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WHAT DOES FUTURES MARKET INTEREST TELL US ABOUT THE MACROECONOMY AND ASSET PRICES?

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ABSTRACT

Open interest, or the amount of contracts outstanding in futures markets, has remarkable power to forecast commodity, currency, bond, and stock prices. Changes in open interest are highly pro-cyclical and predict asset-price fluctuations better than a number of alternative variables including past prices. In commodity markets, rising open interest predicts rising commodity prices, falling bond prices, and a rising short rate. In currency markets, rising open interest predicts appreciation of foreign currencies relative to the U.S. dollar. In bond and stock markets, rising open interest predicts falling bond prices and rising stock prices, respectively. We offer a theoretical explanation of our empirical findings. Open interest is a more informative signal of future economic activity and inflation than past prices because of hedging demand and downward-sloping demand curves in futures markets.

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1. Introduction

We uncover a striking ability of open interest, or the amount of contracts outstanding in futures markets, to predict commodity, currency, bond, and stock prices. Within each of these four asset classes, changes in open interest are highly pro-cyclical and have significant forecasting power beyond a number of alternative variables that include past prices. For instance, rising commodity market interest forecasts rising commodity prices and is a more powerful predictor than conventional predictors of inflation such as past commodity prices. Similarly, rising currency market interest forecasts appreciation of foreign currencies relative to the U.S. dollar and is a more powerful predictor than the forward discount, which is a well known but puzzling determinant of exchange-rate fluctuations. Our findings are somewhat surprising in light of the enormous attention that financial, international, and macro- economists have devoted to these issues. They are potentially relevant to a broad audience that includes policymakers who are concerned about wild fluctuations in commodity prices and exchange rates.

The novelty of our findings are in no small part due to the somewhat unexpected correlation between open interest, macroeconomic activity, and asset prices. Since each futures contract outstanding represents both a long and a short position, quick logic would suggest that open interest should be a non-directional variable that is uncorrelated with macroeconomic activity or asset prices. This is presumably why researchers have focused on transaction prices, which is more obviously directional than transaction quantities, as predictors of asset prices. Contrary to this conventional wisdom, we find that open interest is actually highly correlated with macroeconomic activity as measured by the Chicago Fed National Activity Index (i.e., a weighted average of 85 monthly indicators of U.S. economic activity). Moreover, open interest appears to contain information about future economic activity that is not fully revealed by past asset prices. Open interest turns out to be a more powerful predictor of asset-price fluctuations than past prices.

We offer a theoretical explanation of our empirical findings based on two plausible assumptions. First, information diffuses only gradually in financial markets, which causes asset prices to initially under-react to news. This assumption has been used successfully in a variety of contexts including financial economics (Hong and Stein, 1999), international finance (Gourinchas and Tornell, 2004), and macroeconomics (Mankiw and Reis, 2002). Hong and Stein (2007) survey a large literature that documents empirical evidence for the under-reaction of asset prices to news. Second, supply shocks move asset prices due to financial market frictions that limit arbitrage (De Long et al., 1990). There is now compelling evidence for downward-sloping demand curves in a variety of financial markets, even highly liquid ones such as currency and stock markets (see Shleifer, 1986, for early evidence on stocks).

The key idea that we propose is that open interest is a better signal of the state of the economy than asset prices in the presence of a downward-sloping demand curve. Suppose producers expect high future demand, and in response, enter futures markets to hedge risk arising from high anticipated production. These producers may either go short or long futures, depending on whether they have a natural long or short exposure to the underlying commodity. The futures price can either be low or high today, depending on whether there is more hedging demand from the short or long side of the market, because of limited risk-bearing capacity by speculators. Consequently, the futures price is an ambiguous signal of the state of the economy because it can either be low or high in response to good news. In contrast, high open interest is an unambiguous signal of good news. Therefore, open interest is a more powerful predictor of asset-price fluctuations than past prices.

To test the main predictions of the theory, we construct a portfolio of 30 commodity futures for the sample period of 1966 to 2008. We test the predictability of monthly excess commodity returns by changes in commodity market interest. In our main specification, we find that a standard deviation increase in commodity market interest increases expected commodity returns by 0.63% per month, which is economically large and statistically significant. Commodity market interest remains a powerful and robust predictor of commodity prices even after controlling for a number of conventional predictors like the short rate, the yield spread, the Chicago Fed National Activity Index, past commodity returns, commodity basis (i.e., the ratio of futures to spot price), and commodity market imbalance (i.e., the net short position of hedgers).

We also find that rising commodity market interest predicts low bond returns and a rising short rate. A standard deviation increase in commodity market interest decreases expected bond returns by 0.32% per month. This estimate is highly significant with a t-statistic above three, even after controlling for other known predictors like the short rate, the yield spread, and the Chicago Fed National Activity Index. Our preferred explanation for this finding is that commodity market interest contains information about future economic expansion and inflation that is bad news for the bond market.

We document similar evidence in currency markets, where we construct a portfolio of 8 currency futures for the sample period of 1984 to 2008. We find that rising currency market interest predicts appreciation of foreign currencies relative to the U.S. dollar. Since currency market interest is positively correlated with the Chicago Fed National Activity Index, the sign of this relation is consistent with the fact that inflation in the U.S. causes the U.S. dollar to depreciate relative to foreign currencies. Currency market interest is a more powerful predictor of exchange rates than the forward discount, which is a benchmark against which all other variables are measured in international finance.

Finally, we document similar evidence in bond and stock markets. We find that changes in bond market interest are positively correlated with the Chicago Fed National Activity Index. Moreover, rising bond market interest predicts low bond returns, even after controlling for conventional predictors like the short rate and the yield spread. Hence, bond market interest appears to contain information about future economic expansion and inflation that is bad news for the bond market. We also find that rising stock market interest predicts high stock returns. However, this effect is not statistically significant in our sample period of 1983 to 2008, during which none of the conventional predictors like the dividend yield are statistically significant either.

Our empirical findings have two broader implications. First, our work speaks to the large literature on inflation and interest-rate forecasting in macroeconomics. Commodity market interest is a more powerful predictor of commodity-price inflation, bond returns, and changes in the short rate than more conventional variables like commodity prices or the Chicago Fed National Activity Index. Therefore, commodity market interest can potentially improve the forecasting power of existing models. Second, our work suggests a new approach to modeling expected returns in financial economics. Most empirical models of expected returns are premised on the notion that past prices impound all useful information for predicting future prices. Our work shows that transaction quantities, in particular open interest in futures markets, contain information that is not fully revealed by prices alone.

Our work is quite distinct from traditional theories about the determinants of commodity prices. In the theory of backwardation, the direction of futures market imbalance between hedgers and speculators determines the magnitude of the risk premium earned by speculators (Keynes, 1923; Hicks, 1939). The theory of storage predicts mean reversion in the spot price caused by inventory effects, but it remains silent about the futures price (Working, 1949). Neither of these traditional theories provide an adequate explanation for the set of facts that we uncover in this paper. In particular, rising commodity market interest predicts rising futures and spot prices, regardless of the direction of futures market imbalance between hedgers and speculators.

Our work is most closely related to Chen, Rogoff, and Rossi (2010). They find that the exchange rates of commodity-producing countries predict commodity prices better than past commodity prices. For commodity-producing countries, both commodity prices and their exchange rates are driven by the same underlying demand for commodities. However, exchange rates are a better signal of news about future demand because temporary supply-demand imbalances in the spot market can affect commodity prices. Our work demonstrates that a similar phenomenon exists in futures markets. That is, open interest is a better signal of news about future demand because temporary supply-demand imbalances in the futures market can affect commodity prices.

The rest of the paper proceeds as follows. Section 2 describes the commodity, currency, bond, and stock market data and the construction of the key variables for empirical analysis. Section 3 reports summary statistics for asset prices and the predictor variables. Section 4 presents our main findings on the predictability of asset prices by open interest. Section 5 presents a model that explains why open interest is a better predictor of asset prices than past prices or the direction of futures market imbalance between hedgers and speculators. Section 6 concludes.

2. Futures Market Data and Variable Definitions

2.1. Futures Market Data

We work with data from the Commodity Research Bureau on futures and spot prices in commodity, currency, bond, and stock markets. This database conveniently contains a comprehensive record of daily futures and spot prices for individual futures contracts since December 1964.[1]

We also work with data on open interest, or the number of futures contracts outstanding, as well as the long and short positions of commercial traders (i.e., hedgers) for each futures contract. Since January 1986, the data are available electronically from the Commodity Futures Trading Commission. Prior to that date, we hand-collected data from various volumes of the *Commitments of Traders in Commodity Futures.* Data for December 1964 through June 1972 are from the Commodity Exchange Authority (1964–1972). Data for July 1972 through December 1985 are from the Commodity Futures Trading Commission (1972–1985).

[1] A caveat that applies to this database is that it only contains futures contracts that have survived until the present or that traded for an extended period between 1965 and the present. Various futures contracts fail to survive because of the lack of investor interest, which are subsequently not recorded in the database. Due to potential survivorship bias, one must be careful in interpreting the unconditional average return, which is not the focus of this paper.

There is a 11 month gap from January through November of 1982, during which the Commodity Futures Trading Commission did not collect data due to budgetary reasons. Our analysis uses all available data and excludes the part of the sample affected by the 11 month gap.

2.1.1. Commodity Markets

We work with the broadest set of commodities for which both futures and spot prices are available. Table 1 lists the 30 commodity futures that we use in our analysis, together with the exchange in which they are traded and the date of the first recorded observation.[2] We categorize the universe of commodities into four broad sectors. Agriculture consists of 14 commodities, and this sector tends to contain the oldest futures contracts. Energy consists of five commodities. Heating oil, which is available since November 1978, is the oldest futures contract in this sector. Crude oil is available only since March 1983. Livestock consists of five commodities, among which live cattle and pork bellies are available since December 1964. Metals consists of six commodities, among which copper and silver are available since December 1964.

Figure 1 shows the share of total dollar open interest that each sector represents. The figure shows that agriculture is the largest sector in the early part of the sample, while energy becomes the largest sector later in the sample. The relative size of the four sectors is much more balanced later in the sample. These stylized facts have two important implications for our empirical analysis. First, we construct the commodity portfolio as an equal-weighted portfolio of the four sectors, which ensures that the portfolio composition is consistent throughout the sample. Second, we have confirmed our main findings by sector and in sub-samples in analysis that is reported an earlier draft of this paper. The recent sub-sample is perhaps more indicative of what we can expect from commodity markets going

[2] A potential concern with using a broad set of commodities is that not all futures contracts are liquid. In analysis that is not reported here, we have confirmed our main findings on a subset of 17 relatively liquid futures contracts that are in the Dow Jones-AIG Commodities Index.

forward because it has a more balanced representation across the four sectors.

2.1.2. Currency, Bond, and Stock Markets

Our sample for currency, bond, and stock futures starts in December 1982 because the *Commitments of Traders in Commodity Futures* were not available between January and November 1982, and these futures markets were small prior to that date. Table 2 lists the 8 currency, 10 bond, and 14 stock futures that we use in our analysis, together with the exchange in which they are traded and the date of the first recorded observation.

The core set of currency futures for which we have data since December 1982 are the British pound, the Canadian dollar, the Deutsche mark, the Japanese yen, and the Swiss franc. The Australian dollar is available since January 1987, the New Zealand dollar since May 1997, and the Euro since May 1998. Unlike commodity markets, trading in currency markets takes place predominantly in over-the-counter forward and swap markets. This is a potential concern for measuring overall currency market activity because open interest in futures markets is a small share of activity that includes over-the-counter markets. Unfortunately, data on open interest in over-the-counter currency markets are not available at the frequency or sample length necessary for our analysis. Despite this problem, the growth rate of open interest in futures markets should be a good proxy for the overall growth rate of currency markets as long as futures markets and forward markets move (more or less) in proportion to one another. Insofar as open interest in futures markets is a noisy proxy for hedging and speculative activity in currency markets, this measurement problem would weaken the power of our statistical tests.

The universe of bond futures includes various fixed-income instruments that vary in maturity from 30-day federal funds to the 30-year Treasury bond. The oldest bond futures, available since December 1982, are those for the 3-month Eurodollar, the 3-month Treasury bill, the 10-year Treasury note, and the 30-year Treasury bond.

The universe of stock futures includes all major indices including the Dow Jones Industrial

Index, the Major Market Index, the NASDAQ 100 Index, the NYSE Composite Index, the Russell 2000 Index, the S&P 400 and 500 Indices, and the Value-Line Arithmetic Index. The oldest stock futures, available since December 1982, are those for the NYSE Composite Index and the S&P 500 Index.

2.2. Definition of Returns

In this paper, our measure of changes in commodity prices is the return on commodity futures. Similarly, our measure of changes in exchanges rates is the return on currency futures. We prefer using commodity futures prices, as opposed to spot prices, for two reasons. First, commodity futures data are arguably higher quality with fewer missing observations because they are actual transaction prices. Second, rates of return on commodity futures have a straightforward economic interpretation as an actual rate of return on an investment strategy. That being said, we have confirmed our main findings using commodity spot prices in analysis that is reported in an earlier draft of this paper.

2.2.1. Commodity Markets

To compute the return on a portfolio of commodity futures, we first compute the return on a fully collateralized position for each futures contract as follows. Let $F_{i,t,T}$ be the futures price for commodity i at the end of month t, for a futures contract that matures at the end of month T. Let $R_{f,t}$ be the monthly gross return on the 1-month T-bill in month t, which is assumed to be the interest earned on collateral. The monthly gross return on a fully collateralized long position in futures contract i with maturity $T - t$ is

$$R_{i,t,T} = \frac{F_{i,t,T} R_{f,t}}{F_{i,t-1,T}}. \tag{1}$$

We then sort the universe of commodity futures into four sectors and two levels of maturity. We define short-maturity contracts as those with more than one but no more than three months to maturity. We exclude futures contracts with one month or less to maturity, which are typically illiquid because futures traders do not want to take physical delivery of the underlying. Long-maturity contracts are those with more than three months to maturity. We then construct eight equal-weighted portfolios of commodity futures, corresponding to two levels of maturity for each of the four sectors. For each portfolio, we compute its monthly gross return as an equal-weighted average of returns on fully collateralized commodity futures. Finally, we construct an aggregate commodity portfolio as an equal-weighted portfolio of these eight portfolios. The commodity portfolio that results from this construction is consistently balanced with respect to sector and maturity.

In some of our analysis, we examine commodity returns separately by sector and maturity. Using the eight portfolios, we construct four sector portfolios as an equal-weighted portfolio of the short- and long-maturity portfolio for each sector. For example, the agriculture portfolio is an equal-weighted portfolio of the short- and long-maturity portfolios for agriculture. Using the eight portfolios, we also construct two maturity-sorted portfolios as an equal-weighted portfolio of the four sector portfolios for each level of maturity. For example, the short-maturity portfolio is an equal-weighted portfolio of the short-maturity portfolios for agriculture, energy, livestock, and metals. The advantage of our approach is that the sectors are always equal-weighted, and hence no sector dominates even as the number of commodities within each sector changes over time.

2.2.2. Currency, Bond, and Stock Markets

We define a long position on currency futures from the perspective of a U.S. investor that buys foreign currencies. Therefore, a high currency return refers to an appreciation of foreign currencies relative to the U.S. dollar. Our construction of the return on a portfolio of currency futures is analogous to our construction of the commodity-sector portfolios. We first compute the return on a fully collateralized position for each futures contract. We then sort the universe of currency futures into two levels of maturity. We define short-maturity contracts as those with no more than three months to maturity. We include futures contracts with one month or less to maturity since physical delivery of the underlying is not an issue for currency futures. Long-maturity contracts are those with more than three months to maturity. We then construct two equal-weighted portfolios of currency futures, corresponding to two levels of maturity. Finally, we construct an aggregate currency portfolio as equal-weighted portfolio of the short- and long-maturity portfolios.

For bond and stock markets, we simply use the usual benchmarks for returns, rather than computing these returns based on futures contracts. The bond return is the return on the 10-year U.S. Treasury note. The stock return is the return on the CRSP value-weighted portfolio of NYSE, AMEX, and Nasdaq stocks.

2.3. Definition of the Predictor Variables

2.3.1. Commodity Markets

Our new predictor variable for commodity prices is the growth rate of commodity market interest. To construct this variable, we first compute the dollar open interest for each commodity as the spot price times the number of futures contracts outstanding. We then aggregate dollar open interest within each of the four sectors and compute its monthly growth rate. Finally, we compute the aggregate growth rate of open interest as an equal-weighted average of the growth rate for each of the four sectors.[3] Because the monthly growth rate of open interest is noisy, we smooth it by taking a 12-month geometric average in the time series. To test for momentum in commodity returns, we also construct the 12-month geometric average of commodity returns.

To test the incremental forecasting power of commodity market interest, we consider a

[3]We have tried an alternative construction that uses only the number of futures contracts outstanding and does not involve the spot price. We first compute the growth rate of open interest (i.e., the number of futures contracts outstanding) for each commodity. We then compute the median of the growth rate of open interest across all commodities within each sector. Finally, we compute the aggregate growth rate of open interest as an equal-weighted average of the growth rate for each of the four sectors. This alternative construction leads to a time series that is very similar to our preferred construction of the aggregate growth rate of open interest.

number of other variables that are known to predict commodity returns. These other predictor variables can be grouped into two categories. The first category consists of aggregate market predictors, which are motivated by theories like (I)CAPM that view commodity markets as being fully integrated (Merton, 1973). We focus on the short rate and the yield spread in particular, which are known to predict the common variation in commodity, bond, and stock returns (Fama and Schwert, 1977; Campbell, 1987; Bessembinder and Chan, 1992).[4] The short rate is the monthly average yield on the 1-month T-bill. The yield spread is the difference between Moody's Aaa corporate bond yield and the short rate. In addition to these financial variables, we also consider the Chicago Fed National Activity Index as a measure of real economic activity, which is known to predict inflation (Stock and Watson, 1999).

The second category consists of commodity-specific predictors, which are motivated by the view that commodity markets are segmented to some degree. In particular, we consider two measures of supply-demand imbalances in commodity futures markets, motivated by the theory of backwardation (Keynes, 1923; Hicks, 1939). The first measure is commodity basis, which we construct in analogy to our construction of commodity returns. We first compute basis for each commodity i with maturity $T-t$ as

$$\text{Basis}_{i,t,T} = \left(\frac{F_{i,t,T}}{S_{i,t}}\right)^{\frac{1}{T-t}} - 1. \tag{2}$$

[5] We then compute the median of basis within each of eight portfolios, corresponding to four sectors and two levels of maturity. We use the median, instead of the mean, because

[4]In analysis that is not reported here, we have also examined the default spread (i.e., the difference between Moody's Baa and Aaa corporate bond yields) and measures of aggregate stock market volatility (i.e., both realized and implied volatility). Although these variables can predict returns individually, they have weak incremental forecasting power once we control for the short rate and the yield spread.

[5]While the Commodity Research Bureau has a reliable record of spot prices, a spot price is not always available on the same trading day as a recorded futures price. In instances where the spot price is missing, we first try to use an expiring futures contract to impute the spot price. If an expiring futures contract is not available, we then use the last available spot price within 30 days to compute basis. For example, if we have a futures price on December 31, but the last available spot price is from December 30, we compute basis as the ratio of the futures price on December 31 to the spot price on December 30.

it is less sensitive to outliers in basis for individual futures contracts. Finally, we compute commodity basis as an equal-weighted average of basis across the eight portfolios.

The second measure is an aggregate version of a more direct measure of supply-demand imbalances in commodity futures markets that is found in the literature (e.g., Chang, 1985). We first compute futures market imbalance for each sector as the ratio of two objects. The numerator is the dollar value of short minus long positions held by commercial traders in the *Commitments of Traders in Commodity Futures*, summed across all commodities in that sector. The denominator is the dollar value of short plus long positions held by commercial traders, summed across all commodities in that sector. We then compute commodity market imbalance as an equal-weighted average of the futures market imbalance across the four sectors.

2.3.2. Currency, Bond, and Stock Markets

For aggregate market predictors of currency, bond, and stock returns, we examine the short rate, the yield spread, and the Chicago Fed National Activity Index. For currency-specific predictors, we examine currency market interest, currency returns, currency basis, and currency market imbalance. For bond-specific predictors, we examine bond market interest, bond returns, and bond market imbalance. For stock-specific predictors, we examine stock market interest, stock returns, stock market imbalance, and the dividend yield on the CRSP value-weighted stock portfolio. The construction of these variables for currency, bond, and stock markets are analogous to our construction of the same variables for commodity markets.

3. Summary Statistics for Returns and Futures Market Interest

3.1. Summary Statistics for Returns

In Panel A of Table 3, we report summary statistics for monthly excess returns over the 1-month T-bill rate during the sample period of 1965 to 2008. The set of assets for which we have observations on returns in this sample period are the commodity portfolio, the 10-year U.S. Treasury note, and the CRSP value-weighted stock portfolio. The returns on the currency portfolio are only available since 1983.

Commodities have an average excess return of 0.58% and a standard deviation of 4.05%. This corresponds to an annualized average excess return of 6.96% and an annualized standard deviation of 14.03%. During the same sample period, bonds have an annualized average excess return of 2.04% and an annualized standard deviation of 8.00%, and stocks have an annualized average excess return of 4.32% and an annualized standard deviation of 15.66%. Thus, commodities had a higher realized Sharpe ratio than bonds or stocks. The first-order autocorrelation of monthly excess commodity returns is 0.08, which is virtually identical to that for bond and stock returns. The correlation between commodity and bond returns is -0.11. The sign of this correlation is unsurprising given the inverse relationship between bond prices and inflation. The correlation between commodity and stock returns is slightly positive at 0.07.

Panel B of Table 3 reports the same statistics for the sub-sample of 1983 to 2008, during which we also have observations on currency returns. Commodities have an annualized average excess return of 4.20% and an annualized standard deviation of 10.63%. During the same sample period, currencies have an annualized average excess return of 1.08% and an annualized standard deviation of 7.41%. Bonds have an annualized average excess return of 3.96% and an annualized standard deviation of 7.62%, and stocks have an annualized average excess return of 5.76% and an annualized standard deviation of 15.35%. The first-order autocorrelation for monthly excess returns is close to 0.1 for all four asset classes. All four returns are positively correlated with each other, except for the negative correlation of −0.15 between commodity and bond returns. Commodity and currency returns have the strongest correlation at 0.32.

3.2. Summary Statistics for the Predictor Variables

3.2.1. Commodity Markets

Table 4 reports summary statistics for the predictors of commodity returns for the sample period of 1965 to 2008. The short rate has a mean of 5.52% and a standard deviation of 2.71%. The yield spread has a mean of 2.64% and a standard deviation of 1.60%. The Chicago Fed National Activity Index has a mean of 0.05% and a standard deviation of 0.82%. The next two variables in the table, the 12-month change in commodity market interest and 12-month commodity returns, are our main variables of interest. Commodity market interest has a mean of 1.47% and a standard deviation of 2.06%, while commodity returns have a mean of 1.03% and a standard deviation of 1.24%. All five of these variables are persistent with a monthly autocorrelation of at least 0.90.

The correlation between the yield spread and the Chicago Fed National Activity Index is negative, which is consistent with the known fact that the yield spread is counter-cyclical. Both commodity market interest and commodity returns are positively correlated with the Chicago Fed National Activity Index, implying that they are pro-cyclical. To examine the pro-cyclicality of commodity market interest in closer detail, Figure 2 shows the time series of changes in commodity market interest together with the Chicago Fed National Activity Index. During the recent commodity boom, commodity market interest grew over a period of five years from $103 billion at the end of 2003 to $621 billion in June 2008. Only the energy crisis of the 1970s witnessed higher activity. During these two historic periods and also more generally, there is a high degree of correlation between changes in commodity market interest and the Chicago Fed National Activity Index.

Table 4 reports summary statistics for two additional predictors of commodity returns. The first is commodity basis, which has a mean of 0.07% and a standard deviation of 0.80%. The second is commodity market imbalance, which has a mean of 17.80% and a standard deviation of 13.80%. Commodity basis has a relatively low autocorrelation of 0.68, which implies that it operates at a higher frequency than the other predictor variables whose autocorrelations are at least 0.90. Commodity market interest is essentially uncorrelated with commodity basis. However, commodity market interest has a positive correlation of 0.31 with commodity market imbalance. This means that unusually high commodity market interest tends to coincide with hedgers taking unusually strong short positions in commodity futures.

3.2.2. Currency, Bond, and Stock Markets

Panel A of Table 5 reports summary statistics for the predictors of currency returns for the sample period of 1983 to 2008. The correlations between the predictors of currency returns are qualitatively similar to those between the predictors of commodity returns in Table 4. In particular, currency market interest has a positive correlation of 0.19 with the Chicago Fed National Activity Index, a positive correlation of 0.40 with currency returns, and a positive correlation of 0.25 with currency market imbalance.

Panel B of Table 5 reports summary statistics for the predictors of bond returns. On the one hand, bond market interest has a positive correlation of 0.27 with the Chicago Fed National Activity Index. That is, a strong economy is associated with rising bond market interest. On the other hand, bond returns have a negative correlation of -0.30 with the Chicago Fed National Activity Index. The sign of this correlation is consistent with the fact that a strong economy is associated with higher inflation, which is bad news for bonds.

Panel C of Table 5 reports summary statistics for the predictors of stock returns. Stock market interest has a positive correlation of 0.33 with the Chicago Fed National Activity Index and a positive correlation of 0.61 with stock returns. That is, a strong economy is associated with rising stock market interest and high stock returns.

To examine the pro-cyclicality of currency, bond, and stock market interest in closer detail, Figure 3 shows the time series of changes in open interest in each of these markets together with the Chicago Fed National Activity Index. In each of these markets, there is a high degree of correlation between changes in open interest and the Chicago Fed National Activity Index. Having established that open interest is related to economic activity, we next turn to testing whether changes in open interest predict asset-price fluctuations.

4. Predictability of Returns by Futures Market Interest

4.1. Commodity Market Interest

Figure 4 shows the time series of 12-month changes in commodity market interest and 12-month commodity returns. This figure confirms that these two time series are highly correlated. More interestingly, this figure reveals that commodity returns look like a version of changes in commodity interest that is shifted forward by a few months. In other words, changes in commodity market interest lead changes in commodity prices in the same direction. This is not only a new finding for commodity markets, but as discussed below, this finding ties more generally to the empirical literature on gradual information diffusion.

In Table 6, we formally test the hypothesis that changes in commodity market interest predict commodity returns. In column (1), we first estimate a benchmark specification in which the predictor variables are the short rate, the yield spread, and commodity basis. This benchmark allows us to measure the incremental forecasting power of commodity market interest, which is our key variable of interest. All coefficients are standardized so that they can be interpreted as the percentage point change in monthly expected returns per one standard deviation change in the predictor variable.

The short rate enters with a coefficient of -0.48 and a t-statistic of -2.40. A more interesting finding is that the yield spread predicts commodity returns with a coefficient of -0.45 and a t-statistic of -2.37. This means that a standard deviation increase in the yield spread decreases expected commodity returns by 0.45% per month. The fact that the yield spread predicts commodities with a negative coefficient is in sharp contrast to the positive coefficient found for bonds and stocks (Campbell, 1987; Fama and French, 1989). The conventional interpretation for bond and stock markets is that when the yield spread is high (typically in recessions), the risk premia for all risky assets are high (due to risk aversion or fundamental risk). Since expected commodity returns are low (i.e., commodity prices are high) when the yield spread is high, commodities are a good hedge for time-varying investment opportunities in bond and stock markets.

Commodity basis predicts commodity returns with a coefficient of -0.49 and a t-statistic of -2.31. This means that a standard deviation increase in commodity basis decreases expected commodity returns by 0.49% per month. The fact that low commodity basis (i.e., low futures relative to spot price) predicts high returns on being long commodity futures is consistent with the theory of backwardation. Overall, the R^2 of the forecasting regression is 2.78%. While the specification in column (1) follows earlier work and is not our main focus, we obtain much stronger results than previously reported. The primary reasons are that we have a longer sample period and that we use of a broader cross section of commodities in constructing commodity basis.

In column (2) of Table 6, we introduce changes in commodity market interest to examine its incremental forecasting power for commodity returns. Commodity market interest enters with a coefficient of 0.63 and a t-statistic of 2.60. This means that a standard deviation increase in commodity market interest increases expected commodity returns by 0.63% per month. The coefficients for the other three predictor variables are virtually unchanged from column (1) because commodity market interest is essentially uncorrelated with these other variables. In this sample period, commodity market interest explains a larger share of the variation in expected commodity returns than the other predictor variables. Moreover, the inclusion of commodity market interest increases the R^2 of the forecasting regression from 2.78% to 5.19%.

In column (3) of Table 6, we introduce past commodity returns to the benchmark specification and find that they enter with a coefficient of 0.42 and a t-statistic of 1.90. This means that a standard deviation increase in past commodity returns increases expected commodity returns by 0.42% per month, which is comparable in economic magnitude to the 0.63% found for commodity market interest. The fact that past commodity returns predict future commodity returns can be summarized as momentum in the time series of commodity returns. In column (4), we find that commodity market interest drives out the forecasting power of past commodity returns in a horse race between these two variables. Commodity market interest enters with a coefficient of 0.57 and a t-statistic of 1.79, while past commodity returns enter with a statistically insignificant coefficient of 0.13. On the one hand, this result shows that the forecasting power of commodity market interest is closely related to momentum in commodity returns. On the other hand, while commodity market interest and commodity returns are highly correlated, they contain different information about future commodity returns. As revealed by Figure 5, commodity market interest tends to lead commodity returns and can therefore be more informative.

In column (5) of Table 6, we introduce commodity market imbalance to the benchmark specification and find that it enters with a coefficient of 0.29 and a t-statistic of 1.50. The sign of this coefficient is consistent with the theory of backwardation, which implies that high hedging demand should predict high returns being long commodity futures. In column (6), we find that commodity market interest drives out the forecasting power of commodity market imbalance in a horse race between these two variables. Commodity market interest enters with a coefficient of 0.59 and a t-statistic of 2.43, while commodity market imbalance enters with a statistically insignificant coefficient of 0.11. As reported in Table 4, commodity market interest and commodity market imbalance are positively correlated. Hence, a potential interpretation of these results is that commodity market imbalance is just a noisy proxy for commodity market interest.

In column (7) of Table 6, we introduce the Chicago Fed National Activity Index to the benchmark specification and find that it enters with a coefficient of 0.53 and a t-statistic of 2.47. The sign of this coefficient is additional evidence that expected commodity returns are pro-cyclical, which is the opposite of counter-cyclical expected returns found in bond and stock markets. In column (8), we find that commodity market interest reduces the forecasting power of the Chicago Fed National Activity Index in a horse race between these two variables. Commodity market interest enters with a coefficient of 0.55 and a t-statistic of 1.97, while the Chicago Fed National Activity Index enters with a statistically insignificant coefficient of 0.42.

We summarize our main findings in Tables 6 as follows. The fact that the short rate, the yield spread, and the Chicago Fed National Activity Index predict changes in commodity prices is consistent with the integrated markets view. That is, the same aggregate factors that drive other financial markets are partly responsible for commodity-price fluctuations. The fact that commodity basis and commodity market imbalance predict changes in commodity prices is consistent with the segmented markets view. That is, the theory of backwardation is partly responsible for commodity-price fluctuations. More importantly, changes in commodity market interest predict changes in commodity prices even after controlling for these other variables. This finding challenges us to develop a new view of commodity markets that is unrelated to these traditional theories. Our preferred hypothesis is that commodity market interest contains information about the future supply and demand for commodities, which is not entirely impounded in commodity prices. The key facts supporting this hypothesis are that changes in commodity market interest are contemporaneously correlated with changes in commodity prices and the Chicago Fed National Activity Index, and that all three variables predict future changes in commodity prices. In Section 5, we show how these facts fit together in a simple model of futures pricing with gradual information diffusion.

We now present further evidence that commodity market interest contains information about macroeconomic activity, or inflation in particular, that gets priced into financial markets with delay. In Panel A of Table 7, we predict excess returns on the 10-year U.S. Treasury note over the 1-month T-bill rate. In a benchmark specification in column (1), the short rate enters with a statistically insignificant coefficient of 0.20. The yield spread enters with a coefficient of 0.49 and a t-statistic of 3.41. In column (2), we introduce commodity market interest to the benchmark specification and find that it enters with a coefficient of -0.32 and a t-statistic of -3.14. This means that a standard deviation increase in commodity market interest decreases expected bond returns by 0.32% per month. The forecasting power of commodity market interest is comparable to that of the yield spread, which is known to be a strong predictor of bond returns. Column (3) shows that commodity returns predict bond returns by itself, but column (4) shows that they do not have forecasting power beyond commodity market interest. Similarly, column (5) shows that the Chicago Fed National Activity Index predicts bond returns by itself, but column (6) shows that it does not have forecasting power beyond commodity market interest.

In Panel B of Table 7, we predict changes in the 1-month T-bill rate. By the Fisher hypothesis, changes in the short rate can be interpreted as changes in expected monthly inflation if the real rate were constant. In a benchmark specification in column (1), the yield spread enters with a statistically insignificant coefficient of 0.06. In column (2), we introduce commodity market interest to the benchmark specification and find that it enters with a coefficient of 0.12 and a t-statistic of 3.28. This means that a standard deviation increase in commodity market interest increases the expected annualized short rate by 0.12%. Column (3) shows that commodity returns also predict changes in the short rate with a coefficient of 0.13 and a t-statistic of 3.53. In a horse race between commodity market interest and commodity returns, column (4) shows that both variables enter with a coefficient of 0.08 and that commodity market interest remains marginally significant. Column (5) shows that the Chicago Fed National Activity Index predicts changes in the short rate, which is consistent with its ability to predict realized inflation (Stock and Watson, 1999). Column (6) shows that the Chicago Fed National Activity Index does not drive out the forecasting power of commodity market interest.

To summarize, Table 7 shows that commodity market interest has incremental forecasting power for bond returns and changes in the short rate beyond conventional predictors of inflation like commodity prices and the Chicago Fed National Activity Index. This evidence lends further support to the hypothesis that commodity market interest contains information about macroeconomic activity and inflation expectations that gets priced into commodity and bond markets with delay. Our findings here have a broader implication that the power of existing forecasting models of inflations expectations and bond prices may be improved by incorporating information contained in commodity market interest.

4.2. Currency Market Interest

The previous section showed that commodity market interest predicts commodity-price fluctuations. This section documents an analogous relation between currency market interest and exchange-rate fluctuations. The economic rationale for why currency market interest predicts exchange-rate fluctuations is analogous to our hypothesis for commodity markets. A strong U.S. economy leads to inflation and consequently depreciation of the U.S. dollar relative to foreign currencies.[6] Suppose importers expect high future demand, and in response, enter currency futures markets to hedge risk arising from high anticipated imports. Insofar as this good news about the U.S. economy diffuses gradually in currency markets, rising open interest predicts high returns on being long foreign currencies. In Section 5, we develop a simple model of futures pricing with gradual information diffusion to formalize this relation between open interest and returns in futures markets.

[6]More formally, a positive U.S. productivity shock leads to depreciation of the U.S. dollar relative to foreign currencies in a standard Ricardian model of bilateral trade (Backus, Kehoe, and Kydland, 1994). The intuition for this result is that a positive U.S. productivity shock makes goods produced by the U.S. relatively abundant, so that the price of these goods must fall relative to the price of goods produced by foreign countries.

Table 8 tests whether changes in currency market interest predict currency returns. In column (1), we first estimate a benchmark specification in which the predictor variables are the short rate, the yield spread, and currency basis (i.e., the forward discount). The short rate and the yield spread have little forecasting power for currency returns. However, currency basis predicts currency returns with a coefficient of -0.24 and a t-statistic of -1.44. This means that a standard deviation increase in currency basis decreases expected currency returns by 0.24% per month. By the covered interest-rate parity, currency basis is the difference in interest rates between the U.S. and foreign countries. Therefore, the negative coefficient means that when the U.S. interest rate is low relative to the rest of the world, foreign currencies are expected to appreciate relative to the U.S. dollar. This failure of the uncovered interest-rate parity is the so-called "forward-discount puzzle" in international finance.

In column (2) of Table 8, we introduce changes in currency market interest to examine its incremental forecasting power for currency returns. Currency market interest enters with a coefficient of 0.35 and a t-statistic of 2.53. This means that a standard deviation increase in currency market interest increases expected currency returns by 0.35% per month. Figure 5 is a visual representation of this regression result. Throughout the sample period, changes in currency market interest tend to lead changes in currency returns, except perhaps for a period in the 1990s. The coefficient for currency market interest is larger in economic magnitude than that for currency basis. Moreover, the inclusion of currency market interest increases the R^2 of the forecasting regression from 2.01% to 4.59%. These finding suggests that currency market interest is a more important determinant of exchange rates than currency basis.

In column (3) of Table 8, we introduce past currency returns to the benchmark specification and find that they enter with a coefficient of 0.25 and a t-statistic of 1.56. In other words, there is some evidence for momentum in the time series currency returns, but one that is weaker than that for commodity returns. In column (4), we find that currency market interest weakens the forecasting power of currency returns in a horse race between these two variables. Currency market interest enters with a coefficient of 0.30 and a t-statistic of 2.18, while currency returns enter with a statistically insignificant coefficient of 0.12.

In column (5) of Table 8, we introduce currency market imbalance to the benchmark specification and find that it enters with a coefficient of 0.23 and a t-statistic of 1.97. The sign of this coefficient is consistent with the theory of backwardation, which implies that high hedging demand should predict high returns on being long futures. In column (6), we find that currency market interest drives out the forecasting power of currency market imbalance in a horse race between these two variables. Currency market interest enters with a coefficient of 0.31 and a t-statistic of 2.29, while currency market imbalance enters with a statistically insignificant coefficient of 0.14.

In column (7) of Table 8, we introduce the Chicago Fed National Activity Index to the benchmark specification and find that it enters with a coefficient of 0.30 and a t-statistic of 1.35. The sign of this coefficient is consistent with the hypothesis that a strong U.S. economy leads to inflation and consequently depreciation of the U.S. dollar relative to foreign currencies. In column (8), we find that currency market interest drives out the forecasting power of the Chicago Fed National Activity Index in a horse race between these two variables. Currency market interest enters with a coefficient of 0.31 and a t-statistic of 2.29, while the Chicago Fed National Activity Index enters with a statistically insignificant coefficient of 0.22.

4.3. Bond Market Interest

Table 9 tests whether changes in bond market interest predict bond returns. In column (1), we first estimate a benchmark specification in which the predictor variables are the short rate and the yield spread. The short rate enters with a statistically insignificant coefficient of 0.20. However, the yield spread is a powerful predictor of bond returns with a coefficient of 0.34 and a t-statistic of 2.39.

In column (2) of Table 9, we introduce bond market interest and find that it enters with a coefficient of -0.31 and a t-statistic of -1.91. This means that a standard deviation increase in bond market interest decreases expected bond returns by 0.31% per month. To make sense of the sign of this coefficient, recall from Table 5 that bond market interest is positively correlated with the Chicago Fed National Activity Index. A high Chicago Fed National Activity Index signals inflation, which is bad news for bonds.

In columns (3) and (4) of Table 9, we find that past bond returns do not have forecasting power for future bond returns. Similarly, in columns (5) and (6), we find that bond market imbalance does not have forecasting power for bond returns. In column (7), we introduce the Chicago Fed National Activity Index to the benchmark specification and find that it enters with a coefficient of -0.33 and a t-statistic of -2.03. In column (8), we find that the Chicago Fed National Activity Index slightly weakens the forecasting power of bond market interest in a horse race between these two variables. Given that bond market interest and the Chicago Fed National Activity Index both signal inflation, these results are consistent with our hypothesis.

4.4. Stock Market Interest

Table 10 tests whether changes in stock market interest predict stock returns. Column (1) is our benchmark specification in which the predictor variables are the short rate, the yield spread, and the dividend yield. None of these variables, which are known to predict stock returns, are statistically significant in our sample period of 1984 to 2008. This is perhaps not surprising given that stock returns are notoriously difficult to predict, especially in a short sample period that includes the unusual stock market behavior in the late 1990s. Hence, the results that follow for stock market interest should be interpreted with this caveat in mind.

In column (2) of Table 10, we introduce stock market interest to our benchmark specification and find that it enters with a coefficient of 0.38 and a t-statistic of 1.38. This means that a standard deviation increase in stock market interest increases expected stock returns by 0.38% per month. Although this coefficient is not statistically significant in this sample period, the economic magnitude of the coefficient is comparable to that for the short rate, the yield spread, and the dividend yield.

In columns (3) and (4) of Table 10, we find that past stock returns do not have forecasting power for future stock returns. In column (5), we introduce stock market imbalance to our benchmark specification and find that it enters with a coefficient of -0.45 and a t-statistic of -1.79. In column (6), we find that stock market interest enters with a coefficient of 0.50 and a t-statistic of 1.76 in a specification that controls for stock market imbalance. In column (7), we introduce the Chicago Fed National Activity Index to our benchmark specification and find that it enters with a coefficient of 0.73 and a t-statistic of 2.03. In column (8), we find that the Chicago Fed National Activity Index weakens the forecasting power of stock market interest in a horse race between these two variables.

Overall, our findings for currency, bond, and stock markets mirror those for commodity markets. The key finding in each market is that open interest is an important predictor of returns, even after controlling for a number of conventional predictors. In the next section, we turn to explaining this robust relation between open interest and returns in futures markets.

5. A Model in which Futures Market Interest Predicts Returns

We now develop a simple model of futures pricing that explains why open interest can be a better predictor of asset-price fluctuations than past asset prices or the direction of the futures market imbalance between hedgers and speculators. The two key assumptions of our model are delayed reaction to news by some market participants and a downward-sloping demand curve that arises from limited risk-bearing capacity. As discussed in the introduction, there is now a large literature that documents evidence for gradual information diffusion as well as downward-sloping demand curves in financial markets. For expositional purposes, the underlying asset in our model is a commodity. The economics of the model would be the same if the underlying asset were a currency, bond, or stock as long as there is hedging demand that arises from economic expansion.

5.1. Economic Environment

There are three periods indexed as $t = 0, 1, 2$. The riskless interest rate is constant and normalized to zero. There is a spot market for a commodity in period 2, and there is a futures contract on the same commodity that is traded in periods 0 and 1. Let S_2 denote the spot price of the commodity in period 2. We assume that the spot price is exogenous and stochastic, and that there is elastic demand at the realized spot price in period 2. In period 1, the economy can be in one of two states, which we call "up" and "down". In the up state, the spot price in period 2 is distributed as $S_2 \sim \mathbf{N}(S^U, \sigma^2)$. In the down state, the spot price in period 2 is distributed as $S_2 \sim \mathbf{N}(S^D, \sigma^2)$. There is relatively high demand for the commodity in the up state so that $S^U > S^D$. As of period 0, the probability that the economy will be in the up state in period 1 is $\pi = 0.5$. Note that

$$\mathbf{E}_0[S_2] = \pi S^U + (1 - \pi) S^D = \bar{S}, \tag{3}$$

$$\mathrm{Var}_0(S_2) = \sigma^2 + \pi S^{U2} + (1 - \pi) S^{D2} - \bar{S}^2. \tag{4}$$

In period 1, there are producers that commit to production of the commodity for delivery in period 2. Alternatively, there are producers that commit to use the commodity as an input for production in period 2. The producers know the state of the economy in period 1 (i.e., whether it is up or down), but they still face uncertainty about the spot price in period 2 (captured by σ^2). Let Y^U denote the quantity of the commodity that the producers commit to producing (or buying) in the up state. Let Y^D denote the quantity of the commodity that the producers commit to producing (or buying) in the down state. In each state, $Y > 0$ if the commodity is an output for the producers, and $Y < 0$ if the commodity is an input. We make a natural assumption that there is relatively more demand for the commodity in the up state so that $|Y^U| > |Y^D|$. We normalize $Y^D = 0$ to simplify notation.

The producers are infinitely risk averse and would like to hedge all uncertainty about the spot price. They can do so by entering the futures market in period 1. Let F_t denote the futures price in period t on a futures contract that matures in period 2. The producers choose the optimal futures position D_1^p to minimize the variance of their total profit from production and hedging activity:

$$\min_{D_1^p} \mathrm{Var}_1(S_2 Y + (S_2 - F_1) D_1^p). \tag{5}$$

The producers can perfectly hedge all uncertainty by choosing $D_1^p = -Y$. Note that the producers go short futures if the commodity is an output, and they go long futures if the commodity is an input. The producers are active in the futures market only in the up state since $D_1^p = -Y^D = 0$ in the down state. Otherwise, the producers do not participate in the futures market.

In addition to the producers, there are two groups of investors in the futures market. The first group consists of "active" one-period investors, who have mass $\lambda \in (0, 1)$ in the population of investors. They have the usual mean-variance objective function with risk-aversion parameter γ. These investors are active in the sense that they are fully aware of the probability distribution for S_2 at each point in time. In particular, they know the state of the economy in period 1. The active investors choose the optimal futures position D_t^a in periods $t = 0, 1$ to maximize their objective function. Their optimal futures position is given by the usual mean-variance demand function:

$$D_t^a = \frac{\mathbf{E}_t[F_{t+1} - F_t]}{\gamma \mathrm{Var}_t(F_{t+1} - F_t)}. \tag{6}$$

The second group consists of "inactive" one-period investors, who have mass $1 - \lambda$ in the population of investors. They also have a mean-variance objective function with risk-aversion parameter γ. The key modeling assumption is that these inactive investors under-react to news about the state of the economy. Specifically, they are not aware of the state of the economy in period 1, so that their subjective distribution of S_2 in period 1 is the same as their prior about S_2 in period 0. The inactive investors choose the optimal futures position D_t^i in periods $t = 0, 1$ to maximize their objective function. Their optimal futures position is given by the mean-variance demand function:

$$D_t^i = \frac{\bar{S} - F_t}{\gamma \mathrm{Var}_0(S_2)}. \tag{7}$$

5.2. Equilibrium Futures Prices

We now solve for the equilibrium futures price in period 1. The market clearing condition in period 1 is

$$\lambda D_1^a + (1-\lambda) D_1^i + D_1^p = 0. \tag{8}$$

Substituting the demand functions, the futures price in the up state is

$$F_1^U = \omega_1 S^U + (1-\omega_1)\bar{S} - \frac{\omega_1 \gamma \sigma^2 Y^U}{\lambda}, \tag{9}$$

where

$$\omega_1 = \frac{\lambda \mathrm{Var}_0(S_2)}{\lambda \mathrm{Var}_0(S_2) + (1-\lambda)\sigma^2}. \tag{10}$$

The futures price in the down state is

$$F_1^D = \omega_1 S^D + (1-\omega_1)\bar{S}. \tag{11}$$

We now work backwards to solve for the equilibrium futures price in period 0. The market clearing condition in period 0 is

$$\lambda D_0^a + (1-\lambda) D_0^i = 0. \tag{12}$$

Substituting the demand functions, the futures price is

$$F_0 = \omega_0 \left(\bar{S} - \frac{\pi \omega_1 \gamma \sigma^2 Y^U}{\lambda} \right) + (1-\omega_0)\bar{S}, \tag{13}$$

where

$$\omega_0 = \frac{\lambda \mathrm{Var}_0(S_2)}{\lambda \mathrm{Var}_0(S_2) + (1-\lambda)\mathrm{Var}_0(F_1)}. \tag{14}$$

We now make two key observations about the model. The first observation is that the futures price in the up state is higher than that in the down state if hedging demand is sufficiently low. More formally, $F_1^U > F_1^D$ if

$$Y_U < \frac{\lambda(S^U - S^D)}{\gamma \sigma^2}. \tag{15}$$

The intuition for this result is straightforward. In the up state, good news about the economy leads to a high futures price in the absence of hedging demand by the producers. In the presence of hedging demand, however, the producers put a downward pressure on the futures price when $Y^U > 0$. Because the investors have limited risk-bearing capacity (captured by $\gamma\sigma^2$), hedging demand can completely offset the impact of good news, leading to a low futures price.

The second observation is that open interest in the up state is always higher than that in the down state due to hedging demand by the producers. In the up state, the active investors are the only ones to go long futures if $Y^U > 0$, while both the active investors and the producers go long futures if $Y^U < 0$. Therefore, open interest in the up state is

$$O_1^U = \begin{cases} \lambda D_1^a = \frac{\lambda(1-\omega_1)(S^U-\bar{S})}{\gamma\sigma^2} + \omega_1 Y^U & \text{if } Y^U > 0 \\ \lambda D_1^a + D_1^p = \frac{\lambda(1-\omega_1)(S^U-\bar{S})}{\gamma\sigma^2} - (1-\omega_1)Y^U & \text{if } Y^U < 0 \end{cases}. \tag{16}$$

In the down state, the inactive investors are the only ones to go long futures. Therefore, open interest in the down state is

$$O_1^D = (1-\lambda)D_1^i = \frac{\lambda(1-\omega_1)(\bar{S}-S^D)}{\gamma\sigma^2}. \tag{17}$$

Note that $O_1^U > O_1^D$ since $S^U - \bar{S} = \bar{S} - S^D$ (implied by $\pi = 0.5$). Importantly, this is true regardless of the direction of hedging demand (i.e., whether $Y^U > 0$ or $Y^U < 0$).

Define the return on going long futures from period 0 to 1 as $R_1 = F_1 - F_0$. Similarly, define the return on going long futures from period 1 to 2 as $R_2 = S_2 - F_1$. The expected return on futures from period 1 to 2 is

$$\mathbf{E}_1[R_2] = \begin{cases} (1-\omega_1)(S^U - \bar{S}) + \frac{\omega_1\gamma\sigma^2 Y^U}{\lambda} & \text{in the up state} \\ -(1-\omega_1)(\bar{S} - S^D) & \text{in the down state} \end{cases}. \tag{18}$$

The expected return is higher in the up state than in the down state if

$$Y_U > \frac{-\lambda(1-\omega_1)(S^U - S^D)}{\omega_1\gamma\sigma^2}. \tag{19}$$

Note that this condition is trivially satisfied when $Y_U > 0$ (i.e., the commodity is an output for the producers). In what follows, we assume that this condition is satisfied, which is the empirically relevant case. We are now ready to state our main result.

Proposition 1. *If $Y_U < \lambda(S^U - S^D)/(\gamma\sigma^2)$, high return R_1 signals high expected return $\mathbf{E}_1[R_2]$. Otherwise, high return signals low expected return. High change in open interest $O_1 - O_0$ always signals high expected return, regardless of the direction of hedging demand* *(i.e., whether* $Y^U > 0$ *or* $Y^U < 0$*).*

When hedging demand is sufficiently low or negative, a high return signals good news about the economy. Therefore, we would observe positive serial correlation in returns due to under-reaction by the inactive investors. When hedging demand is sufficiently high, however, the return can be low in response to good news about the economy. Consequently, past returns are not a reliable signal of future returns because the sign of the serial correlation depends on the importance of hedging demand. In contrast, high open interest unambiguously signals good news about the economy and therefore high expected returns. Interestingly, the direction of hedging demand does not matter, that is, whether producers go long or short futures to hedge the economic expansion. Our model is therefore distinct from traditional theories of futures market in which the direction of hedging demand matters for expected returns (Keynes, 1923; Hicks, 1939).

6. Conclusion

This paper showed that open interest in futures markets is highly pro-cyclical and predicts asset prices in different financial markets, even after controlling for conventional predictors that include past prices. Most notably, commodity market interest is a more powerful predictor of commodity prices than past prices, and currency market interest is a more powerful predictor of exchange rates than the forward discount. These findings are entirely new and surprising since one might have expected that open interest is a non-directional variable that is uncorrelated with macroeconomic activity, inflation, and asset prices. We offer a simple explanation for the empirical findings based on gradual information diffusion and downward-sloping demand curves in financial markets.

Commodity prices are very volatile and arguably the least predictable component of the consumer price index. Therefore, our findings on the predictability of commodity prices have broader implications for the large macro literature on inflation forecasting. Macroeconomists have already known for some time that asset prices can be useful for forecasting (Stock and Watson, 2003). These forecasting models generally assume that asset prices contain timely information about macroeconomic activity and inflation expectations. However, our findings suggest that asset prices initially under-react to news about macroeconomic activity and inflation expectations, which are better captured by commodity market interest. Our work suggests a new approach to inflation forecasting, in which commodity market interest may be fruitfully used to improve forecasting power of existing models.

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Table 1: Commodity Market Futures

This table lists the 30 commodity futures included in our analysis, for which futures and spot prices are available through the Commodity Research Bureau. The futures contracts are traded on the Chicago Board of Trade (CBOT), the Chicago Mercantile Exchange (CME), the Intercontinental Exchange (ICE), and the New York Mercantile Exchange (NYMEX). The sample starts in December 1964, after which prices are available for many commodities.

Sector	Commodity	Exchange	First Observation	
			Futures Price	*Commitments of Traders*
Agriculture	Butter	CME	September 1996	May 1997
	Cocoa	ICE	December 1964	July 1978
	Coffee	ICE	August 1972	July 1978
	Corn	CBOT	December 1964	December 1964
	Cotton	ICE	December 1964	December 1964
	Lumber	CME	March 1970	July 1978
	Oats	CBOT	December 1964	December 1964
	Orange juice	ICE	May 1967	January 1969
	Rough rice	CBOT	August 1986	October 1986
	Soybean meal	CBOT	December 1964	December 1964
	Soybean oil	CBOT	December 1964	December 1964
	Soybeans	CBOT	December 1964	December 1964
	Sugar	ICE	December 1964	July 1978
	Wheat	CBOT	December 1964	December 1964
Energy	Crude oil	NYMEX	March 1983	April 1983
	Gasoline	NYMEX	December 1984	December 1984
	Heating oil	NYMEX	November 1978	October 1980
	Natural gas	NYMEX	April 1990	April 1990
	Propane	NYMEX	August 1987	August 1987
Livestock	Broilers	CME	February 1991	March 1991
	Feeder cattle	CME	March 1972	December 1975
	Lean hogs	CME	February 1966	July 1968
	Live cattle	CME	December 1964	July 1968
	Pork bellies	CME	December 1964	July 1968
Metals	Aluminum	NYMEX	December 1983	January 1984
	Copper	NYMEX	December 1964	December 1982
	Gold	NYMEX	December 1974	December 1982
	Palladium	NYMEX	January 1977	July 1978
	Platinum	NYMEX	March 1968	July 1978
	Silver	NYMEX	December 1964	December 1982

Table 2: Currency, Bond, and Stock Market Futures

This table lists the 8 currency, 10 bond, and 14 stock futures included in our analysis, for which futures and spot prices are available through the Commodity Research Bureau. The futures contracts are traded on the Chicago Board of Trade (CBOT), the Index and Option Market (IOM), the Intercontinental Exchange (ICE), the International Monetary Market (IMM), and the Kansas City Board of Trade (KCBT). The sample starts in December 1982 because the *Commitments of Traders in Commodity Futures* were not available between January and November 1982, and these futures markets were small prior to that date.

Market	Instrument	Exchange	First Observation	
			Futures Price	*Commitments of Traders*
Currency	Australian dollar	IMM	January 1987	January 1987
	British pound	IMM	December 1982	December 1982
	Canadian dollar	IMM	December 1982	December 1982
	Deutsche mark	IMM	December 1982	December 1982
	Euro	IMM	May 1998	January 1999
	Japanese yen	IMM	December 1982	December 1982
	New Zealand dollar	IMM	May 1997	January 1999
	Swiss franc	IMM	December 1982	December 1982
Bond	30-day federal funds	CBOT	October 1988	October 1988
	1-month Eurodollar	IMM	May 1990	May 1990
	3-month Eurodollar	IMM	December 1982	December 1982
	3-month U.S. Treasury bill	IMM	December 1982	December 1982
	2-year U.S. Treasury note	CBOT	June 1990	June 1990
	5-year U.S. Treasury note	CBOT	May 1988	May 1988
	5-year U.S. Treasury note swap	CBOT	June 2002	February 2003
	10-year U.S. Treasury note	CBOT	December 1982	December 1982
	10-year U.S. Treasury note swap	CBOT	October 2001	November 2001
	30-year U.S. Treasury bond	CBOT	December 1982	December 1982
Stock	Dow Jones Industrial Index	CBOT	October 1997	October 1997
	Major Market Index	IOM	August 1985	October 1991
	NASDAQ 100 Index	IOM	April 1996	April 1996
	NASDAQ 100 Index E-Mini	IOM	June 1999	June 1999
	NYSE Composite Index	ICE	December 1982	December 1982
	Russell 2000 Index	IOM	February 1993	February 1993
	Russell 2000 Index E-Mini	IOM	November 2001	August 2002
	S&P 400 MidCap Index	IOM	February 1992	February 1992
	S&P 400 MidCap Index E-Mini	IOM	January 2002	November 2002
	S&P 500 Barra Value Index	IOM	November 1995	April 1996
	S&P 500 Barra Growth Index	IOM	November 1995	December 1995
	S&P 500 Index	IOM	April 1982	October 1983
	S&P 500 Index E-Mini	IOM	September 1997	September 1997
	Value-Line Arithmetic Index	KCBT	August 1983	October 1983

Table 3: Summary Statistics for Commodity, Currency, Bond, and Stock Returns

This table reports the mean, the standard deviation, the autocorrelation, and the pairwise correlation of monthly excess returns over the 1-month T-bill rate. The portfolio of fully collateralized commodity futures is equal-weighted across agriculture, energy, livestock, and metals. The portfolio of fully collateralized currency futures is equal-weighted across the 8 currencies listed in Table 2. The other assets are the 10-year U.S. Treasury note and the CRSP value-weighted stock portfolio.

Variable	Mean (%)	Standard Deviation (%)	Auto-correlation	Correlation with		
				Commodity Portfolio	Currency Portfolio	10-Year Bond
Panel A: 1965:1–2008:12						
Commodity portfolio	0.58	4.05	0.08			
10-year bond	0.17	2.31	0.08	-0.11		
Stock portfolio	0.36	4.52	0.09	0.07		0.18
Panel B: 1983:1–2008:12						
Commodity portfolio	0.35	3.07	0.13			
Currency portfolio	0.09	2.14	0.12	0.32		
10-year bond	0.33	2.20	0.07	-0.15	0.17	
Stock portfolio	0.48	4.43	0.10	0.14	0.09	0.06

Table 4: Summary Statistics for Predictors of Commodity Returns

This table reports the mean, the standard deviation, the autocorrelation, and the pairwise correlation for predictors of commodity returns. The short rate is the monthly average yield on the 1-month T-bill. The yield spread is the difference between Moody's Aaa corporate bond yield and the short rate. The Chicago Fed National Activity Index is a weighted average of 85 monthly indicators of U.S. economic activity. The next predictor variables are the 12-month geometric average of the growth rate of commodity market interest and the 12-month geometric average of commodity returns. Commodity market imbalance is the ratio of short minus long positions relative to short plus long positions held by commercial traders in the *Commitments of Traders in Commodity Futures*. Commodity basis is equal-weighted across agriculture, energy, livestock, and metals. The sample period is 1965:12–2008:12.

Variable	Mean (%)	Standard Deviation (%)	Auto-correlation	Correlation with					
				Short Rate	Yield Spread	Chicago Fed Index	Commodity Market Interest	Commodity Returns	Commodity Basis
Short rate	5.52	2.71	0.97						
Yield spread	2.64	1.60	0.92	-0.54					
Chicago Fed Index	0.05	0.82	0.93	0.00	-0.13				
Commodity market interest	1.47	2.06	0.90	0.02	-0.11	0.35			
Commodity returns	1.03	1.24	0.94	0.07	-0.37	0.27	0.50		
Commodity basis	0.07	0.80	0.68	0.21	-0.17	-0.05	-0.06	0.06	
Commodity market imbalance	17.80	13.80	0.90	0.27	-0.32	0.18	0.31	0.44	0.13

Table 5: Summary Statistics for Predictors of Currency, Bond, and Stock Returns

Panel A reports the mean, the standard deviation, the autocorrelation, and the pairwise correlation for predictors of currency returns. The short rate is the monthly average yield on the 1-month T-bill. The yield spread is the difference between Moody's Aaa corporate bond yield and the short rate. The Chicago Fed National Activity Index is a weighted average of 85 monthly indicators of U.S. economic activity. The next predictor variables are the 12-month geometric average of the growth rate of currency market interest and the 12-month geometric average of currency returns. Currency market imbalance is the ratio of short minus long positions relative to short plus long positions held by commercial traders in the *Commitments of Traders in Commodity Futures*. Currency basis is equal-weighted across the 8 currencies listed in Table 2. Panels B and C report summary statistics for analogous predictor variables in bond and stock markets. The sample period is 1983:12–2008:12.

Variable	Mean (%)	Standard Deviation (%)	Auto-correlation	Correlation with					
				Short Rate	Yield Spread	Chicago Fed Index	Market Interest	Returns	Basis
Panel A: Currency Market									
Short rate	4.58	2.14	0.98						
Yield spread	3.16	1.35	0.94	-0.48					
Chicago Fed Index	0.00	0.61	0.94	0.29	-0.09				
Currency market interest	0.92	1.94	0.75	-0.08	-0.01	0.19			
Currency returns	0.52	0.72	0.94	-0.12	0.20	0.02	0.40		
Currency basis	0.02	0.13	0.89	0.54	-0.28	0.49	-0.06	-0.23	
Currency market imbalance	6.81	26.61	0.66	0.00	0.24	0.10	0.25	0.41	0.10
Panel B: Bond Market									
Bond market interest	1.66	1.59	0.93	0.21	0.28	0.27			
Bond returns	0.69	0.67	0.92	0.05	0.08	-0.30	0.01		
Bond market imbalance	0.87	6.95	0.91	-0.28	0.24	-0.54	-0.08	0.29	
Panel C: Stock Market									
Stock market interest	1.72	1.88	0.88	0.35	-0.09	0.33			
Stock returns	0.66	1.29	0.91	0.25	-0.38	0.47	0.61		
Stock market imbalance	-1.06	8.50	0.72	-0.08	0.09	-0.05	0.18	-0.11	

Table 6: Predictability of Commodity Returns by Commodity Market Interest

We test the predictability of returns on a portfolio of fully collateralized commodity futures. We regress monthly excess returns over the 1-month T-bill rate onto 1-month lags of the predictor variables. The table reports standardized coefficients with heteroskedasticity-consistent t-statistics in parentheses. The sample period is 1966:1–2008:12.

Predictor Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short rate	-0.48	-0.48	-0.40	-0.46	-0.54	-0.50	-0.48	-0.54
	(-2.40)	(-2.04)	(-1.96)	(-1.98)	(-2.49)	(-2.17)	(-2.35)	(-2.24)
Yield spread	-0.45	-0.41	-0.25	-0.36	-0.41	-0.39	-0.50	-0.52
	(-2.37)	(-1.95)	(-1.45)	(-1.86)	(-2.03)	(-1.84)	(-2.46)	(-2.34)
Commodity basis	-0.49	-0.46	-0.50	-0.47	-0.51	-0.47	-0.63	-0.62
	(-2.31)	(-2.18)	(-2.37)	(-2.28)	(-2.34)	(-2.21)	(-2.65)	(-2.58)
Commodity market interest		0.63		0.57		0.59		0.55
		(2.60)		(1.79)		(2.43)		(1.97)
Commodity returns			0.42	0.13				
			(1.90)	(0.42)				
Commodity market imbalance					0.29	0.11		
					(1.50)	(0.60)		
Chicago Fed Index							0.53	0.42
							(2.47)	(1.56)
R^2 (%)	2.78	5.19	3.65	5.26	3.27	5.26	5.32	7.37

Table 7: Predictability of Bond Returns and Changes in the Short Rate by Commodity Market Interest

In Panel A, we test the predictability of returns on the 10-year U.S. Treasury note. We regress monthly excess returns over the 1-month T-bill rate onto 1-month lags of the predictor variables. In Panel B, we test the predictability of changes in the 1-month T-bill rate. The table reports standardized coefficients with heteroskedasticity-consistent t-statistics in parentheses. The sample period is 1966:1–2008:12.

Predictor Variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Bond Return						
Short rate	0.20	0.14	0.16	0.13	0.19	0.14
	(1.26)	(0.79)	(0.98)	(0.72)	(1.19)	(0.77)
Yield spread	0.49	0.38	0.38	0.34	0.47	0.38
	(3.41)	(2.63)	(2.57)	(2.33)	(3.14)	(2.42)
Commodity market interest		-0.32		-0.28		-0.33
		(-3.14)		(-2.40)		(-3.09)
Commodity returns			-0.23	-0.09		
			(-1.88)	(-0.60)		
Chicago Fed Index					-0.21	-0.06
					(-1.74)	(-0.48)
R^2 (%)	3.15	4.26	3.96	4.35	4.03	4.66
Panel B: Change in Short Rate						
Yield spread	0.06	0.07	0.11	0.10	0.07	0.08
	(1.24)	(1.46)	(2.19)	(1.99)	(1.47)	(1.53)
Commodity market interest		0.12		0.08		0.09
		(3.28)		(1.71)		(2.64)
Commodity returns			0.13	0.08		
			(3.53)	(1.60)		
Chicago Fed Index					0.12	0.09
					(3.11)	(2.27)
R^2 (%)	0.76	3.98	3.88	4.92	3.96	5.68

Table 8: Predictability of Currency Returns by Currency Market Interest

We test the predictability of returns on a portfolio of fully collateralized currency futures. We regress monthly excess returns over the 1-month T-bill rate onto 1-month lags of the predictor variables. The table reports standardized coefficients with heteroskedasticity-consistent t-statistics in parentheses. The sample period is 1984:1–2008:12.

Predictor Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short rate	0.05	0.09	0.03	0.07	0.03	0.07	0.04	0.07
	(0.26)	(0.48)	(0.16)	(0.39)	(0.18)	(0.40)	(0.21)	(0.42)
Yield spread	0.17	0.19	0.13	0.16	0.1	0.14	0.14	0.17
	(1.08)	(1.22)	(0.77)	(1.02)	(0.60)	(0.89)	(0.88)	(1.03)
Currency basis	-0.24	-0.24	-0.19	-0.21	-0.28	-0.26	-0.40	-0.35
	(-1.44)	(-1.42)	(-1.09)	(-1.23)	(-1.65)	(-1.55)	(-1.81)	(-1.59)
Currency market interest		0.35		0.30		0.31		0.31
		(2.53)		(2.18)		(2.29)		(2.29)
Currency returns			0.25	0.12				
			(1.56)	(0.75)				
Currency market imbalance					0.23	0.14		
					(1.97)	(1.27)		
Chicago Fed Index							0.30	0.22
							(1.35)	(0.98)
R^2 (%)	2.01	4.59	3.24	4.84	3.07	4.95	3.44	5.31

Table 9: Predictability of Bond Returns by Bond Market Interest

We test the predictability of returns on the 10-year U.S. Treasury note. We regress monthly excess returns over the 1-month T-bill rate onto 1-month lags of the predictor variables. The table reports standardized coefficients with heteroskedasticity-consistent t-statistics in parentheses. The sample period is 1984:1–2008:12.

Predictor Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short rate	0.20	0.34	0.20	0.33	0.22	0.34	0.30	0.40
	(1.18)	(1.92)	(1.11)	(1.84)	(1.25)	(1.95)	(1.86)	(2.31)
Yield spread	0.34	0.50	0.33	0.49	0.33	0.49	0.36	0.49
	(2.39)	(3.00)	(2.26)	(2.87)	(2.34)	(2.95)	(2.57)	(3.06)
Bond market interest		-0.31		-0.31		-0.31		-0.25
		(-1.91)		(-1.89)		(-1.88)		(-1.63)
Bond returns			0.06	0.05				
			(0.45)	(0.36)				
Bond market imbalance					0.06	0.04		
					(0.47)	(0.30)		
Chicago Fed Index							-0.33	-0.28
							(-2.03)	(-1.83)
R^2 (%)	1.95	3.55	2.03	3.60	2.02	3.58	4.06	5.06

Table 10: Predictability of Stock Returns by Stock Market Interest

We test the predictability of returns on the CRSP value-weighted stock portfolio. We regress monthly excess returns over the 1-month T-bill rate onto 1-month lags of the predictor variables. The table reports standardized coefficients with heteroskedasticity-consistent t-statistics in parentheses. The sample period is 1984:1–2008:12.

Predictor Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short rate	-0.55	-0.73	-0.62	-0.73	-0.30	-0.49	-1.02	-1.10
	(-0.87)	(-1.14)	(-1.00)	(-1.12)	(-0.47)	(-0.75)	(-1.76)	(-1.82)
Yield spread	-0.53	-0.59	-0.47	-0.57	-0.31	-0.34	-0.75	-0.78
	(-1.29)	(-1.42)	(-1.09)	(-1.22)	(-0.75)	(-0.83)	(-1.87)	(-1.89)
Dividend yield	0.77	0.81	0.82	0.82	0.48	0.46	1.04	1.04
	(1.36)	(1.44)	(1.47)	(1.46)	(0.83)	(0.80)	(1.92)	(1.92)
Stock market interest		0.38		0.33		0.50		0.23
		(1.38)		(0.88)		(1.76)		(0.87)
Stock returns			0.29	0.08				
			(0.83)	(0.17)				
Stock market imbalance					-0.45	-0.56		
					(-1.79)	(-2.12)		
Chicago Fed Index							0.73	0.68
							(2.03)	(1.90)
R^2 (%)	1.05	1.67	1.40	1.69	1.92	2.97	3.42	3.63

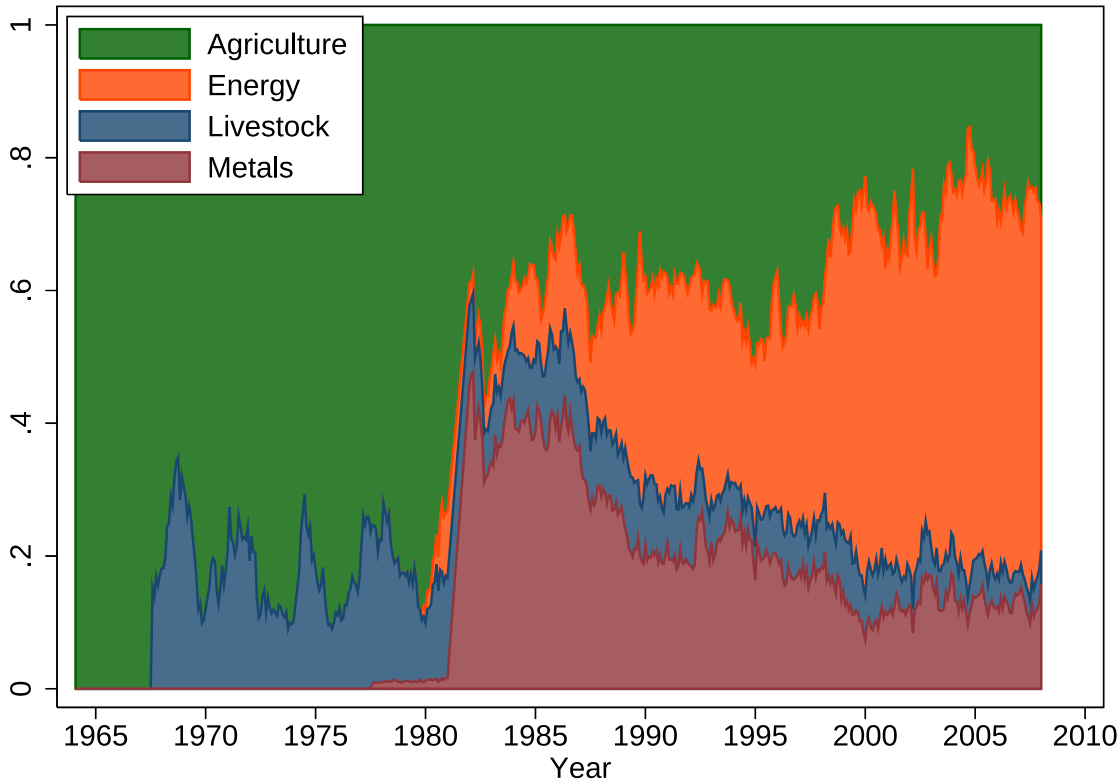

Figure 1: Open Interest in Commodity Futures by Sector
This figure shows the share of dollar open interest in commodity futures that each sector represents. The sample period is 1965:1–2008:12.

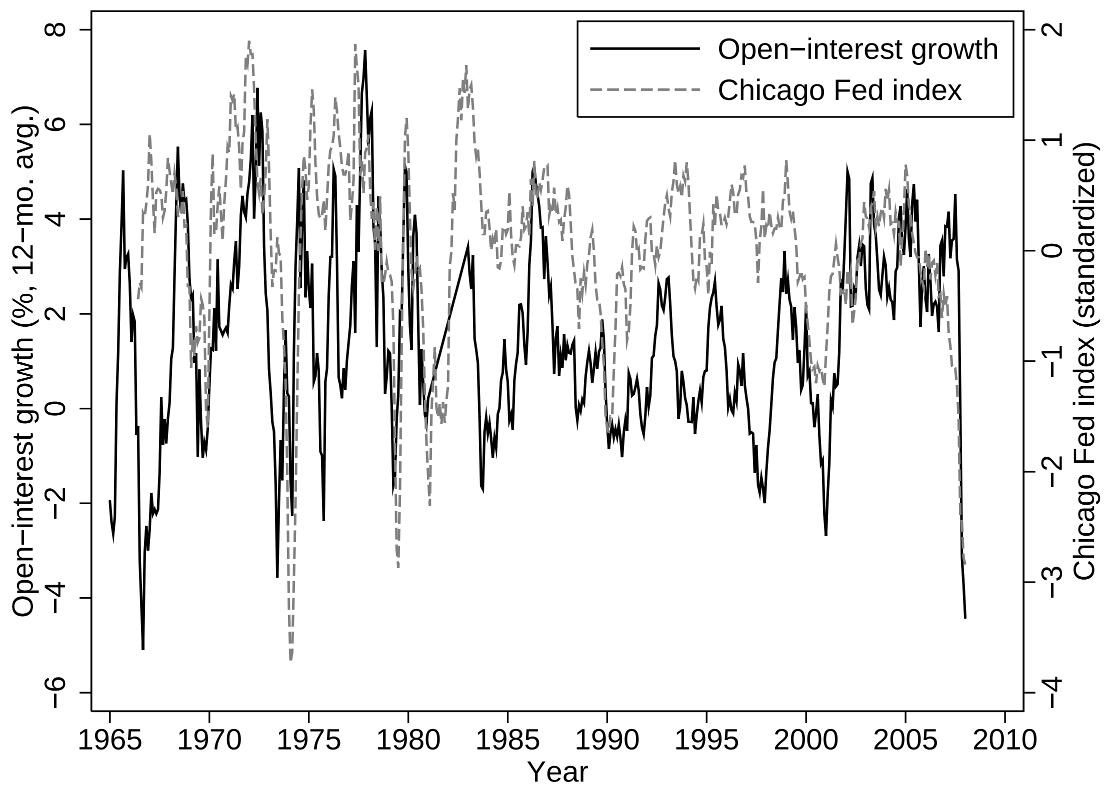

Figure 2: Commodity Market Interest and the Chicago Fed National Activity Index
This figure shows the 12-month geometric average of the growth rate of commodity market interest. It also shows the Chicago Fed National Activity Index, which is a weighted average of 85 monthly indicators of U.S. economic activity. The sample period is 1965:12–2008:12.

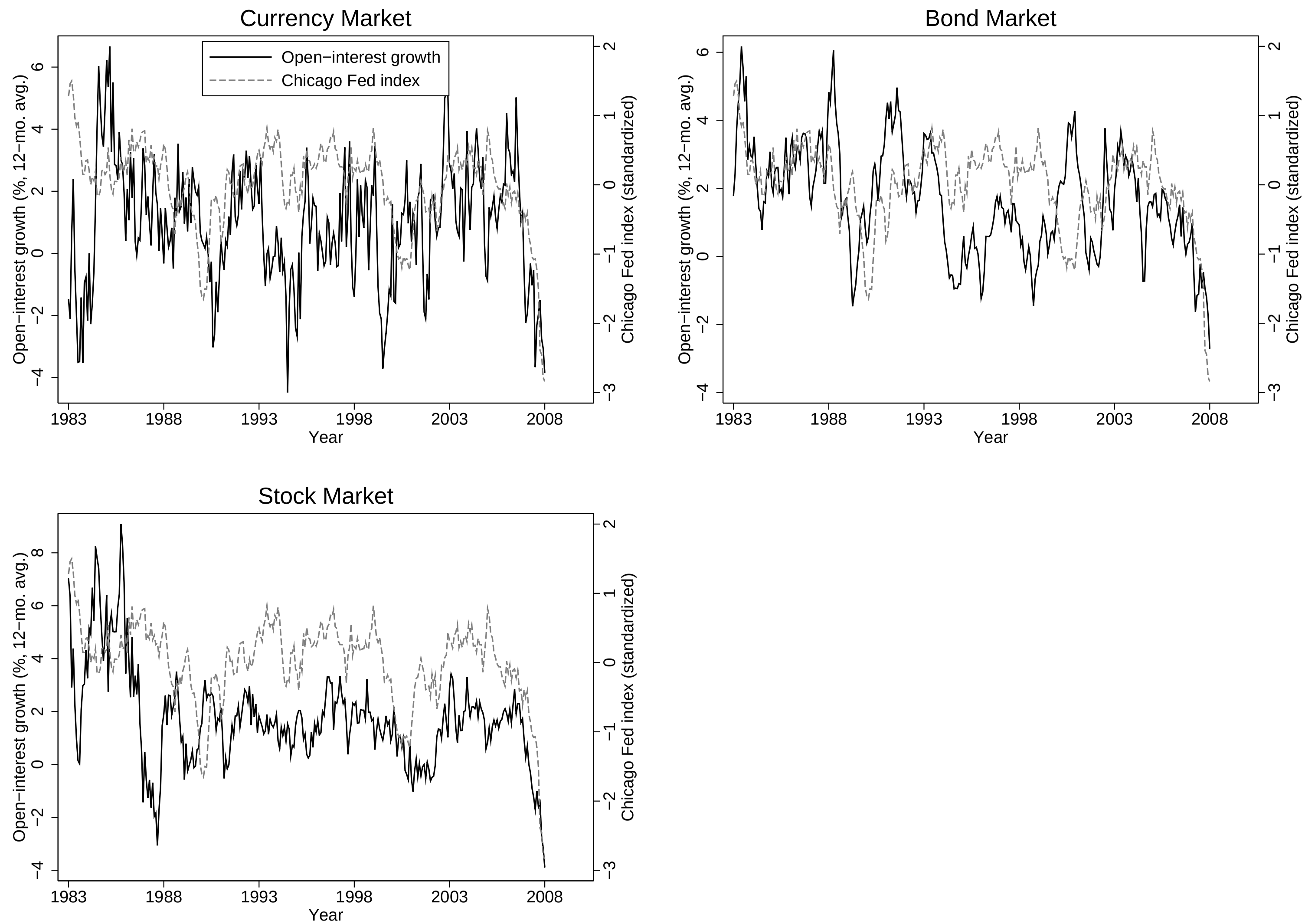

Figure 3: Currency, Bond, and Stock Market Interest and the Chicago Fed National Activity Index

This figure shows the 12-month geometric average of the growth rate of currency, bond, and stock market interest. It also shows the Chicago Fed National Activity Index, which is a weighted average of 85 monthly indicators of U.S. economic activity. The sample period is 1983:12–2008:12.

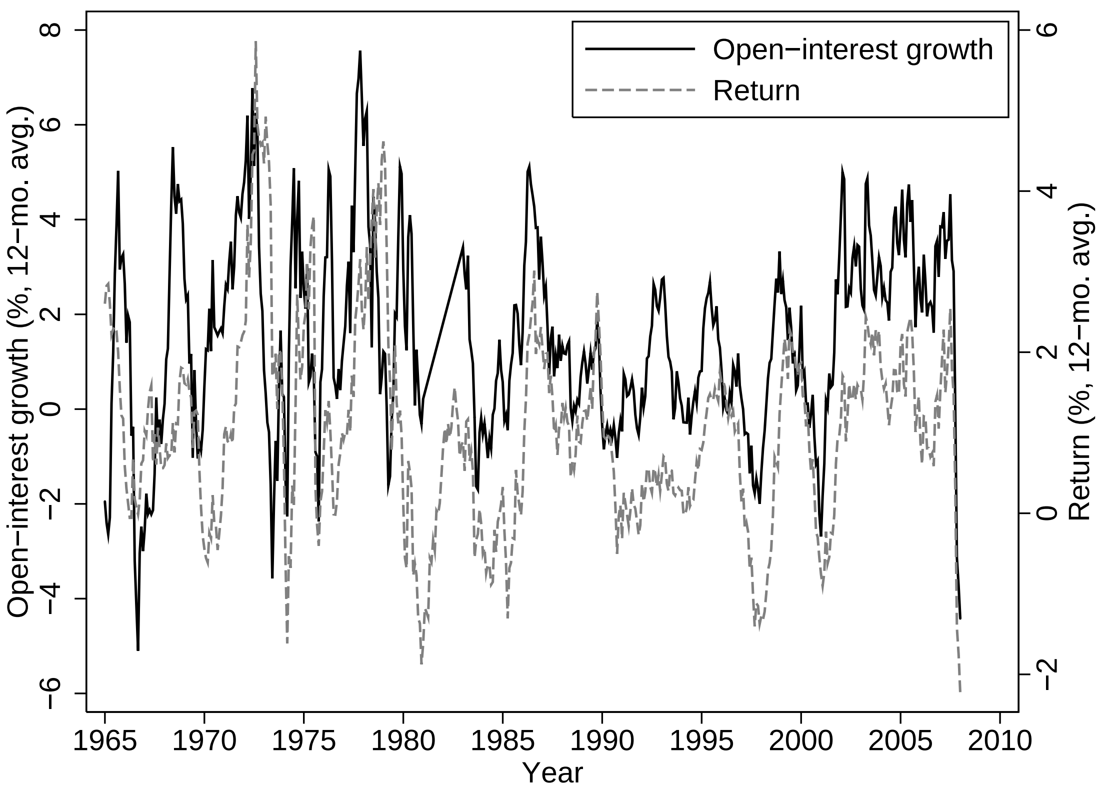

Figure 4: Commodity Market Interest and Returns
This figure shows the 12-month geometric average of the growth rate of commodity market interest. It also shows the 12-month geometric average of returns on a portfolio of fully collateralized commodity futures, equal-weighted across agriculture, livestock, energy, and metals. The sample period is 1965:12–2008:12.

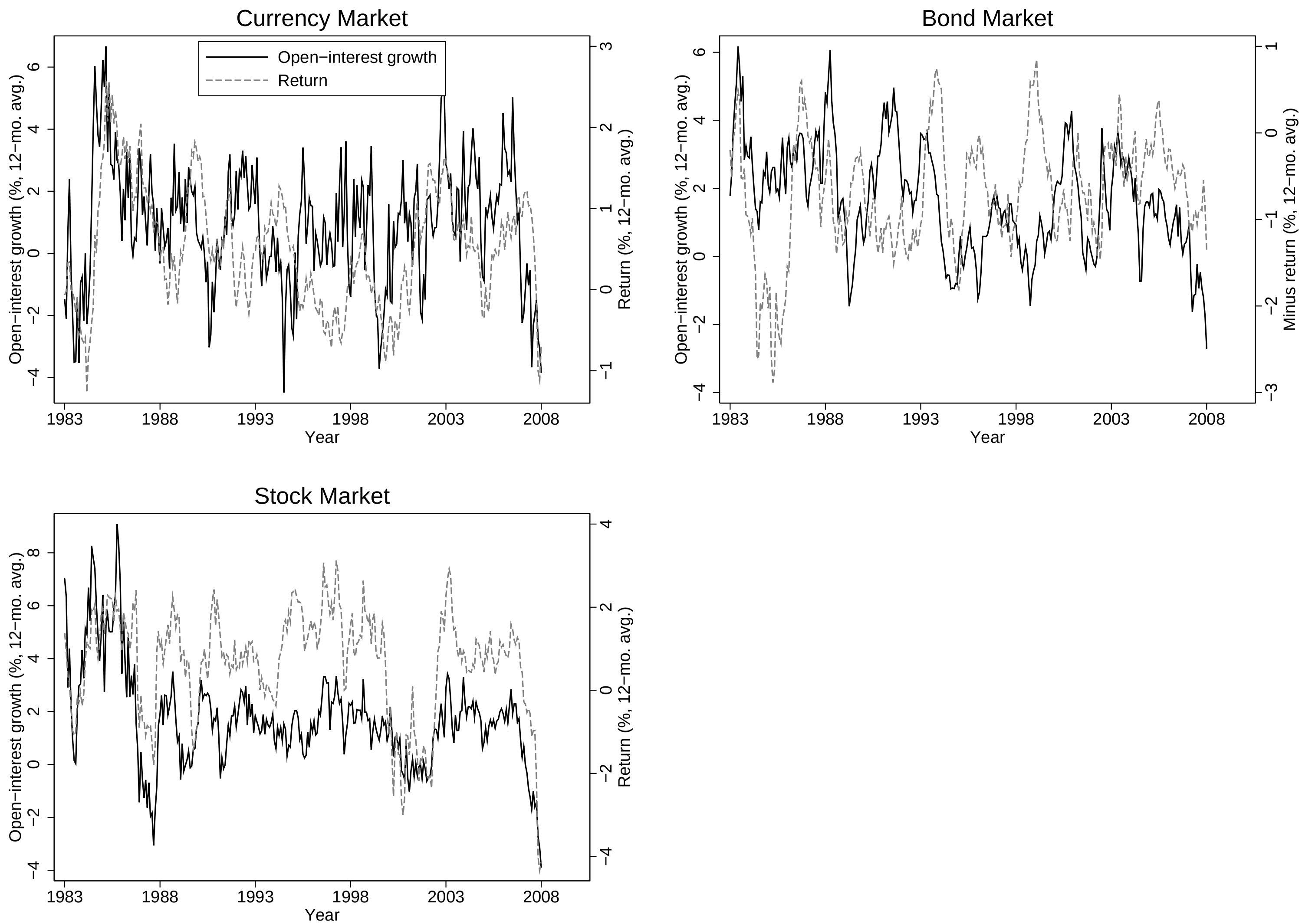

Figure 5: Currency, Bond, and Stock Market Interest and Returns

This figure shows the 12-month geometric average of the growth rate of currency, bond, and stock market interest. It also shows the 12-month geometric average of returns on a portfolio of fully collateralized currency futures, the 10-year U.S. Treasury note, and the CRSP value-weighted stock portfolio. The sample period is 1983:12–2008:12.