obtained by comparing the model as in Equation (4) to the nested benchmark model without the spreading indicator as follows:

$$R^2 = 100 \times \left(1 - \frac{\sum_{t=T_b}^{T_e} \text{rec}_t \log(\hat{p}_t) + (1 - \text{rec}_t) \log(1 - \hat{p}_t)}{\sum_{t=T_b}^{T_e} \text{rec}_t \log(\hat{p}_t^0) + (1 - \text{rec}_t) \log(1 - \hat{p}_t^0)} \right), \quad (5)$$

where T_b and T_e denote the beginning and end of the out-of-sample evaluation period, respectively; \hat{p}_t^0 denotes the recession probability forecast associated with the benchmark model excluding the spreading indicator; and \hat{p}_t denotes the recession probability forecast associated with the larger model including the spreading indica-

tor. The statistical significance of the larger model against the benchmark model is evaluated using the McCracken (2007) test. The models are recursively estimated in each month throughout the out-of-sample evaluation period. I calculate an average of the coefficients on the spreading indicator over the out-of-sample evaluation period in order to see its effect on recession probabilities.

Panel A of Table 3 shows out-of-sample forecasting results, including out-of-sample R^2 s, test statistics, and average coefficients ($\bar{\beta}$) on spreading indicators. The panel shows that STEEP has incremental forecasting power beyond term spreads with an R^2 of 28.6% (3 months ahead) or 22.9% (6 months ahead); and beyond bond excess premiums with an R^2 of 14.8% (3 months ahead) or 6.9% (6 months ahead). The panel also shows that FLAT has incremental forecasting power beyond term spreads with an R^2 of 15.4% (3 months ahead) or 11.1% (6 months ahead); and beyond bond excess premiums with an R^2 of 6.1% (3 months ahead) or 1.7% (6 months ahead). All the results are statistically significant at the 1% or 5% level.

Panel A of Table 3 also shows the out-of-sample performance measures during recessions (R_{Rec}^2) and expansions (R_{Exp}^2). The steepening indicator sometimes yields false detections of recessions during expansionary periods with $R_{Exp}^2 < 0$. This result arises because speculators tend to maintain steepening positions in the recovery periods immediately following the recessions, as can be seen in Figure 1. For example, while the 2001 recession came to an end in November 2001, speculators still maintained a strong steepening view in the following couple of years or so. Nevertheless, it appears that the benefit of correctly detecting recessions outweighs the cost of falsely detecting recessions.

2.2 Forecasting non-farm payroll growth rates

I next examine the predictive power of spreading indicators for non-farm payroll growth rates by running the following h -month-ahead predictive linear regression:

$$g_{t+h} = \alpha + \beta \text{SPRD}_t + \gamma' z_t + \delta g_t + \varepsilon_{t+h}, \quad (6)$$

where g_{t+h} denotes the annualized non-farm payroll growth rate between $t + h - 1$ and $t + h$ and ε_{t+h} is a forecasting error. The first-release vintage data on payrolls are

used to avoid a look-ahead bias (the results would be stronger for the revised data).⁷ A special case with $h=0$ is referred to as nowcasting.

Panel B of Table 2 shows in-sample prediction results. The coefficient on STEEP is negative, implying that a higher value of STEEP is associated with a lower payroll growth rate in subsequent months. The statistical significance of STEEP is obtained at the 1% level for every forecasting horizon. The coefficient on FLAT is positive, implying that a higher value of FLAT is associated with a higher payroll growth rate in subsequent months, with statistical significance at the 1% level for every forecasting horizon. Note that the forecasting power of the spreading indicators survives the inclusion of the control variables, suggesting that the predictive information in spreading indicators is not subsumed by that in other variables.

To assess out-of-sample forecasting power, I compare the full model as in Equation (6) to the nested benchmark model without the spreading indicator. Specifically, an out-of-sample R^2 measure is defined as

$$R^2 = 100 \times \left(1 - \frac{\sum_{t=T_b}^{T_e} (g_t - \hat{g}_t)^2}{\sum_{t=T_b}^{T_e} (g_t - \hat{g}_t^0)^2} \right), \quad (7)$$

where \hat{g}_t and \hat{g}_t^0 denote the forecast associated with the full and benchmark models, respectively. As before, the first-release vintage data are used.

Panel B of Table 3 shows out-of-sample forecasting results for non-farm payroll growth rates. STEEP has incremental forecasting power beyond term spreads with an R^2 of 16.2% (3 months ahead) or 17.2% (6 months ahead); and beyond bond excess premiums with an R^2 of 10.8% (3 months ahead) or 14.4% (6 months ahead). The results are statistically significant at the 1% level in every case. Similarly, FLAT has incremental forecasting power beyond term spreads with an R^2 of 4.6% (3 months ahead) or 5.1% (6 months ahead); and beyond bond excess premiums with an R^2 of 2.2% (3 months ahead) or 4.3% (6 months ahead). The forecasting power of the spreading indicators varies along phases of the business cycle. In particular, STEEP has greater forecasting power during recessions than during expansions, while R_{Rec}^2 and R_{Exp}^2 are both positive.

⁷ The vintage data are available from the Federal Reserve Bank of Philadelphia, <https://www.philadelphiafed.org/research-and-data/real-time-center/real-time-data/data-files/employ>.

To summarize, spreading indicators have the predictive power for future economic activity particularly during recessions. The state dependence is somewhat aligned with the literature suggesting that economic agents tend to process macroeconomic information more actively during recessions than during expansions. For example, Kacperczyk, Nieuwerburgh, and Veldkamp (2014) show that professional managers are good at market timing particularly in bad times. Coibion and Gorodnichenko (2015) provide evidence that forecasters update macroeconomic information more frequently in bad times than in good times.

Given that a futures market has a zero net supply, one may wonder who took the opposite positions from speculators. To help understand this question, I repeat a similar analysis for the other two groups: commercial hedgers and small players. The unreported results show that small players' spreading indicators have predictive power for recession probabilities with an opposite sign, whereas hedgers' spreading indicators have no predictive power. Therefore, small players appear to have met the net demand from spread traders.

2.3 Spread trading versus outright trading

I compare the information content of spread trading to that of outright trading in various futures markets. This comparison is interesting because investors' macroeconomic expectations can be revealed in other futures markets as well. For example, informed traders may engage in outright trading in short-term bond futures because short-term rates are directed by monetary policy. Piazzesi and Swanson (2008) document that positions in Eurodollar futures have predictive power for excess returns on federal funds futures. Furthermore, business-cycle risk is fundamental to all kinds of asset classes and professional investors rebalance asset allocations along phases of the business cycle. For example, ahead of an impending recession, asset managers may reduce positions in stock and crude oil futures, while increasing positions in safe-haven assets such as Treasury and gold futures.

I consider eight futures markets covering bonds, stocks, currencies, and commodities; and define an outright indicator in each market as the net number of speculators in that market. Let $\hat{p}_{steep,t}$ and $\hat{p}_{out,t}$ denote the recession probability forecasts associated with the steepening indicator and the outright indicator in each of the selected futures markets, respectively. A combination forecast, denoted by $\hat{p}_{fc,t}$, is defined as

a convex combination of the two individual forecasts:

$$\widehat{p}_{fc,t} = \lambda \widehat{p}_{steep,t} + (1 - \lambda) \widehat{p}_{out,t}, \quad (8)$$

where λ is the weight given to the forecast associated with the steepening indicator and $(1 - \lambda)$ is the weight given to the forecast associated with the outright indicator. I then implement the forecast encompassing test introduced by Harvey, Leybourne, and Newbold (1998) to see whether λ is equal to 1 or 0. If $\lambda = 1$ (0), then the steepening indicator (the outright indicator) encompasses the information contained in the outright indicator (the steepening indicator).

Panel A of Table 4 shows the results of the forecast encompassing test between the spreading indicator and the outright indicator for various futures markets. As is shown in the table, I reject the null hypothesis $H_{\lambda=0}$, with a p value smaller than 1%, for every outright indicator considered, implying that any of the outright indicators do not encompass the information contained in the steepening indicator. In contrast, I fail to reject the null hypothesis that the steepening indicator encompasses the information contained in the outright indicators in all futures, except for crude oil futures.

I next compare the information content of the steepening indicator to that of the outright indicators in light of payroll growth forecasting. Let $\widehat{g}_{steep,t}$ and $\widehat{g}_{out,t}$ denote the payroll growth forecasts associated with the steepening indicator and the outright indicator, respectively. Panel B of Table 4 shows the results of the forecast encompassing tests between $\widehat{g}_{steep,t}$ and $\widehat{g}_{out,t}$. Again, I reject the null hypothesis $H_{\lambda=0}$, with a p value smaller than 1%, implying that any of the outright indicators do not encompass the information contained in the steepening indicator. In contrast, I fail to reject the null hypothesis that the steepening indicator encompasses the information contained in the outright indicators. Overall, spread trading contains more information about future economic activities than outright trading.

2.4 Evidence of private information

One may argue that the forecasting power of spreading indicators does not necessarily mean that speculators have private information about economic activity. It is possible that speculators' superior ability to play the slope of the yield curve is based on the

financial market data, such as term spreads and credit spreads, that have causal effects on economic activity.⁸ I attempt to reduce such an endogeneity concern by comparing the forecasting ability of speculators to that of professional forecasters.

I first show that speculators have some information that is not impounded into payroll forecasts by running the following regression:

$$\text{NFP}_{t+h} = \alpha + \beta \widetilde{\text{NFP}}_{t+h} + \gamma \text{SPRD}_t + \eta' z_t + \varepsilon_{t+h}, \quad (9)$$

where NFP_{t+h} and $\widetilde{\text{NFP}}_{t+h}$ denote the first-release payrolls and the consensus forecast for the month $t + h$, respectively. The consensus forecast data come from Action Economics over the period from December 1987 to December 1996 and Bloomberg over the period from January 1997 to July 2017. In the regression as in Equation (9), the information between t and $t + h$ is visible to professional forecasters but not to speculators in bond futures. If forecasters are fully informed and rational, β should be 1 and the other coefficients 0. I am particularly interested in testing the significance of the coefficient on SPRD_t , γ , to see whether professional forecasters miss out on some important information held by speculators.

Table 5 shows regression results. Panel A of the table shows that the steepening indicator contains valuable information about future payrolls beyond consensus forecasts, although statistical significance varies over horizons. The coefficient on STEEP is estimated to be negative, implying that a high level of the steepening indicator is associated with a negative payroll surprise in subsequent months. Panel B of the table shows that the flattening indicator also has some information beyond consensus forecasts four to six months ahead, with statistical significance at the 5% level. The coefficient on FLAT is estimated to be positive, implying that a high level of the flattening indicator is associated with a positive payroll surprise in subsequent months. Unlike the spreading indicators, other business-cycle indicators, such as term spreads and bond excess premiums, have no predictive power. Overall, spreading indicators have unique information about future payrolls that is not accounted for by professional forecasters.

I next examine whether spreading indicators can predict asset returns over in-

⁸ For example, term spreads and credit spreads may influence the real economy by affecting banks' net interest margins and firms' cost of funding, respectively.

trading windows surrounding future payroll release times as follows:

$$r_{i,t+h}^{w_-,w_+} = \alpha_i + \beta_i \text{SPRD}_t + \varepsilon_{i,t+h}, \quad (10)$$

where $r_{i,t+h}^{w_-,w_+}$ denotes the intraday return on a futures contract i over the short window starting w_- minutes before the h -month-ahead payroll release time and ending w_+ minutes after. If all investors are rational and information is symmetric, the intraday returns should be unpredictable, with the coefficient on SPRD_t being insignificant. The high-frequency returns data come from Refinitiv.

Table 6 shows the predictive power of spreading indicators for the three-month-ahead ($h = 3$) intraday returns with two choices of windows: $w_- = 5$ and $w_+ = 5$ or 25. Panels A and B correspond to the predictive power of steepening and flattening indicators, respectively. The table shows that the intraday returns on short-term bond futures are predictable by spreading indicators. Today's strong steepening (flattening) is followed by a positive (negative) shock to federal funds and Eurodollar futures prices at subsequent payroll release times. The results are statistically significant at the 1% to 5% levels.

Similarly, today's strong steepening (flattening) is associated with a positive (negative) shock to the British pound and Swiss franc futures prices at subsequent payroll release times. That is, strong steepening (flattening) is followed by the depreciation (appreciation) of the U.S. dollar against the British pound and Swiss franc.⁹ The results are statistically significant at the 1% to 5% levels with the shorter intraday window. However, spreading indicators have no predictive power for long-term Treasury futures, stock futures, and Japanese yen futures.

A puzzling aspect of my result is that information about future payrolls is not fully incorporated into bond and currency futures prices until the payroll release times. This result is at odds with the strategic trading model of Kyle (1985) in which information should be fully incorporated into asset prices as market makers can learn from informed traders' order flows. Instead, the partial adjustment of prices that I have found may be explained by imperfect competition and limited capital. If bond futures markets are concentrated in the hands of a finite number of large players, prices may not be fully revealing in the limit as noise traders vanish (see Kyle 1989). In addition, lack of capital may prevent informed traders from taking optimal portfolios

⁹ I do not use Euro currency futures because of their short sample period.

in crisis periods in which they turn out to be particularly informed as shown in my previous analyses.

To summarize, spreading indicators predict payroll surprises in following months and short-term bond futures' and some currency futures' reaction to subsequent payroll surprises. These results suggest that speculators have some private information about future payrolls that is not impounded into consensus forecasts and futures prices. While I find no similar result for other key macroeconomic announcements such as GDPs and industrial productions, payrolls are dubbed the king of announcements by scholars (see Andersen and Bollerslev 1998) and practitioners, and they constitute a key component in the dual mandate of the Federal Reserve. Gilbert, Scotti, Strasser, and Vega (2016) find that payrolls have the biggest effect on U.S. Treasury bond yields. Accordingly, I argue that the predictive information contained in spread trading is particularly associated with speculators' superior information about future payrolls.

3 Information content for stock returns

Lucca and Moench (2015) document that a large fraction of stock excess returns have materialized during 24-hour windows prior to scheduled FOMC announcements. This section studies the predictive power of spread trading for the pre-FOMC stock drift in sample and out of sample. I also assess the economic gain of a pre-FOMC timing strategy using the information contained in spread trading and draw a policy implication.

3.1 Explaining the pre-FOMC drift puzzle

To show the association between the information in spread trades and the pre-FOMC stock drift, I obtain a pre-FOMC same-day return, the return on the S&P 500 futures between 9:30 a.m. EST on the day of an FOMC announcement and 15 minutes before the announcement.¹⁰ The high-frequency returns data come from Refinitiv over the period from September 1997 to July 2017. I then run the predictive regression of the steepening indicator for the next pre-FOMC same-day return, denoted by r_{t+1}^{sd} , as

¹⁰ The pre-FOMC same-day return normally captures the return between 9:30 a.m. and 2:00 p.m.

follows:

$$r_{t+1}^{sd} = \beta_0 + \beta_1 \text{STEEP}_t + \beta_2 \text{VIX}_t + \beta_3 \text{TMSP}_t + \beta_4 \text{EBP}_t + \varepsilon_{t+1}, \quad (11)$$

where t denotes a scheduled FOMC date and VIX denotes the Chicago Board of Options Exchange VIX index. Without predictors in the regression, β_0 would indicate an average pre-FOMC same-day return.

Panel A of Table 7 shows the in-sample forecasting power of the steepening indicator for the pre-FOMC same-day returns. Regression (1) shows that the same-day returns have an average of 19 basis points over my sample period. The average is statistically significant at the 1% level with a t statistic of 3.24, suggesting that stock prices tend to rise in the mornings of FOMC announcements. Regression (2) shows that the steepening indicator has statistically significant power for the same-day returns with a t statistic of 3.77. Unlike the steepening indicator, Regression (3) shows that the VIX and term spreads have little-to-weak predictive power for the same-day returns. While EBP has strong predictive power for the same-day returns, Regression (4) shows that the steepening indicator is still important in predicting the same-day returns at the 1% level after EBP is controlled for. Importantly, as long as the steepening indicator is accounted for in Regressions (2) and (4), β_0 is no longer statistically significant. That is, the same-day stock drift is largely explained by the information contained in the steepening indicator.

What channel can explain the positive relationship between steepening trades and future stock returns? This relationship cannot be explained by the cash flow channel because steepening trades are likely to signal low corporate earnings as they are related to low economic activities. Instead, my result can be better explained by another channel through which information held by speculators gets incorporated into stock prices: the policy anticipation channel. Specifically, financial markets sometimes interpret bad incoming data positively for stocks with the expectation that the Federal Reserve may step in to rescue the economy. In light of my finding, speculators appear to have engaged in informed trading ahead of FOMC announcements in anticipation of an easing policy. This interpretation is broadly consistent with empirical research showing that stock prices tend to increase following easing monetary policies (see Rigobon and Sack 2004; and Bernanke and Kuttner 2005). Overall, my results suggest that informed speculators predominantly focus on the policy anticipation channel on days of FOMC announcements, which in turn drives the positive pre-FOMC same-day

drift.

I now study how the information in spread trades gets incorporated into stock prices during overnight trading hours prior to FOMC announcements. To do so, I compute a pre-FOMC overnight return, the return between 24 hours before a scheduled FOMC announcement and 9:30 a.m. on the following FOMC day. I then examine the predictive power of the steepening indicator for the next pre-FOMC overnight return, denoted by r_{t+1}^{ov} , as follows:

$$r_{t+1}^{ov} = \beta_0 + \beta_1 \text{STEEP}_t + \beta_2 \text{VIX}_t + \beta_3 \text{TMSP}_t + \beta_4 \text{EBP}_t + \varepsilon_{t+1}. \quad (12)$$

Panel B of Table 7 shows the regression results for the pre-FOMC overnight returns. Regression (1) shows that the overnight returns have an average of 17 basis points. The average is statistically significant at the 5% level with a t statistic of 2.22, suggesting a significant pre-FOMC overnight drift. Regression (2) shows that the steepening indicator has no predictive power for the overnight returns, suggesting little evidence of informed overnight trading in stock markets. Unlike the steepening indicator, Regression (3) shows that the VIX index and term spreads have predictive power for the overnight returns at the 1% levels. A possible explanation for this finding is that the overnight drift may be the result of a risk compensation for heightened uncertainty, given that the VIX index and term spreads are associated with uncertainty and the business cycle, respectively.

Taken together, the information in steepening trades has been impounded into stock prices through pre-FOMC same-day trading but not overnight trading. This last-hour trading behavior may be explained by the literature suggesting a stealth motive in informed trading. For example, Foster and Viswanathan (1994) provide a dynamic model of strategic trading with two informed traders in which one has more information than the other while both share some common information. The model shows that exclusively private information gets incorporated into asset prices in the last trading periods as the more informed tries to avoid revealing information to the less informed. That said, the last-hour informed trading that I have found is consistent with my argument that speculators have some private information.

Aside from the stealth motive, there are two additional reasons why informed trading is more active during same-day trading hours than during overnight trading hours. First, as long as intraday trading is completely squared off until the day's

market close, it does not incur any extra margin (although a very small intraday margin can be temporarily required). As a result, same-day trading is more practically feasible than overnight trading even if informed traders face a binding capital constraint during recessions in which they turn out to be particularly informed. Second, an overnight position can be too risky because it is difficult to be attentive to news through the night and to square off the position immediately because of lack of market liquidity.

3.2 Out-of-sample evidence and economic significance

I examine the out-of-sample forecasting power of the steepening indicator for the pre-FOMC same-day and overnight returns. To this end, the sample period is divided into two subperiods: the first in-sample estimation period (September 1997 to December 2002) and the out-of-sample evaluation period (January 2003 to July 2017). I then compare the univariate predictive regression model including the steepening indicator to the historical average model.¹¹ The models are estimated on each FOMC date throughout the out-of-sample evaluation period based on a rolling window. An out-of-sample R^2 measure is defined based on a quadratic loss function.

The left panel of Table 8 shows the out-of-sample forecasting results, including out-of-sample R^2 s and Clark and West (2007) test statistics. The panel shows that the steepening indicator has forecasting power for the same-day returns with an R^2 of 16.8%. The result is statistically significant at the 1% level. The explanatory power is greater during recessions than during expansions, consistent with the previous finding that spreading indicators are particularly informative during recessions.

I next study whether out-of-sample forecasting power can be translated into economic value by introducing an active pre-FOMC timing strategy using the steepening indicator. The active pre-FOMC timing strategy for the same-day returns is defined as follows. On each FOMC date I predict the next pre-FOMC same-day return using the univariate predictive regression model including the steepening indicator. If the predicted same-day return is positive (negative), I buy (sell) stock futures at 9:30 a.m. on the FOMC announcement day and square off the position 15 minutes before the announcement. Note that the prediction is made about 45 days before the futures

¹¹ Goyal and Welch (2008) show that it is difficult to beat the historical average model in out-of-sample forecasting for stock returns.

position is formed. This procedure can be similarly applied for the overnight returns.

The right panel of Table 8 shows that the active pre-FOMC timing strategy yields a Sharpe ratio of 1.085 for the same-day returns. To give some perspective, I compare the active strategy to a naive pre-FOMC strategy that always buys stock futures at 9:30 a.m. on the FOMC announcement day and sells the equal amount 15 minutes before the announcement. The naive pre-FOMC strategy leads to a Sharpe ratio of 0.748 for the same-day returns, which is 0.34 smaller than that of the active strategy. No similar improvement is found for the overnight returns.

Overall, I demonstrate that the steepening indicator has out-of-sample forecasting power for pre-FOMC same-day returns and can deliver some economic gain. Further improvements can be made in several ways. For example, it would be interesting to combine both information on the steepening indicator and bond excess premiums for the pre-FOMC same-day returns. The preceding results show that the pre-FOMC overnight returns are predictable by the VIX index and term spreads, so it would be interesting to study a pre-FOMC 24-hour timing strategy using the VIX index and term spreads for the overnight component and using the steepening indicator and bond excess premiums for the same-day component. I will leave these possibilities to future research.

3.3 Policy implication

Recent studies document the possibility of information leakage before macroeconomic announcements. Bernile, Hu, and Tang (2016) find that abnormal pre-FOMC order imbalances are aligned with subsequent policy surprises and attribute the alignment to information leakage. Cieslak, Morse, and Vissing-Jorgensen (2018) argue that the informal communication of policy makers with the financial media and markets generates the cyclical pattern of stock returns over the FOMC cycle. Kurov, Sancetta, Strasser, and Wolfe (2017) discover similar evidence of informed trading right before several macroeconomic news announcements. Ai and Bansal (2018) provide a theoretical framework in which a pre-FOMC drift can arise if the representative investor receives an informative signal before FOMC announcements. As these papers point to some form of information leakage, policymakers have been more concerned about safeguarding confidential information.

However, evidence provided in this paper offers an alternative explanation for the source of informed trading before macroeconomic announcements. In particular, I show that the pre-FOMC same-day drift is predictable by the steepening indicator observed a few months before the announcements. Unless information leakage is similarly predictable by the steepening indicator observed a few months ago, I argue that the pre-announcement drift is driven by the strategic informed trading by speculators with a superior ability to form macroeconomic expectations. After all, a pre-announcement drift in asset markets itself does not necessarily indicate information leakage.

4 Conclusion

I document that speculators' spread trades in bond futures have predictive information about subsequent recession probabilities and non-farm payroll growth rates. The predictive power of spread trades cannot be spanned by other business-cycle indicators such as term spreads and bond excess premiums. I attribute the predictive power to speculators' superior ability to form macroeconomic expectations because their spread positions are aligned with subsequent payroll surprises and asset markets' reaction to the payroll surprises.

I also document that the information in spread trades plays a key role in explaining the pre-FOMC stock drift puzzle. Specifically, speculators' stronger steepening is followed by larger increases in stock prices during a few trading hours before subsequent FOMC announcements. I interpret the result to imply that informed speculators engage in pre-FOMC same-day trading in anticipation of the adoption of an easing policy. An active pre-FOMC timing strategy conditioned on the information in steepening trades would have delivered a large Sharpe ratio gain of 0.34 relative to a naive pre-FOMC buy-and-sell strategy.

Overall, this paper provides new evidence that sophisticated investors have private information about future economic activity and that such information is critically important for understanding asset returns at the times of macroeconomic announcements or during a few trading hours before macroeconomic announcements. A policy implication of such evidence is that a pre-announcement drift itself does not necessarily indicate information leakage.

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Table 1: **Summary statistics and correlation matrix**

This table shows the summary statistics of the business-cycle indicators and the correlation matrix among them. STEEP denotes the steepening indicator implied by speculators' positions in bond futures; FLAT denotes the flattening indicator implied by speculators' positions in bond futures; TMSP denotes term spreads, the quarterly moving averages of the yield spreads between ten-year Treasury bonds and three-month Treasury bills; EBP denotes the bond excess premiums as calculated by Gilchrist and Zakrajsek (2012); and FFR denotes real federal fund rates, the differences between the effective federal fund rates and the inflation rates as implied by the core PCE price index. The sample spans from July 1986 to July 2017.

	STEELP	FLAT	TMSP	EBP	FFR
Panel A: Summary statistics					
Mean	0.40	0.32	1.89	0.05	1.35
Median	0.33	0.17	1.93	-0.07	1.01
Min.	0.00	0.00	-0.49	-1.08	-2.01
Max.	1.00	1.00	3.74	3.05	5.50
Std.	0.38	0.36	1.06	0.58	2.23
Skew.	0.40	0.77	-0.22	1.92	0.06
Kurt.	1.61	2.07	2.07	8.57	1.48
AR(1)	0.92	0.93	0.98	0.91	0.99
Panel B: Correlation matrix					
STEELP	1.00	-0.74	-0.06	0.37	0.05
FLAT		1.00	-0.04	-0.25	-0.06
TMSP			1.00	0.00	-0.62
EBP				1.00	0.03
FFR					1.00

Table 2: **Information content for economic activity: In-sample**

This table shows the in-sample forecasting power of spreading indicators for economic activity. Panel A reports the h -month-ahead Probit regression results for recession probabilities, and Panel B reports the h -month-ahead linear regression results for the first-release non-farm payroll growth rates. STEEP denotes the steepening indicator implied by speculators' positions in bond futures; FLAT denotes the flattening indicator implied by speculators' positions in bond futures; TMSP denotes term spreads, the quarterly moving averages of the yield spreads between ten-year Treasury bonds and three-month Treasury bills; EBP denotes the bond excess premiums as calculated by Gilchrist and Zakrajšek (2012); and FFR denotes real federal fund rates, the differences between the effective federal fund rates and the inflation rates as implied by the core PCE price index. The sample spans from July 1986 to July 2017. Newey and West (1987) robust t -statistics with an optimal lag are shown in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	STEEP as a predictor				FLAT as a predictor		
	3 months ahead	6 months	12 months		3 months ahead	6 months	12 months
Panel A: Forecasting recession probabilities							
STEEP	1.83*** (4.00)	1.65*** (3.70)	0.77** (2.08)	FLAT	-1.44** (-2.48)	-1.21** (-2.18)	-0.45 (-0.95)
TMSP	-0.52** (-2.54)	-1.02*** (-4.07)	-1.19*** (-4.95)	TMSP	-0.59*** (-3.10)	-1.10*** (-4.42)	-1.27*** (-5.20)
EBP	0.58*** (5.17)	0.56*** (4.74)	0.28** (2.46)	EBP	0.64*** (6.12)	0.62*** (5.47)	0.32*** (2.90)
FFR	0.02 (0.10)	-0.08 (-0.35)	-0.04 (-0.18)	FFR	-0.13 (-0.70)	-0.25 (-1.22)	-0.13 (-0.64)
Const.	-2.04*** (-3.22)	-1.22* (-1.92)	-0.45 (-0.82)	Const.	-0.43 (-1.07)	0.24 (0.56)	0.23 (0.55)
<i>adj. R</i> ²	0.45	0.47	0.43	<i>adj. R</i> ²	0.39	0.42	0.41
Panel B: Forecasting non-farm payroll growth rates							
STEEP	-1.12*** (-4.83)	-1.30*** (-4.53)	-1.06*** (-3.19)	FLAT	0.73*** (3.30)	0.84*** (3.24)	0.96*** (3.03)
TMSP	0.18* (1.66)	0.34*** (2.83)	0.53*** (3.04)	TMSP	0.24** (2.26)	0.41*** (3.40)	0.59*** (3.18)
EBP	-0.51*** (-3.84)	-0.57*** (-4.96)	-0.41** (-2.51)	EBP	-0.58*** (-4.11)	-0.65*** (-5.13)	-0.47*** (-2.93)
FFR	0.32** (2.46)	0.37** (2.47)	0.22 (1.43)	FFR	0.35** (2.47)	0.39** (2.47)	0.25 (1.51)
Lagged	0.56*** (4.80)	0.30*** (2.63)	0.16 (1.07)	Lagged	0.61*** (4.95)	0.37*** (3.18)	0.18 (1.17)
Const.	0.75*** (2.73)	0.67** (2.28)	0.37 (0.83)	Const.	-0.08 (-0.29)	-0.28 (-0.85)	-0.48 (-0.91)
<i>adj. R</i> ²	0.44	0.38	0.23	<i>adj. R</i> ²	0.41	0.34	0.22

Table 3: **Information content for economic activity: Out-of-sample**

This table shows the out-of-sample forecasting power of spread indicators for economic activity. Panels A and B correspond to the prediction of recession probabilities and the prediction of first-release non-farm payroll growth rates, respectively. STEEP denotes the steepening indicator implied by speculators' positions in bond futures, and FLAT denotes the flattening indicator implied by speculators' positions in bond futures. The sample spans from July 1986 to July 2017. Here, I divide the entire sample period into two subperiods: the first in-sample estimation period (July 1986 to December 1999) and the out-of-sample evaluation period (January 2000 to July 2017). The models are recursively estimated at each point in time throughout the out-of-sample evaluation period. I then measure the incremental forecasting power of spread indicators beyond term spreads and bond excess premiums by comparing the models with and without the spread indicator. The out-of-sample R^2 is measured using the log loss function for forecasting recession probabilities and using the quadratic loss function for forecasting the first-release non-farm payroll growth rates. The McCracken (2007) test is applied to compare two nested models. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. $\bar{\beta}$ denotes an average of the coefficients on the spread indicator over the out-of-sample evaluation period. The out-of-sample R^2 is further broken down into two subperiods, recessions and expansions, which are denoted by R^2_{Rec} and R^2_{Exp} , respectively.

	3 months ahead					6 months ahead				
	$\bar{\beta}$	R^2	Statistic	R^2_{Rec}	R^2_{Exp}	$\bar{\beta}$	R^2	Statistic	R^2_{Rec}	R^2_{Exp}
Panel A: Forecasting recession probabilities										
<u>After controlling for term spreads</u>										
STEEP	2.11	28.6	1.79***	41.2	-25.2	1.85	22.9	1.36**	37.0	-32.4
FLAT	-1.73	15.4	2.00***	19.4	-1.4	-1.05	11.1	1.44***	13.5	2.0
<u>After controlling for bond excess premiums</u>										
STEEP	1.51	14.8	1.21**	32.3	-20.7	1.10	6.9	0.91**	21.8	-13.7
FLAT	-0.93	6.1	1.67***	8.7	0.9	-0.44	1.7	0.75**	0.1	3.9
Panel B: Forecasting non-farm payroll growth rates										
<u>After controlling for term spreads</u>										
STEEP	-1.35	16.2	2.17***	25.4	7.9	-1.49	17.2	2.02***	22.2	11.4
FLAT	0.93	4.6	1.66***	6.8	2.6	1.04	5.1	1.59***	7.9	1.9
<u>After controlling for bond excess premiums</u>										
STEEP	-1.10	10.8	2.24***	16.4	7.6	-1.19	14.4	2.65***	17.1	12.1
FLAT	0.65	2.2	0.86**	-0.5	3.8	0.64	4.3	2.00***	2.2	6.0

Table 4: **Forecast encompassing test results between steepening trades and outright trades**

This table shows the results of the Harvey, Leybourne, and Newbold (1998) forecast encompassing test between the steepening indicator and outright indicators in various futures markets. λ is the weight given to the forecast associated with the steepening indicator. The null hypothesis denoted by $H_{\lambda=0}$ tests whether the information contained in the outright indicator encompasses that in the steepening indicator. The null hypothesis denoted by $H_{\lambda=1}$ tests whether the information contained in the steepening indicator encompasses that in the outright indicator. The sample spans from July 1986 to July 2017. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Futures	3 months ahead			6 months ahead		
	λ	p value		λ	p value	
		$H_{\lambda=0}$	$H_{\lambda=1}$		$H_{\lambda=0}$	$H_{\lambda=1}$
Panel A: Forecasting recession probabilities						
Eurodollar	0.82	0.003***	0.223	1.35	0.000***	0.866
Ten-year Treasury	0.86	0.000***	0.254	0.67	0.002***	0.083*
30-year Treasury	1.11	0.000***	0.691	1.03	0.000***	0.553
S&P 500	1.23	0.000***	0.832	1.37	0.000***	0.907
British pound	1.09	0.000***	0.704	1.23	0.000***	0.834
Japanese yen	0.99	0.000***	0.476	1.04	0.000***	0.557
Gold	1.02	0.000***	0.548	1.10	0.000***	0.727
WTI	0.61	0.000***	0.006***	0.65	0.000***	0.041**
Panel B: Forecasting non-farm payroll growth rates						
Eurodollar	0.89	0.000***	0.254	0.86	0.000***	0.146
Ten-year Treasury	1.12	0.000***	0.789	1.05	0.000***	0.658
30-year Treasury	1.07	0.000***	0.687	1.13	0.000***	0.796
S&P 500	1.25	0.000***	0.946	1.36	0.000***	0.987
British pound	0.98	0.000***	0.443	1.20	0.000***	0.890
Japanese yen	1.18	0.000***	0.865	1.21	0.000***	0.882
Gold	1.08	0.000***	0.725	1.11	0.000***	0.820
WTI	0.93	0.000***	0.304	1.02	0.000***	0.555

Table 5: **Forecasting future payrolls beyond consensus forecasts**

This table shows the following regression results for future payrolls:

$$\text{NFP}_{t+h} = \alpha + \beta \widetilde{\text{NFP}}_{t+h} + \gamma \text{SPRD}_t + \eta' z_t + \varepsilon_{t+h}, \quad (13)$$

where NFP_{t+h} and $\widetilde{\text{NFP}}_{t+h}$ denote the first-release payrolls and the consensus forecast for the month $t+h$, respectively, and SPRD_t denotes either STEEP_t or FLAT_t . Note that the information between t and $t+h$ is visible to professional forecasters but not to speculators in bond futures. STEEP denotes the steepening indicator implied by speculators' positions in bond futures; FLAT denotes the flattening indicator implied by speculators' positions in bond futures; TMSP denotes term spreads, the quarterly moving averages of the yield spreads between ten-year Treasury bonds and three-month Treasury bills; EBP denotes the bond excess premiums as calculated by Gilchrist and Zakrajšek (2012); and FFR denotes real federal fund rates, the differences between the effective federal fund rates and the inflation rates as implied by the core PCE price index. Panels A and B show the predictive power of the steepening and flattening indicators, respectively, for various forecasting horizons. Newey and West (1987) robust t -statistics with an optimal lag are shown in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	h=1	h=2	h=3	h=4	h=5	h=6
Panel A: Using the steepening indicator ($\text{SPRD}_t = \text{STEEP}_t$)						
$E_{t+h}[\text{NFP}_{t+h}]$	0.96*** (19.99)	0.97*** (18.92)	0.96*** (18.27)	0.93*** (16.41)	0.95*** (17.27)	0.98*** (20.05)
STEEP	-24.80* (-1.90)	-33.06** (-2.49)	-43.32*** (-2.99)	-45.47*** (-3.17)	-36.43** (-2.58)	-13.63 (-0.92)
TMSP	-0.08 (-0.01)	1.06 (0.16)	-2.08 (-0.36)	-1.16 (-0.19)	3.07 (0.47)	4.51 (0.72)
EBP	-8.13 (-1.31)	-4.32 (-0.73)	-1.82 (-0.31)	-8.84 (-1.41)	-6.02 (-0.83)	-5.81 (-0.95)
FFR	-0.35 (-0.05)	0.01 (0.00)	-2.96 (-0.46)	-2.17 (-0.33)	-0.01 (-0.00)	-1.22 (-0.19)
Const.	3.14 (0.20)	3.55 (0.21)	14.53 (0.92)	18.24 (1.07)	3.17 (0.18)	-11.74 (-0.74)
$\text{adj. } R^2$	0.72	0.72	0.73	0.73	0.73	0.73
Panel B: Using the flattening indicator ($\text{SPRD}_t = \text{FLAT}_t$)						
$E_{t+h}[\text{NFP}_{t+h}]$	0.98*** (18.76)	0.99*** (17.81)	0.99*** (18.06)	0.95*** (17.36)	0.97*** (18.58)	0.97*** (20.66)
FLAT	13.17 (0.87)	11.80 (0.78)	20.85 (1.41)	28.96** (2.09)	32.10** (2.27)	31.03** (2.32)
TMSP	1.11 (0.18)	2.33 (0.35)	-0.25 (-0.04)	0.99 (0.16)	5.10 (0.78)	6.23 (0.94)
EBP	-9.50 (-1.48)	-5.95 (-0.91)	-3.59 (-0.55)	-10.02 (-1.52)	-6.62 (-0.92)	-5.83 (-1.00)
FFR	-0.24 (-0.03)	-0.33 (-0.04)	-3.00 (-0.46)	-1.81 (-0.26)	0.78 (0.11)	0.22 (0.03)
Const.	-14.42 (-0.98)	-18.03 (-1.22)	-15.73 (-1.19)	-16.40 (-1.20)	-27.69* (-1.80)	-29.70** (-2.00)
$\text{adj. } R^2$	0.72	0.72	0.73	0.73	0.73	0.73

Table 6: **Predicting asset markets' response to future payroll releases**

This table tests if spreading indicators can predict intraday returns on various futures at future payroll release times as follows:

$$r_{i,t+h}^{w_-,w_+} = \alpha_i + \beta_i \text{SPRD}_t + \varepsilon_{i,t+h}, \quad (14)$$

where $r_{i,t+h}^{w_-,w_+}$ denotes the intraday return on a futures contract i over the short window starting w_- minutes before the h -month-ahead payroll release time and ending w_+ minutes after. SPRD_t denotes either the steepening indicator or the flattening indicator. Panels A and B show the predictive ability of the steepening and flattening indicators with $h = 3$, respectively. Newey and West (1987) robust t -statistics with an optimal lag are shown in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Futures	$(w_-, w_+) = (5, 5)$			$(w_-, w_+) = (5, 25)$		
	β_i	t stat.	$adj. R^2$	β_i	t stat.	$adj. R^2$
Panel A: Using the steepening indicator ($\text{SPRD}_t = \text{STEEP}_t$)						
Federal funds	1.32***	2.99	3.1	1.36***	3.15	2.8
Eurodollar	1.77***	3.11	2.5	1.89***	3.32	2.8
Two-year Treasury	3.05**	2.04	0.5	2.95*	1.81	0.5
Five-year Treasury	6.51	1.60	0.3	4.56	1.16	-0.1
Ten-year Treasury	8.92	1.58	0.3	5.54	1.02	-0.1
30-year Treasury	11.77	1.49	0.3	6.40	0.84	-0.2
S&P 500	-10.58	-1.45	0.3	-9.23	-1.20	0.1
British pound	7.52**	2.19	1.3	3.69	0.80	-0.1
Swiss franc	11.43**	2.34	1.3	6.48	1.01	-0.1
Japanese yen	7.35	1.47	0.3	2.06	0.34	-0.4
Panel B: Using the flattening indicator ($\text{SPRD}_t = \text{FLAT}_t$)						
Federal funds	-0.99**	-2.53	1.4	-0.93**	-2.50	1.0
Eurodollar	-1.41***	-2.77	1.3	-1.53***	-3.14	1.5
Two-year Treasury	-2.57*	-1.79	0.2	-2.32*	-1.73	0.1
Five-year Treasury	-6.04	-1.65	0.2	-5.31	-1.51	0.0
Ten-year Treasury	-7.46	-1.46	0.1	-5.68	-1.16	-0.1
30-year Treasury	-6.69	-0.98	-0.2	-3.10	-0.43	-0.4
S&P 500	0.34	0.05	-0.4	-2.03	-0.25	-0.4
British pound	-9.68***	-2.81	2.2	-8.24**	-2.18	0.7
Swiss franc	-12.97***	-2.61	1.6	-8.70	-1.52	0.2
Japanese yen	-6.08	-1.21	0.0	-0.67	-0.10	-0.4

Table 7: **Predicting the pre-FOMC stock drifts: In-sample evidence**

This table shows the in-sample predictive power of the steepening indicator for the pre-FOMC same-day returns (Panel A) and overnight returns (Panel B). The pre-FOMC same-day return is defined as the return on the S&P 500 futures between 9:30 a.m. EST on the day of an FOMC announcement and 15 minutes before the announcement. The pre-FOMC overnight return is defined as the return on the S&P 500 futures between 24 hours before an FOMC announcement and 9:30 a.m. on the following FOMC day. The sample period here spans from September 1997 to July 2017, restricted by the availability of the intraday S&P 500 futures data from Refinitiv. STEEP denotes the steepening indicator implied by speculators' positions in bond futures; TMSP denotes term spreads, the quarterly moving averages of the yield spreads between ten-year Treasury bonds and three-month Treasury bills; EBP denotes the bond excess premiums as calculated by Gilchrist and Zakrajšek (2012); and VIX denotes the Chicago Board of Options Exchange VIX index. Newey and West (1987) robust t -statistics with an optimal lag are shown in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Constant	STEEP	VIX	TMSP	EBP	$adj. R^2$
Panel A: Forecasting the pre-FOMC same-day returns						
Reg. (1)	0.19*** (3.24)					0.0
Reg. (2)	-0.01 (-0.15)	0.44*** (3.77)				12.8
Reg. (3)	0.23* (1.91)		0.25 (0.40)	-0.06* (-1.83)	0.28*** (3.33)	17.2
Reg. (4)	0.13 (1.25)	0.28*** (2.75)	0.12 (0.20)	-0.06* (-1.75)	0.22*** (3.02)	21.1
Panel B: Forecasting the pre-FOMC overnight returns						
Reg. (1)	0.17** (2.22)					0.0
Reg. (2)	0.06 (1.14)	0.24 (1.13)				0.3
Reg. (3)	-0.04 (-0.26)		2.53*** (2.73)	-0.17*** (-2.64)	0.01 (0.10)	4.6
Reg. (4)	-0.07 (-0.39)	0.07 (0.46)	2.50*** (2.67)	-0.17** (-2.58)	-0.00 (-0.01)	4.1

Table 8: Predicting the pre-FOMC stock drifts: Out-of-sample evidence and economic significance

This table shows the out-of-sample forecasting power of the steepening indicator for the pre-FOMC same-day and overnight returns and its economic significance. The pre-FOMC same-day return is defined as the return on the S&P 500 futures between 9:30 a.m. EST on the day of an FOMC announcement and 15 minutes before the announcement. The pre-FOMC overnight return is defined as the return on the S&P 500 futures between 24 hours before an FOMC announcement and 9:30 a.m. on the following FOMC day. The sample period here spans from September 1997 to July 2017. I divide the sample period into two subperiods: the first in-sample estimation period (September 1997 to December 2002) and the out-of-sample evaluation period (January 2003 to July 2017). An out-of-sample R^2 is measured using a quadratic loss function and the Clark and West (2007) statistic is computed to test statistical significance. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. The out-of-sample R^2 is further broken down into two subperiods, recessions and expansions, which are denoted by R^2_{Rec} and R^2_{Exp} , respectively. SR_{active} denotes the annualized Sharpe ratio of an active pre-FOMC timing strategy conditioned on the steepening indicator. SR_{naive} denotes the annualized Sharpe ratio of a naive pre-FOMC always-buy-and-sell strategy. ΔSR denotes the Sharpe ratio difference between the two strategies.

Returns	Out-of-sample evidence				Economic significance		
	R^2	Statistic	R^2_{Rec}	R^2_{Exp}	SR_{active}	SR_{naive}	ΔSR
Same-day	16.8	4.32***	25.9	12.6	1.085	0.748	0.34
Overnight	-1.9	0.65	0.8	-9.5	0.217	0.542	-0.32

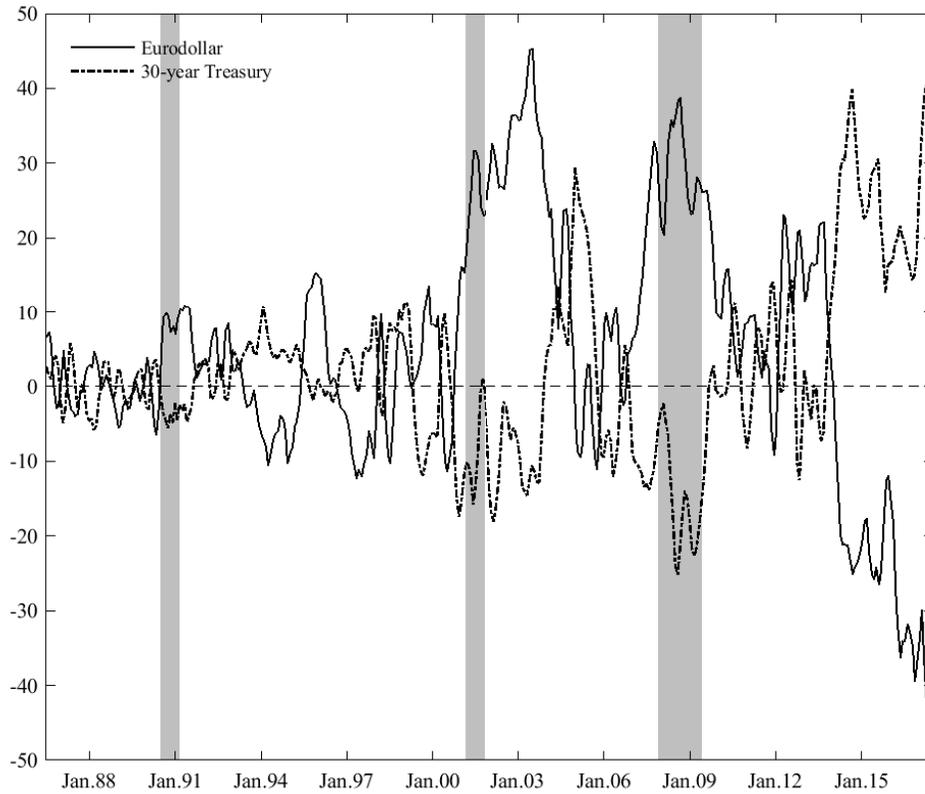


Figure 1: Time series of the excess net number of speculators in bond futures. The solid and dotted lines correspond to Eurodollar futures and 30-year Treasury futures, respectively. The shaded areas refer to the three NBER-designated recessions included in my sample period.

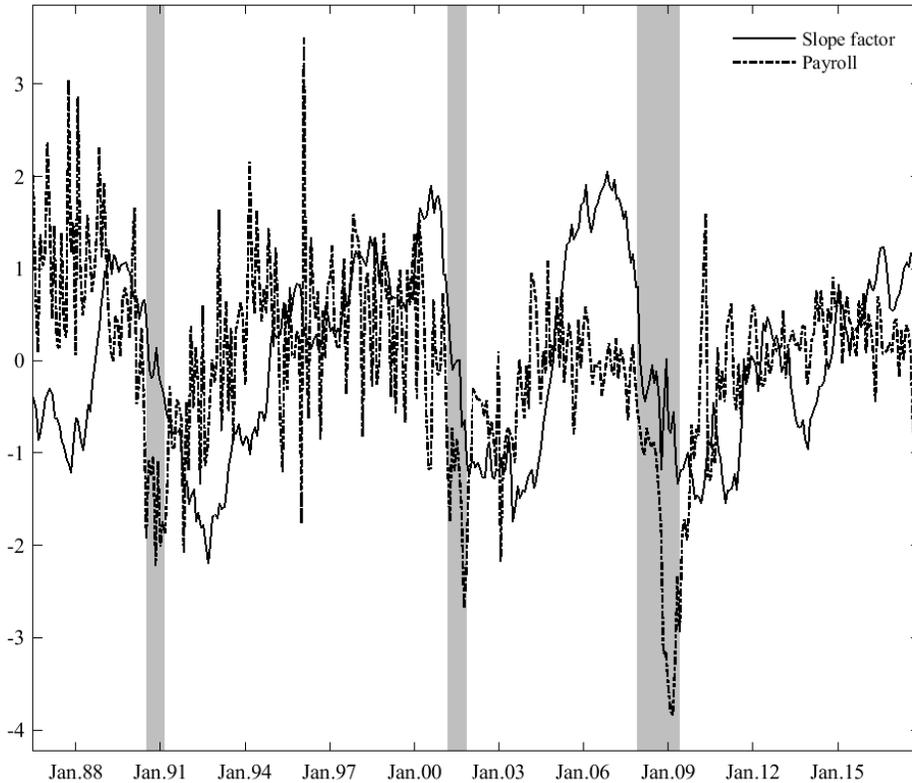


Figure 2: Time series of the slope of the yield curve and the non-farm payroll growth rate. The slope factor (solid line) is the second principal component of a cross-section of Treasury yields with maturities from 1 to 30 years. The first-release vintage data on non-farm payroll growth rates (dotted line) are available from the Federal Reserve Bank of Philadelphia. Both time series are standardized for comparison. The shaded areas refer to the three NBER-designated recessions included in my sample period.

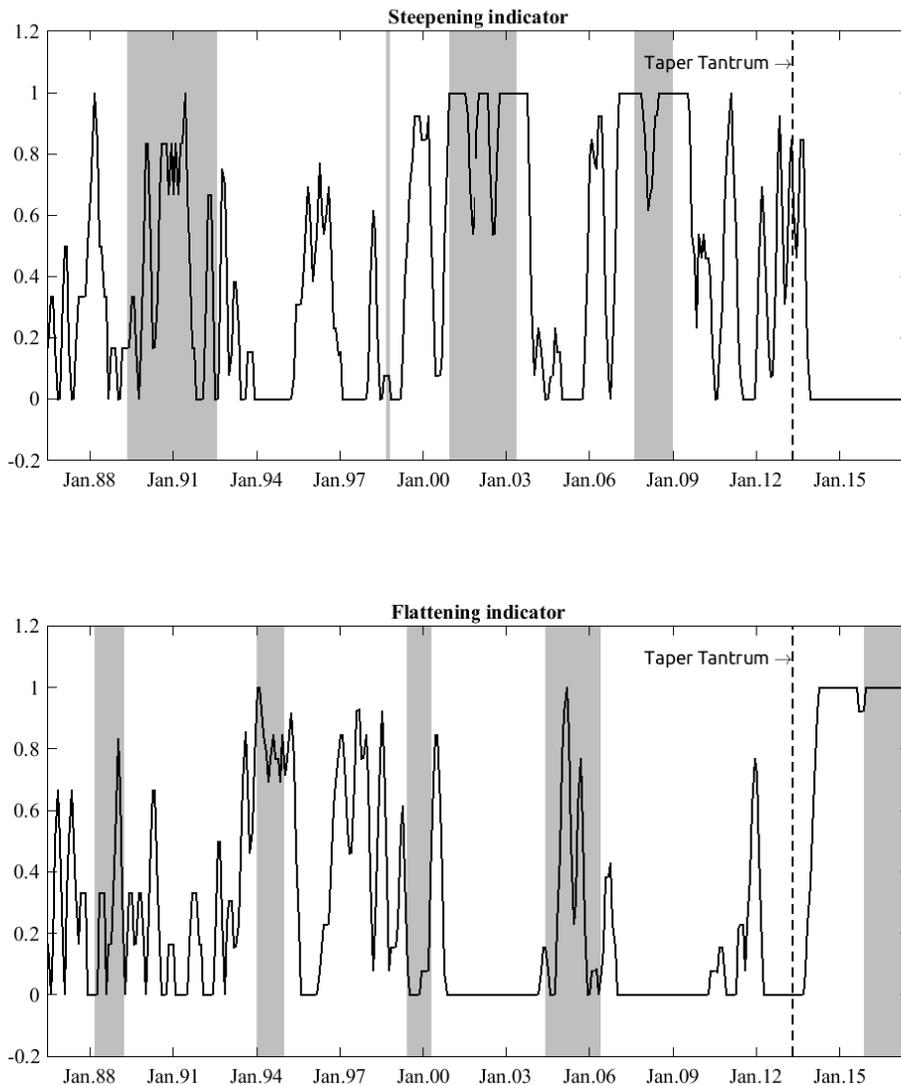


Figure 3: Time series of the spread indicators. Panel A shows the time series of the steepening indicator, with the shaded areas referring to the four easing episodes included in my sample: (i) June 6, 1989 to September 4, 1992; (ii) September 29, 1998 to November 17, 1998; (iii) January 3, 2001 to June 25, 2003; and (iv) September 18, 2007 to January 28, 2009. Panel B shows the time series of the flattening indicator, with the shaded areas referring to the five tightening episodes included in my sample: (i) March 30, 1988 to May 4, 1989; (ii) February 4, 1994 to February 1, 1995; (iii) June 30, 1999 to May 16, 2000; (iv) June 30, 2004 to June 29, 2006; and (v) December 17, 2015 to the end of the sample period. The vertical dotted line refers to the taper tantrum in May 2013 when former Chairman Ben Bernanke first indicated a slowdown of quantitative easing in testimony before the Joint Economic Committee.