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Financialization in commodity markets

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VV Chari and Lawrence J. Christiano

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Financialization in Commodity Markets

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August 15, 2017

Abstract

The financialization view is that increased trading in commodity futures markets is associated with increases in the growth rate and volatility of commodity spot prices. This view gained credence because in the 2000s trading volume increased sharply and many commodity prices rose and became more volatile. Using a large panel dataset we constructed, which includes commodities with and without futures markets, we find no empirical link between increased futures market trading and changes in price behavior. Our data sheds light on the economic role of futures markets. The conventional view is that futures markets provide one-way insurance by allowing outsiders, traders with no direct interest in a commodity, to insure insiders, traders with a direct interest. The data are not consistent with the conventional view and we argue that they point to an alternative mutual insurance view, in which all participants insure each other. We formalize this view in a model and show that it is consistent with key features of the data.

Key Words: Spot Price Volatility, Futures Market Returns, Open interest, Net Financial Flows.

JEL Codes: E02, G12, G23.

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1. Introduction

Commodity markets are said to become more financialized when futures market trading volume rises relative to production. The financialization view is that increased trading activity is associated with increases in commodity spot price growth and spot price volatility. This view gained credence because, starting in the early 2000s, trading activity in commodity futures markets increased sharply relative to its level in the 1990s, while many spot prices rose and became more volatile. In this paper, we construct annual and monthly datasets which contain panel data on 136 and 52 commodities, respectively. These data include traded commodities, namely commodities with futures markets in the United States, as well as a variety of non-traded commodities without such markets. The data allow us to investigate whether the prices of traded and non-traded commodities behave differently and also allows us to investigate how the volume of trade in a particular commodity affects the price behavior of that commodity. We find essentially no support for the financialization view.

Our data also allow us to shed light on the economic role of futures markets. The conventional view of such markets divides traders into insiders, firms and individuals with a direct commercial role in a particular commodity, and outsiders, namely those individuals and firms without such an interest. Under the conventional view, the role of futures markets is for outsiders to provide insurance to insiders. That is, these markets provide *one-way insurance*. The Commodity Futures Trading Commission (CFTC) classifies traders into categories that correspond to insiders and outsiders. We use the CFTC data to measure the net long position of outsiders, which we refer to as net financial flows. Under the one-way insurance view, the bulk of trading should consist of net financial flows. The data are simply inconsistent with this view. Net financial flows account for only about 10 percent of open interest, the volume of outstanding contracts. The bulk of open interest is due to insiders trading with each other and a smaller fraction is due to outsiders trading with each other.

Another implication of the one-way insurance view is also inconsistent with the data. This implication is that if outsiders are risk averse, increases in insurance demand by insiders in a particular commodity should lead to an increase in the insurance premium charged by outsiders. This insurance premium consists of the futures market returns earned on that particular commodity by outsiders. Thus, the conventional view implies that when net financial flows are high for a particular commodity, expected futures returns should also be high for that commodity. In the data, it turns out that there is no relationship between net financial flows and returns.

These observations lead us to an alternative *mutual insurance view* in which futures markets are used by insiders to insure each other, outsiders to insure each other, and both trading groups to insure each other. That is, futures markets are a mutual insurance mechanism.

The challenge is to develop a model of the mutual insurance view, which is consistent with two key features of the data: no relationship between net financial flows and returns and a positive relationship between open interest and returns. We show that our model is consistent with both key features of the data. In addition, it is consistent with the observation that net financial flows account for a small fraction of overall volume.

Our model has two types of insiders, "farmers" who produce wheat, and "bakers" who use the wheat to produce bread. For simplicity, we assume only one type of outsider. The demand for bread is affected by shocks. One of these shocks is realized before production decisions are made, and is to be thought of as a shock that affects the expected level of demand. The demand for bread is also affected by a component which is correlated with outsiders' income. This correlation fluctuates randomly. Outsiders have incentives to use futures markets to insure themselves and the desire for this insurance fluctuates due to fluctuations in the correlation.

All agents are risk averse and seek to use futures markets to purchase insurance if risks are high relative to returns as well as to provide insurance if returns are high relative to risk. Farmers seek to hedge risk, and this risk fluctuates with the expected level of demand. Bakers also seek to insure risk, but their incentives to purchase insurance are weaker than those of farmers. The reason is that bakers are partially hedged against price risk because when the price of wheat is high, so is the price of bread.

In the data, net financial flows are typically positive. To reproduce this feature in the equilibrium of our model requires that outsiders be long on wheat futures. We choose parameters so that the equilibrium of our model has this feature. Thus, in the equilibrium of our model, for all realizations of shocks, farmers go short in the market and bakers and outsiders go long. Thus open interest consists of the sum of the long position of outsiders and bakers, and net financial flows consists of the long positions of outsiders.

Consider now the response to various shocks. A positive shock to expected demand for bread increases the risk faced by farmers who respond by increasing their insurance purchases and going further short. Futures prices fall relative to the expected spot price, and so the expected return on futures rises. This rise in expected returns induces outsiders to increase their supply of insurance and go further long. It also induces bakers to go further long. The reason is that bakers' concerns with risk are weaker than those of farmers, but they still respond to returns. Since both bakers and outsiders increase their long positions, open interest rises by more than net financial flows. Thus, in response to expected demand shocks the covariance between open interest and returns is larger than that between net financial flows and returns, and both are positive.

Consider next a correlation shock which tends to increase the long positions of outsiders. Such a shock leads to a rise in futures prices and a reduction to the expected return in futures markets. Bakers respond to this reduction in expected returns by reducing their long positions. Thus, the rise in open

interest is smaller than the rise in net financial flows. In response to correlation shocks, the covariance between open interest and returns is larger than that between net financial flows and returns, and both are negative.

Since the covariance between net financial flows and returns have opposite signs with respect to the two shocks, there exists some value of the variances such that this covariance is zero. Using our previous logic, at these parameter values the covariance between open interest and returns is positive. Given that farmers and bakers can insure each other, our model is consistent with the observation that the bulk of volume is accounted for by insiders trading with each other. Thus, our model is consistent with three key features of the commodity futures markets: net financial flows are a small part of overall volume, there is no relationship between net financial flows and returns, and there is a positive relationship between open interest and returns.

Finally, our model is also consistent with the observation that there is no systematic relationship between financialization and spot price behavior. We assume that the variances of the exogenous shocks differ across commodities and time. Outsiders must incur a fixed cost to participate in the market for a given commodity, so that the extent of outsider participation is determined endogenously. With endogenous participation, our model generates the lack of a systematic relationship between financialization and spot price volatility.

Our empirical findings are based on an extensive data collection effort. For each commodity in our data set we obtain spot price data and world production data from a variety of sources. In the case of traded commodities, we use data on world production to scale the volume of futures trading. This scaling is needed to allow trading activity across commodities and over time to be expressed in comparable units. For non-traded commodities, the data on production is needed to develop indices of prices which reflect each commodity's economic importance. A separate Technical Appendix describes our data and empirical methods in detail. In addition, we have assembled the data in a user-friendly form, which is available upon request.

In order to evaluate the financialization view, we conduct two broad types of empirical analyses, a decadal analysis, and a higher frequency analysis. The decadal analysis starts with the observation that open interest is relatively constant in the 1990s at about one year's worth of world production, and then in the early 2000s it begins to grow rapidly and reaches about four year's worth of world production by 2012. We ask whether the trend behavior and the volatility of prices is different in the periods before 2002 and after 2002. The idea is that some common change in financialization affected all commodities at roughly the same time. We find that the distributions of the growth rates of prices across commodities is indeed different across the two sub samples, but that this distribution changes in roughly the same way for traded and non-traded goods. We look at a variety of measures of trend price growth and volatility and

find that none of decadal changes in these variables is systematically associated with associated decadal changes in volume.

The higher frequency analysis allows for the extent of financialization to have changed at different times for different commodities. In this analysis we find that the volatility of prices, measured as the standard deviation of prices over a moving window is not systematically associated with measures of volume. We find that the distribution of volatilities shows a great deal of dispersion for non-traded commodities and for commodities with low levels of volume but that for commodities with substantial amounts of volume, the distribution is essentially unaffected by the level of volume.

Taken together, these findings suggest that the data provide no support for the financialization view.

We now elaborate on the empirical relationship between volume of trade for a particular commodity and returns for that commodity. We investigate the ex post returns on different portfolio trading strategies. We define the hot net financial flow strategy as a strategy in which a portfolio of commodity futures is heavily weighted towards commodities where net financial flows have been high recently. We define a random strategy as one that rebalances portfolios randomly. We find that the hot net financial flow strategy generates returns that are similar to those on the random strategy. This result contradicts the conventional view. We also consider an analogous hot open interest strategy. We find that this strategy performs significantly better than the random strategy or a strategy based on a fixed portfolio of equities.[1]

The findings on the relationship between volume of trade and returns are related those in Hong and Yogo (2012). The main focus of their analysis is on the relationship between aggregate measures of the volume of trade and overall returns in futures markets for commodities. Our focus, in contrast, is on the relationship between fluctuations in volume of trade and returns at the individual commodity level.

In terms of the relationship to the literature on the economic role of futures markets, the one-way insurance view dates back to Keynes (1923), and Hicks (1939). See Hirshleifer (1990) for a more modern rendering. Telser (1981) provides a succinct summary of the conventional view by saying "an organized futures market furnishes legitimate businessmen with a means of hedging so they can obtain insurance against price risk". Challenges to this conventional view are also long standing (see Telser (1981), Cheng and Xiong (2014) and Hong and Yogo (2012)).

Our analysis investigates the role of financialization by studying a broad cross section of commodities, including a substantial number of non-traded commodities. In terms of non-traded goods, Irwin et al. (2009), Kilian (2009), Kilian and Hicks (2013) look at the behavior of a few non-traded commodities. None of the papers in the literature systematically study the behavior of the range of non-traded commodities that we do.

In terms of our broad cross sectional analysis, much of the literature examines the role of financial-

[1] We are grateful to Craig Burnside for suggesting this economically meaningful way to measure the relationship between financialization and futures market returns.

ization on a specific commodity or groups of commodities. Even at the level of individual commodities, the studies come to very different conclusions. Some studies such as Acharya et al. (2013), Brunetti and Reiffen (2014), Etula (2013), Henderson et al. (2014), Masters (2008), Singleton (2014), Tang and Xiong (2012) find evidence that supports the financialization view. Fattouh et al. (2013), Hamilton and Wu (2015), Irwin and Sanders (2012), Irwin et al. (2009), Kilian and Murphy (2014), Stoll and Whaley (2010) argue that the data does not support the financialization view. Brunetti and Buyuksahin (2009) and Brunetti et al. (2016) argue that financialization reduces spot price volatility.

Section 2 describes our data and sources, sections 3 and 4 contain the decadal and high frequency analysis. Section 5 contains our analysis of trading activity and returns in futures and other financial markets. Finally, Section 6 contains description and analysis of a model which is consistent with our empirical findings.

2. Data Description and Sources

2.1. Spot Price and Production Data

We construct a monthly dataset and an annual dataset for a variety of commodities to study the association between futures trading and market outcomes. For 29 commodities, referred to here as *traded commodities,* monthly and annual futures markets volume data can be constructed from the CFTC dataset. For the rest of the commodities in our dataset the CFTC does not track futures trading, typically because such futures markets do not exist, at least in the United States. We refer to these commodities as *non-traded commodities*. We also subdivide commodities into various subcategories. In particular, we sort the data into softs (i.e., agricultural commodities like corn and lumber), minerals and fuels. We also sort traded commodities according to whether they are included in widely-used indices.[2]

We gathered spot price data for commodities for which annual world production data are available. Monthly and annual spot market price data are available for our traded commodities from a variety of sources (see Table 1 for the annual data, and Table 2 for the monthly data). For 23 non-traded commodities, we were able to obtain monthly spot price data from a variety of sources (see Table 3) and for 107 commodities we were able to obtain annual spot price data from British Petroleum, the US Geological Survey and the United Nations Food and Agricultural Organization (see the Technical Appendix). The tables also report the subcategories to which each commodity belongs. Note that the sets of non-traded commodities covered in the monthly and annual data are different, so that the results for these two

[2]Following Tang and Xiong (2012) we identify commodities traded on futures exchanges as 'indexed' if in 2008 they receive non-zero weight in both the basket of commodities in the Standard and Poor's Goldman Sachs commodity index (S&P GSCI) and the commodities in the Dow Jones-UBS commodity index (DJ-HBSCI).

datasets need not be the same.

2.2. Futures Market Volume Data

Monthly and annual data on the volume of activity in futures markets can be obtained from a weekly dataset provided by the CFTC for our 29 commodities. For our annual dataset, for each commodity we sum the CFTC data over all the contracts within each year. We scale our measures of volume in each year by world production of the underlying commodity in the same year. This scaling ensures that our measure of volume is comparable across commodities and captures the notion that the market for commodities is more financialized if the volume of futures trade is larger relative to production for that commodity. Table 1 reports our sources for world production of traded goods. For our monthly data set we convert the CFTC data into monthly terms by summing over all the contracts within each month. We interpolate the annual world production data to obtain monthly world production. We then scale monthly open interest by monthly world production for each commodity.

Motivated by our interest in measuring the extent to which insiders and outsiders insure each other, we construct a second measure of futures trade volume, which we call *net financial flows.* We construct this measure using the positions in futures markets of insiders and outsiders, reported by the CFTC. Specifically, the CFTC categorizes futures market trades as *commercial, non-commercial* and *non-reported*.[3] A trade is classified as commercial if the associated trader is operating on behalf of entities whose main business is in the production, sale or use of the relevant commodity, and if the trader's position at the end of the day is sufficiently large. A trade is classified as non-commercial if the associated trader is not operating on behalf of such a business and if the trader's position at the end of the day is sufficiently large. Both these types of trades are referred to as *reported*. A trade is *non-reported* if the trader's position at the end of the day is not sufficiently large. In this case, the CFTC does not report whether the trade is commercial or non-commercial.

We categorize all commercial trades as trades by insiders and all non-commercial trades as trades by outsiders.[4] We allocate non-reported trades at each date to the insider and outsider categories in proportion to the share of commercial and non-commercial trades respectively in total reported trades at that date. For each commodity, i, and date, t, let S_{it}^L denote the gross long positions of outsiders, summed across all outstanding futures contracts in commodity i at date$t$, scaled by date t world production. Let S_{it}^s denote the analogous short positions. Let H_{it}^L and H_{it}^s denote the analogous positions for insiders. With

[3] For details, see http://www.cftc.gov/MarketReports/CommitmentsofTraders/ExplanatoryNotes/index.htm.

[4] To obtain the gross long and short positions of non-commercial trades from the CFTC data requires some care. The CFTC reports the sum, across traders, of their net long and short positions, as well as the sum of a variable they refer to as the spread. The spread is the sum, across all traders, of the position (long or short) that is smaller. The sum of the net long positions and the spread gives the gross long positions and similarly so, for the short positions.

this notation, open interest, oi_{it}, and net financial flows, nff_{it}, for commodity i at date t are given by:

$$\begin{aligned} oi_{it} &= S_{it}^L + H_{it}^L = S_{it}^s + H_{it}^s \\ nff_{it} &= S_{it}^L - S_{it}^s = -\left(H_{it}^L - H_{it}^s\right). \end{aligned} \tag{1}$$

We also use data on returns on futures contracts. To construct these returns we use the daily prices for futures contracts of various maturities for the commodities used in Tang and Xiong (2012), kindly provided to us by the authors.

3. Spot Price Behavior and Financialization: Decadal Analysis

In this section we document that open interest is substantially higher in the 2000s than in the 1990s. Under the financialization view, this increase in trading activity should be associated with a change in the behavior of spot prices. To the extent that common factors across all commodities, such as taxes, regulation, digital technology, institutional innovation and attitudes towards risk, drove the increase in open interest, we would expect the behavior of the prices of all commodities to be different in the 2000s than in the 1990s. We investigate this implication of the financialization view in this section. We then go on to allow the extent of financialization to differ across commodities in the 1990s and 2000s, but maintain the perspective that these changes all occurred at roughly the same time.

We find no consistent change in behavior among commodities. This finding undercuts the financialization view.

3.1. Patterns in Trade Volume

To characterize the general movements in volume of trade, we construct indices. We construct a trade volume index for commodities by weighting a measure of trade volume for each commodity by the average value of its share in world production. Specifically, for open interest, let oi_{it} denote the volume of open interest in commodity i in period t, scaled by world production, q_{it}. The open interest index, oi_t, for period t is given by

$$oi_t = \sum_i w_i oi_{it},$$

where the weight, w_i, is given by

$$w_i = \frac{1}{T} \sum_t \frac{P_{it} q_{it}}{\sum_j P_{jt} q_{jt}}.$$

Here, P_{it} denotes the spot price of commodity$i$ in period$t$. We construct the index of net financial flows, nff_t, in a similar fashion. The price indices are constructed in a similar fashion, except that we scale

P_{it} by the period$t$ personal consumption expenditure deflator and we normalize the index, P_t, so that its value is unity at $t = 0$.

Figure 2 displays annual and monthly data for our index of open interest and of net financial flows. We emphasize two features of the data that are apparent from this figure. First, open interest is substantially greater than net financial flows at every date. Second, our index of open interest behaves very differently in the 1990s than it does in the 2000s.

3.1.1. Economic Role of Commodity Futures Markets

The first feature of the data sheds light on the economic role of futures markets. The conventional view of this role is that futures markets enable outsiders to insure insiders. Under this view, we would expect open interest to be roughly equal to net financial flows. This view is not supported by the data. Figure 2 shows that open interest is several times as large as net financial flows. This observation suggests that futures markets also allow insiders to insure each other and outsiders to insure each other.

One measure of the amount of insurance provided by insiders to each other is $min\left[H^L, H^s\right]$. We think of this minimum as the amount of insurance provided by insiders to each other, and the excess over this minimum as net trades between insiders and outsiders. We refer to this minimum as *within insider* insurance. Analogously, we refer to $min\left[S^L, S^s\right]$ *as within outsider* insurance. The insurance provided by outsiders and insiders to each other is referred to as *between trader group* insurance is$|nff|$. Using equation (1), it is easy to verify that these three measures sum to open interest, so that

$$\frac{min\left[H^L, H^s\right]}{oi} + \frac{min\left[S^L, S^s\right]}{oi} + \frac{|nff|}{oi} = 1.$$

Figure 3 reports the time series of the three insurance measures (scaled by open interest) for all traded commodities and for subcategories of these commodities. The figure indicates that the bulk of futures market trading consists of within insider insurance. In general, a smaller fraction is due to within outsider insurance and a very small fraction is due to between trader groups insurance. For example, for all commodities, on average about 63 percent of open interest is insider insurance, about 27 percent is within outsider insurance and only about 10 percent is between trader group insurance.

This finding is in sharp contrast to the conventional wisdom, under which the key role of futures markets is to allow trader groups to insure each other. The data suggests that the principal role of futures markets is to enable insiders to insure each other, a secondary role is to allow outsiders to insure each other, and the smallest role is to allow these groups to insure each other.

The figure also shows that the share of between trader group insurance is roughly constant over the sample. Thus, the large increase in open interest in the 2000s is not due to an increase in between trader

group insurance. Instead, it is associated with a sharp increase in within outsider insurance.

3.1.2. Patterns in Trade Volume: Decadal Analysis

The second feature of Figure 2 that we emphasize is that our index of open interest displays no trend and averages roughly a little over one year's production until the early 2000s. It then rises sharply up to a little over four times world production by the end of our sample, 2012. Net financial flows are nearly zero in the first half of the sample and are somewhat higher in the second half of the sample. Figure 2 shows that there is a volatile high-frequency component in the monthly data. In the Technical Appendix, we show that this volatility is not driven by seasonal movements.

Open interest in the second half of the sample is substantially greater than in the first half. Under the financialization view the behavior of commodity prices in the second half of the sample should be very different from its behavior in the first half of the sample. We investigate this implication in the remainder of this section.

3.1.3. Patterns in the Behavior of Price Indices

We begin by displaying the log of the price index for the commodities in our dataset in Figure 1. The dashed line in this figure displays the time series behavior of the index based on the 136 commodities in the annual dataset. The solid line displays the index for the 52 commodities in our monthly dataset.

Figure 1 gives the impression that the behavior of commodity prices did indeed change at roughly the same time that activity in the futures markets increased. This visual inspection apparently supports the financialization view. The eye could be misled, however, by a chance sequence of positive growth rates early in the second sub sample. To guard against this possibility, we conduct tests of the null hypothesis that the mean growth rates in the two sub samples are the same. The $p-$values reported in the figure show that these tests fail to reject the null hypothesis. Thus, the visual evidence could just be an artifact of chance. In this sense, the data do not offer compelling evidence for the financialization view.

Under the financialization view, we would expect the change in price behavior to be greater for traded commodities than for non-traded commodities. We investigate this implication by decomposing our aggregate commodity price index into traded and non-traded goods. Panel A of Figure 4, which uses our annual data set, gives the impression that the behavior of the prices of traded goods is different in the two sub samples and the behavior of non-traded goods is not very different in the two sub samples. This figure shows that the price of traded goods rises at best moderately in the first half of the sample and rises more quickly in the second half of the sample. Furthermore the price of traded goods seems to be more volatile in the second half of the sample than in the first.[5] In contrast, the price of non-traded goods

[5]The index for all goods behaves very similarly to the index for traded goods because traded goods account for a large

rises at about the same rate in both halves of the sample and does not display an increase in volatility.

In panel A of Figure 4 we also report $p-$values for the same test as in Figure 1. The $p-$values indicate that the data in Figure 4 do not offer compelling evidence for the financialization view.

We now turn to our monthly data. Panel B of Figure 4 shows that traded goods prices display a similar pattern as in Panel A. This pattern is not surprising because the underlying commodities are the same in both cases. The underlying commodities are different for non-traded goods. As can be seen from Panel B, the price behavior of the non-traded goods in our monthly data set is different from the behavior of our annual dataset displayed in Panel A. In the first half of the sample, the price of non-traded goods appears to fall and then rises in the second half of the sample. Panel B of Figure 4 gives the impression that non-traded goods prices behave very differently in the two sub samples and that traded goods behave somewhat differently. The $p-$values reported in the figure show that non-traded goods prices are indeed statistically significantly different in the two sub samples, while traded good prices are not statistically significantly different. The financialization view leads to exactly the opposite implication for the data. Thus, the results in this figure undercut the financialization view.

In sum, visual inspection of the annual data suggests that the financialization view should be taken seriously. The monthly data undercuts the financialization view and statistical tests do not provide compelling evidence for the view.

This mixed message leads us to bring more data to address our question. We use data on the behavior of the prices of individual commodities and the extent of financialization in the market for that commodity.

3.1.4. Patterns in the Behavior of Individual Commodity Prices

Here, we bring to bear our data from a large number of commodities traded in a variety of markets to investigate the financialization view. For each commodity, we compute the mean and standard deviation of the one-period growth rate of its log price in the 1990s and the 2000s. We ask whether these means and standard deviations are significantly different in the two sub samples. In effect, this comparison asks whether changes in price behavior comove with changes in aggregate financialization. We go on to investigate the comovement between changes in price behavior for each commodity in the two sub samples and changes in volume of trade for that commodity. We do not find compelling evidence for the financialization view, either at the aggregate level, or at the individual commodity level.

Mean Growth Rates of Commodity Spot Prices

Consider first the average of mean growth rates, for all commodities as well as various subgroups. Table 4 reports the cross-sectional average, across commodities in the relevant group, of the mean growth

fraction of world production of all commodities.

rates and associated standard deviations in the two sub samples. The table also reports $p-$values for the test of the null hypothesis that the statistics are the same in both periods.[6] This table shows that these averages are higher in the 2000s than in the 1990s, but that the difference is not statistically significant in the annual data. This finding is similar to that for the indexes reported in Panel A of Figure 4. The findings for the monthly data for the subcategories of traded and non-traded goods are also similar to those in Panel B of Figure 4. Note that, unlike the findings in Panel B of Figure 4, here the average of the mean growth rates for all commodities is significantly higher in the second half than in the first half. The reason the results are different is that the index assigns a very substantial weight to traded commodities, while in Table 4 each commodity receives equal weight.

Consider next the growth rate of prices for each commodity. This growth rate displays substantial heterogeneity across commodities. In Figure 5, we report the empirical density functions of commodity growth rates in the two sub samples, for all commodities as well as for traded and non-traded commodities. The panels for all commodities show that the distribution of growth rates of commodity is different in the two sub samples. These distributions are statistically significantly different according to the Kolmogorov-Smirnoff test. The observation that these distributions are statistically significantly different is not inconsistent with our observation that the means from these distributions are statistically insignificantly different from each other. The figure shows that the mean from each sample is well inside the distribution of the other sample.

At first glance, the observation that, for all commodities, the distributions are significantly different from each seems to provide support for the financialization view. The panels for traded and non-traded commodities undercut that support. We see in that the shift in distribution occurs for both traded and non-traded goods, and so seems to have nothing to do with financialization.

Overall, the findings here reinforce the findings from the index analysis that the data do not provide compelling evidence for the financialization view.

Averages of Volatility of Spot Prices

Table 4 shows that differences in the volatility of spot price growth across the two sub samples are in general not significantly different.[7] The differences are significant only for non-indexed commodities and marginally significant for traded commodities. The table also shows that the volatility of the growth rate of spot prices of non-traded goods is higher than that of traded goods. Thus, there is no compelling evidence here in support of the financialization view.

Commodity-Level Comovement Between Spot Prices and Volume

[6] These tests were constructed using both a bootstrap method and a sampling theory described in the Technical Appendix.

[7] Volatility statistics are expressed in annual, percent terms. In the case of monthly data, we do this by multiplying the monthly standard deviation by $100\sqrt{12}$. This conversion is the correct one if monthly price data are a logarithmic random walk.

We continue to maintain the decadal perspective, except that we allow the extent of financialization to differ across commodities. We ask whether the data show a significant relationship between changes in spot price behavior and changes in the volume of trade, namely, open interest and net financial flows, for each commodity.

Specifically, for each commodity in our data set, we compute three statistics for each of our two sub samples. The first is the change, over the two sub samples, in the standard deviation of the growth rate of prices. The second and third statistics are based on a linear regression of the log, real commodity price on a time trend and a constant, allowing the coefficients to be different in the two sub samples. The second statistic is the change in coefficient on the time trend and the third statistic is the change in the standard deviation of the regression error term. All statistics are report in annual percent terms.

We ask whether our statistics are large when the change in the average volume of trade across the two sub samples is large. We answer this question by regressing our statistics on the corresponding change in volume of trade. Our measures of volume of trade are open interest and net financial flows, scaled by world production. Table 5 reports the probability, under the null hypothesis that the coefficient on volume of trade higher than its estimated value. The rows of Table 5 correspond to different categories of commodities. Table 5 displays the coefficients of these regressions as well as tests of statistical significance. This table shows that, with one exception, the coefficients are not significantly different from zero. The exception is that, in the case of softs, changes in the coefficient on the time trend are significantly associated with changes in both measures of volume.

We illustrate this exercise in Figure 6. Each panel of the figure is a scatter plot for all commodities and subcategories of commodities. Our second statistic, the change in the coefficient on the time trend, is on the vertical axis and the change in open interest is on the horizontal axis. For convenience, the figure also reports the corresponding entries from Table 5, namely the estimate regression slope term and associated $p-$value. Except for softs, each panel shows a cloud without a clear pattern.

The sense in which there is no systematic relationship between changes in open interest and changes in price behavior can be seen by considering the behavior of gold and silver. Using our annual dataset, we see that open interest in gold increased by about 12 times world production, while open interest in silver declined by about 5 times world production. In both cases, the coefficient on the time trend increased by about 20 percentage points, at an annual rate.

Visual inspection of Figure 6 and the results in Table 5 show that, with the exception of softs, there is no compelling evidence for the financialization view.

4. Patterns in Price Behavior: Higher Frequency Analysis

The decadal approach in the previous section takes the stand that changes in financialization took place at roughly the same date for all commodities. Here, we allow for the possibility that variations in financialization occurred at different dates for different commodities. We ask whether, in our monthly dataset, higher levels of financialization are systematically associated with higher volatility of spot prices.

To answer this question we measure volatility by the plus and minus 2 year centered moving average of the standard deviation of the logarithmic growth rate of commodity prices. Figure 10 is a scatter plot of our measure of volatility against our two measures of volume for all commodities and for various subcategories of commodities. Each point in the figure is a volatility, volume combination for a specific commodity at a particular date. The upper and lower panels of the figure are based on our annual and monthly datasets, respectively. As before, the volatility measures are converted to annual, percent terms. The figure shows that when trading volume is near zero, volatility measures are on average higher and more dispersed than when trading volume is substantial. This finding suggests that higher financialization is associated with lower volatility of spot prices. In this sense, the data contradict the financialization view.

In each case, the line in the figures is the least squares line through the data, with the slope indicated in the associated figure header. These slopes are not significantly different from zero at the five percent level (see Table 6)[8]. Furthermore, except for softs, all the coefficients are negative but quantitatively small. For example, for all commodities and the monthly data, the reported slope implies that an increase in open interest of one year's production is associated with a 0.13 percentage points reduction in the standard deviation of price growth.

We also regressed the volatility of each commodity on our measures of volume, and display the frequency distribution of the slope coefficients in Figure 11. That figure indicates that the distribution, though dispersed, is centered on negative slopes, for both our measures of volume. Thus, there is no evidence that with greater trading volume, volatility goes up. On the contrary, there is modest, not statistically significant, evidence that that volatility actually goes down with increased volume.[9]

Another way of seeing that financialization has essentially no impact on commodity price volatility is with a quartile analysis. In particular, we examine how the distribution of our measure of price volatility depends on our measures of volume. We measure spot price volatility by the standard deviation of spot price growth. For each measure of volume, we restrict attention to the price volatility observations that lie in the second and third quartiles of volume. Panels a and b in Figure 14 report the histograms, means and modes of volatility for the second and third quartiles, sorting on open interest and net financial

[8] In computing the sampling uncertainty for the coefficients, we dropped four commodities, butter, propane, aluminum and coal because there is so little trade.

[9] A Kolmogorov-Smirnov goodness-of-fit hypothesis test on the null hypothesis that the two histograms in Figure11 are sampled from the same underlying population fails to reject at the 5 percent level.

flows, respectively. From Panel a is clear that the distributions of volatility are essentially identical for observations that lie in the second and third quartile of open interest. Panel b shows that the distribution of volatility in the third quartile lies slightly to the right of the distribution in the second quartile. This difference is quantitatively small. For example, the mean of volatility in the third quartile is 27.4 percent and it is 24.4 percent in the second quartile. These findings suggest that there is essentially no empirical link between financialization and commodity price volatility.

5. Trading Volume and Properties of Futures Returns

Here, we examine the relationship between financialization and the behavior of returns in futures markets. First, we consider the relationship between measures of volume and returns. We find that when open interest growth over the preceding 12 months is high, futures returns over the next month also tend to be higher. In this sense, high growth in open interest tends to predict high returns in futures markets. We find no such relationship between net financial flows and returns in futures markets. Second, we consider the relationship between returns in futures markets and returns in equity and Treasury markets. In particular, we examine the correlation between returns in various markets and measures of financialization. While the daily data suggests that the correlation in returns among markets rises with financialization, in the monthly data the change in the correlation is not significant.

5.1. Open Interest, Net Financial Flows and Futures Returns

In order to analyze the relationship between futures returns and past trading volume, we consider portfolio strategies in which assets are allocated according past volume. Specifically, in each month in the period 1960-2008, we select the one-third of our commodities which had the highest volume of futures market trade.[10] When our measure of volume is open interest, we work with the growth rate of aggregate open interest in the preceding 12 months and when our measure is net financial flows, we use the imbalance measure used in Hong and Yogo (2012). This imbalance measure is closely related to our measure of net financial flows.

We then compute the returns associated with a strategy of buying long contracts in each of the commodities inside the group with the largest past volume of trade. For open interest, we refer to this strategy as the *hot open interest* strategy. For net financial flows we refer to the strategy as the *hot net financial flow* strategy. We also consider a *random* strategy in which the portfolio of commodities in each month is selected randomly. We compute 200,000 sequences of returns associated with this strategy by repeated random draws over the whole data sample.

[10] We use the data employed in Hong and Yogo (2012), which they kindly shared with us.

Figure 12 shows the cumulative returns for the hot strategies as well as some statistics for the random strategy. The figure reports the median cumulative return, as well as the 10th to 90th percentiles of the cumulative returns for the random strategy. The figure shows that the hot open interest strategy outperforms 90% of the random strategies over the entire sample, while the hot net financial flow strategy performs approximately as well as the median random strategy. Furthermore, the figure shows that the hot open interest strategy outperforms 90 percent of the random strategies from 2000 onwards.

In Figure 13 we plot the distribution of Sharpe ratios associated with the random strategy, as well as the Sharpe ratios for the two hot strategies. These Sharpe ratios are computed by taking the ratio of the average monthly excess return over the corresponding return from holding 3-month Treasury bills, to the standard deviation of this excess return. The figure shows that the Sharpe ratio for the hot open interest strategy, 0.13, is well above the mean Sharpe ratio of the random strategy, 0.08, while the Sharpe ratio for the hot net financial flow strategy, 0.09, is not very different from the random strategy. The $p-$value for testing the null hypothesis that the hot open interest Sharpe ratio is drawn from the random strategy distribution is 0.007, while the associated $p-$value for the hot net financial flow strategy is 0.44. Interestingly, the Sharpe ratio on the hot open interest strategy also dominates the Sharpe ratio for the value-weighted monthly excess return on equity. Using monthly return data over the period, 1960-2008, the Sharpe ratio for equity is 0.072.[11]

These results suggest that when the value of outstanding futures contracts at the beginning of a month are high, futures returns during that month are also high. The figures also show that the data show no such relationship between net financial flows and futures returns.

5.2. Comovement of Returns Across Markets

Next, we examine the comovement of returns across markets. This examination is motivated by the findings of Tang and Xiong (2012), which suggest that financialization affected return comovement.[12]

Comovement and Volume of Trade

For each year we use the data on asset returns within that year to compute three statistics: two pairwise correlations and the standard deviation on futures returns. The two pairwise correlations are between futures and equity returns and between futures and T-bill returns. We compute these three statistics for each year in our sample using daily as well as monthly returns.

[11] Our equity return data are equally weighted daily equity returns taken from the Center for Research on Securities Prices (CRSP) database. These returns were aggregated into monthly returns in Ferreira (2013), and we are grateful to the author who kindly shared his data with us. We obtained daily and monthly returns on 3 month US government treasury bills from the online data base, FRED, maintained by the Federal Reserve Bank of St. Louis.

[12] We are grateful to Tang and Xiong for kindly sharing their data with us.

We are interested in understanding how the pairwise correlation between returns on futures contracts and on equity and T-bills moves with changes in financialization. For each of 27 commodities, we study the relationship between the three statistics just described and our two measures of financialization. To this end, we run the following regression:

$$y_t = \alpha + \beta x_t + u_t, \; t = 1992, ..., 2009, \tag{2}$$

where y_t is one the three statistics described and x_t is our measure of volume. Our results are displayed in Table 7. That table reports the average value of the β's across the 27 commodities. The table shows that, apart from one case, the average value of β is not statistically significantly different from zero.[13] The monthly data show no evidence of a link between financialization and the volatility of returns or the comovement of returns between futures markets and equity or Treasury markets.

5.2.1. Comovement and Indexation

Next, we look for the effects of financialization by investigating whether the comovement properties of a commodity depend on whether or not it is included in the two popular commodity indexes. Using daily return data, Tang and Xiong (2012) show that the pairwise correlation among commodities included in the indices rose sharply after 2004, relative to the increase for non-indexed commodities. Their results are reproduced in the 1,1 panel of Figure 15.[14] We then redid the calculations using monthly observations on monthly returns and those results are displayed in the 2,2 panel of the figure. Note that now it makes little difference whether the correlations are between commodities that are included in an index or not. To understand the reason for the different properties of daily and monthly data, we went back to the daily data and redid the Tang and Xiong calculations when returns are 10 day returns and 20 day returns. The results are displayed in the 1,2 and 2,1 panels of Figure 15, respectively. Note that when the 10 day returns are considered, the difference between indexed and non-indexed commodities is substantially smaller than it is in the case of one-day returns. By the time we consider 20 day returns, the differences are nearly gone.

We obtain similar results when we consider the average of correlations between commodity futures and the return on equity. Panel a in Figure 16 displays the correlations based on daily returns. Note that it makes a noticeable difference for the correlation, whether or not a commodity is included in the indices. Panel b shows that the difference is gone when the correlations are computed using monthly returns.

In the Technical Appendix we explore the idea that the difference between the monthly and daily data

[13] Consistent with the findings of Tang and Xiong (2012), this coefficient is significantly positive in the daily data.

[14] To construct these correlations, for each pair of commodities and each date, we computed a correlation between returns on the two commodities, using a centered 13 month window of data. For each month, we then computed the average of all that month's pairwise correlations.

can be accounted for by technical details not related to economic fundamentals, about the functioning of futures markets. In any event, in our view the monthly data are likely to be more relevant for determining production, consumption and spot prices of commodities.

In sum, the data suggest that high levels of open interest are associated with high expected futures returns and net financial flows show no relationship with returns.

6. Model of Futures Markets

The empirical findings described so far can be summarized broadly by the following stylized facts.

1. There is no systematic relationship between the volume of trade in the futures markets for a particular commodity and the behavior of spot prices, particularly the volatility of spot prices for that commodity.

2. There is a positive association between open interest and futures market returns, in the sense that high levels of open interest are associated with a subsequent above average return in futures markets.

3. The correlation between net financial flows and futures markets returns is roughly zero.

Here we develop a simple model of futures markets which is consistent with these stylized facts. The model suggests that futures markets play an important social role that has not been emphasized in the conventional view of the economic role of futures markets. The conventional view emphasizes the idea that futures markets allow "insiders", namely firms and individuals who have a direct commercial role in a particular commodity to purchase insurance from "outsiders', namely those individuals and firms who have no direct commercial interest in the particular commodity. In this conventional view, insiders are referred to as hedgers and outsiders as speculators. The conventional view suggests that net financial flows should be positively correlated with returns in futures markets. The reason is that the outsiders, if they are risk averse, should be compensated for the insurance they provide to insiders. The conventional view also suggests that when the hedging needs of insiders are large, open interest should be high and so should net financial flows. As we have seen, the data on net financial flows does not support this implication of the conventional view.

Here we argue that the data suggests an alternative view. In this alternative view, futures markets are used by insiders to insure each other, outsiders to insure each other, and both trading groups to insure each other as well. We formalize this alternative view by developing a model with two key features. First, in our model, futures markets allow outsiders to use futures markets to insure against risks confronting their incomes and portfolios. Second, in our model some insiders wish to purchase insurance and other insiders wish to sell insurance. Thus, futures markets allow outsiders to insure themselves and insiders to insure each other. In our model, futures markets provide a valuable mutual insurance role that is absent

in the conventional view.

We begin by describing the model and then highlight the key features of the model. We consider a static model of trade in an intermediate good labeled "wheat" for convenience. Wheat is produced by "farmers" and transformed by "bakers" into a final consumption good labeled "bread". Farmers and bakers are "insiders' in the sense that they have a direct commercial interest in the wheat market. Our model also has a third type of agents, "outsiders' who have no direct commercial interest in the wheat market. The demand for bread is affected by shocks and the income of outsiders is also stochastic. We assume that the correlation between outsiders' income and bread demand fluctuates. This correlation creates a desire on the part of outsiders to use futures markets as an insurance device. Fluctuations in this correlation imply that in some situations, outsiders could be insuring insiders and in other situations, insiders could be insuring outsiders.

Our modeling of trade in an intermediate good is, in part, motivated by the observation that, in practice, almost all futures markets trade in intermediate goods, rather than final goods or raw materials. This way of modeling trade allows us to develop a sharp distinction between open interest and net financial flows. The idea is that, in the model, as in the data, a significant amount of futures trade is among insiders rather than between insiders and outsiders. In our model, farmers and bakers use futures markets to insure each other against fluctuations in the price of bread, and much of the volume of trade is between these parties.

Our modeling of the shocks is intended to capture the idea that outsiders might wish to trade in futures markets to hedge against risks to their income. Such trade is valuable if spot prices of bread are correlated with the income of outsiders. Whether outsiders wish to go short or long in the futures market depends on whether futures spot prices are positively or negatively correlated with their incomes. The conventional view of futures markets, which emphasizes the role of outsiders in insuring insiders tend to imply that met financial flows are positively correlated with returns on futures markets. In our model, in contrast, depending on the realization of the shocks, outsiders could just as well be purchasing insurance from insiders. This aspect of the model plays a key role in generating a roughly zero correlation between net financial flows and returns.

Formally, we assume that the measure of farmers and bakers is the same and denoted by λ. The measure of outsiders is $(1-2\lambda)$. The demand for bread is affected by three shocks, denoted θ, η and ν. All three shocks have mean zero and have variances given by σ_θ^2, σ_η^2, and σ_ν^2. The shock θ is realized before production and futures trading and affects the average level of demand. The shocks ε and η introduce uncertainty in the spot prices of bread and wheat. This uncertainty makes hedging against price risk desirable. The shock η is correlated with outsiders' income and leads outsiders to seek to trade in futures markets to insure against their risky income. We model this correlation by assuming that

outsiders' income is given by $x = -s\eta$ where the random variable s has mean $\bar{s}$ and variance σ_s^2. All agents are risk averse and have constant absolute risk aversion preferences. For later use, let $\varepsilon = \eta + \nu$.

Formally, the timing is that first θ and s are realized. Then futures markets open, the three types of agents choose how many futures contracts to buy and farmers choose how much wheat, q, to produce. Finally, the demand shocks η and ν are realized, futures contracts are settled, bakers decide how much bread, Q, to produce and how much wheat to buy.

This formulation is meant to capture the following ideas. Risk averse farmers and bakers participate in futures markets to hedge the risks arising from the demand shocks η and ν. Outsiders participate in futures markets to hedge against their income risk which is correlated with the demand shocks. The role of the demand shock θ is to induce fluctuations in hedging demand by insiders. When demand is, on average high, so is production of wheat and bread. As a result, so is the variability of profits of the insiders and they have greater need to hedge fluctuations in profits. Of course, all agents have speculative motives for trade.

The demand function for bread is given

$$P^Q = D\left(Q, \theta + \varepsilon\right), \tag{3}$$

where P^Q denotes the price of bread and D denotes the (inverse) demand function. Here, P^Q, as well as other prices and costs are denominated in terms of a numeraire good. The production technology for producing bread is given by

$$Q = q^\delta, \tag{4}$$

where we assume that the parameter, δ, satisfies $1/2 < \delta < 1$.[15] The cost of producing q units of wheat for each farmer is

$$c\left(q\right) = \bar{c}q + \frac{1}{2}cq^2,\ \bar{c}, c > 0.$$

All agents have the same mean-variance preferences. Let P denote the spot price of wheat and F denote the futures price.

6.1. Wheat Producer's Problem

Consider the production and hedging decision of the wheat producer. Let H^w denote the number of contracts purchased by the wheat producer. If $H^w > 0$ then the producer has a long position and if $H^w < 0$ the producer has a short position. Each such position yields an amount of the numeraire good at

[15] On the face of it, this assumption implies, counterfactually, that the share of commodities in final goods production is greater than one-half. In the appendix we extend this model to allow for other inputs and show that our assumption is consistent with a substantially smaller share of commodities in production.

the end of the period given by $H^w R$, where R denotes the return on a long futures contract, $R = P - F$. That is, a purchaser is entitled to receive one unit of wheat at the end of the period for a payment of F units of the numeraire good. The value of one unit of wheat at the end of the period is P, so that the payoff to a purchaser of a contract is $P - F$.

The profits from production are given by $Pq - c(q)$. The producer chooses q and H^w to solve

$$\max_{q,H^w} E\left[Pq + RH^w\right] - \frac{\alpha}{2} var\left[Pq + RH^w\right] - c(q), \tag{5}$$

taking F and the distribution of P as given. Here α is the coefficient of absolute risk aversion of the wheat producer. Also, $E[x]$ and $var[x]$ denote the expectation and variance of x conditional on θ and s. We find it convenient to adopt the following change variables:

$$h^w = H^w + q.$$

With this change of variables, using the observation that F and q are known, the producer's problem (5) becomes:

$$\max_{q,h^w} Fq + h^w ER - \frac{\alpha}{2}\left(h^w\right)^2 var[R] - c(q).$$

The first order conditions of the wheat producer's problem are:

$$F = c'(q) \tag{6}$$

$$H^w = -q + \frac{ER}{\alpha var(R)}. \tag{7}$$

The first order condition, (6), can be understood by a simple arbitrage argument. From the perspective of an individual farmer, the futures market can be thought of as a technology for producing q units of wheat for sale in the spot market at a cost, Fq. The production technology is a technology for producing q units of wheat for sale in the spot market at a cost,$c(q)$. Since the revenues from both technologies are the same, Pq, at the margin the costs of the two technologies must the same, so that (6) must hold.

The first order condition, (7), can be used to decompose the desired futures position of the wheat producer into two elements. The first element, $-q$, captures the desire to hedge the risk to profits arising from fluctuations in P due to the shock, ε. We refer to this element as *hedging motive* of farmers because by selling q units of wheat in the futures market the farmer hedges all risk and sets the variance of profits to zero. To understand the second element in (7), suppose that the expected return in the futures market, ER, is not zero. Then, the farmer chooses to sell a different amount from q units in the futures market. We call this element the *speculative motive* because doing so provides a gain in the form of higher expected

profits at the cost of higher variance.

6.2. Baker's Problem

Consider the problem of how much bread to produce after all the shocks have been realized. Taking P^Q and P as given, the bakers choose q to solve

$$\max_q P^Q q^\delta - Pq. \tag{8}$$

The first order condition for this problem can be written as

$$\delta P^Q q^{\delta-1} = P. \tag{9}$$

This first order condition determines the price of bread relative to the price of wheat, P^Q/P, for a given quantity of wheat, q. Since wheat producers make their production decisions before observing the realization of ε, it follows that in equilibrium this relative price cannot depend on ε. Using this observation, substituting (9) into (8), we have that the equilibrium profits of the baker from bread production is given by

$$\left(\frac{1}{\delta} - 1\right) Pq.$$

Note that even though q is not a function of ε, profits are a function of this random variable because P is.

Next, we obtain an induced demand function for wheat. To do so, we use (3), (4), and (9) to obtain

$$P = D\left(q^\delta, \theta + \varepsilon\right) \delta q^{\delta-1}. \tag{10}$$

We approximate this induced demand function for q linearly by

$$P = D_0 - D_q q + \theta + \varepsilon \tag{11}$$

where the unit coefficient on $\theta + \varepsilon$ is simply a normalization.

Consider next the hedging decision of the baker, which occurs before the realization of the demand shock ε. The baker solves

$$\max_{H^b} E\left[Pq\left(\frac{1}{\delta} - 1\right) + RH^b\right] - \frac{\alpha}{2} var\left[Pq\left(\frac{1}{\delta} - 1\right) + RH^b\right],$$

where H^b denotes the number of futures contracts purchased by the baker. Using a similar change of variables as in our solution to the wheat producer's problem, it is easy to show that the first order condition

of this problem is:

$$H^b = q\left(1 - \frac{1}{\delta}\right) + \frac{ER}{\alpha var\left(R\right)}. \tag{12}$$

As in our discussion of the farmer's problem, we refer to the first term in (12) as the hedging motive and the second term as the speculative motive. Note that if $1/2 < \delta < 1$, then the hedging motive for the baker is weaker than it is for the farmer. The reason is that in this case the baker's profits are less sensitive to fluctuations in ε than are the farmer's profits, so that the hedging motive is weaker. That is, the baker is naturally hedged against fluctuations in the price of wheat because when the price of wheat is high, so is the price of bread.

6.3. The Outsiders' Problem

We assume that participation has benefits and costs for outsiders. A benefit is that such participation allows outsiders to hedge their own income risk. A cost is that futures returns also fluctuate in response to factors that are not correlated with outsiders' income. Of course, in our model outsiders participate in commodity futures markets for purely speculative reasons as well. We also assume that the benefits of participation fluctuates stochastically. We capture the stochastic benefits and costs of participation by assuming that the demand shock, ε, has a *common component*, η, and a *commodity-specific component*, v :

$$\varepsilon = \eta + v,$$

and outsiders' income, x, is given by

$$x = -s\eta.$$

We assume that s is realized at the beginning of the period, before outsiders choose how many futures contracts to buy or sell. Note that with this specification, outsiders benefit by participating in futures markets because their income, x, is partly correlated with the demand shock, ε. Furthermore, allowing s to be stochastic allows these benefits to fluctuate over time. At the time the outsiders' futures contract decision is made, the covariance between their income and the demand shock is proportional to the realized value of s.

The outsiders solve

$$\max_{H^o} E\left[RH^o - s\eta\right] - \frac{\alpha}{2} var\left[RH^o - s\eta\right].$$

To solve for the optimal H^o, it is useful to note that

$$var\left[RH^o - s\eta\right] = E\left[\varepsilon H^o - s\eta\right]^2,$$

where we have used $R - ER = \varepsilon$ and $Es\eta = 0$. It follows that, after rearranging, the outsiders' problem can be written as:

$$\max_{H^o} ERH^o - \frac{\alpha}{2}\left[\sigma_\varepsilon^2 \left(H^o\right)^2 - 2sH^o\sigma_\eta^2\right] - \frac{\alpha}{2}s^2\sigma_\eta^2. \tag{13}$$

The solution to this problem is

$$H^o = s\frac{\sigma_\eta^2}{\sigma_\varepsilon^2} + \frac{ER}{\alpha\sigma_\varepsilon^2}. \tag{14}$$

Note that the outsiders' hedging motive, $s\sigma_\eta^2/\sigma_\varepsilon^2$, fluctuates over time with s.

6.4. The Futures Price and Equilibrium Conditions

The market clearing condition in the futures market is

$$\lambda\left(H^w + H^b\right) + (1 - 2\lambda)\, H^o = 0. \tag{15}$$

An equilibrium consists of a futures market price, F; quantities of wheat and bread, Q and q; futures demand functions, H^o, H^b and H^w, all of which are functions of s and θ; and of prices, P^Q,P, which are functions of s, θ and ε. These functions must satisfy the production function for bread, (4), and the market clearing conditions in the futures market, (15), and in the market for bread, (3). Given our linearization of the derived demand function for wheat, (11), all these are linear functions of the relevant shocks. We display these functions in the appendix.

Our main proposition below uses the equilibrium functions for wheat production and for the futures return. These are given by

$$R = R_0 + R_\theta\theta + R_s s + \varepsilon, \tag{16}$$

and,

$$q = q_0 + q_\theta\theta + q_s s. \tag{17}$$

We prove the following lemma in the appendix:

Lemma 1. *(Pricing function properties): The equilibrium return and production rules given in (16) and (17) satisfy:* $R_\theta > 0$, $R_s < 0$, *and* $q_\theta, q_s > 0$.

To understand the signs of the coefficients in the lemma, consider a positive shock to bread demand, θ. The direct effect of this shock is to raise the return on futures, R, by raising the expected price of wheat. The rise in the expected price of wheat increases speculative demand for futures contracts and drives up the futures price, F. This rise in F stimulates an increase in wheat production, q. The increase in q and associated changes in hedging demand by farmers and bakers generates partially offsetting effects on q and R. The overall effects are to raise R and q, so that $R_\theta, q_\theta > 0$.

Consider next a positive shock to outsiders' hedging demand, s. By raising the demand for futures contracts, the direct effect of this shock is to raise their price,F, and to lower the expected return on futures contracts, R. The rise in F increases q. As with the shock to θ, there are offsetting effects. The overall effect is to reduce R and raise q, so that $R_s < 0, q_s > 0$.

6.5. Theoretical Results

We use the coefficients derived above to prove our main result. To do so, note that in our model open interest, oi, is given by

$$oi = \lambda \left|H^b\right| + \lambda \left|H^w\right| + (1-2\lambda) \left|H^o\right|, \tag{18}$$

and net financial flows, n, is given by

$$n = (1-2\lambda) H^o. \tag{19}$$

We use our empirical findings to restrict attention to plausible ranges for parameters and shocks. Our empirical findings are that on average, net financial flows are positive and small relative to oi. These observations suggest that reasonable parameter values for our model should imply that, in equilibrium, $n > 0$. Given our assumption that $\delta \in (1/2, 1)$, inspection of (7) and (12) shows that $H^b > H^w$. If n is small relative to oi the equilibrium must also satisfy $H^b > 0$ and $H^w < 0$. That is, the farmers take short positions while the bakers and outsiders take long positions in the futures market.

To obtain expressions for H^b, H^w and H^o we first substitute for these variables from (7), (12) and (14) into (15) and rearrange to obtain:

$$\frac{ER}{\alpha\sigma_\varepsilon^2} = \lambda q \frac{1}{\delta} - (1-2\lambda) \frac{\sigma_\eta^2}{\sigma_\varepsilon^2} s, \tag{20}$$

where we have used that $var(R) = \sigma_\varepsilon^2$. Substituting for expected returns from (20) into (12) and (14), we have

$$H^b = q\left(1 - \frac{1}{\delta} + \frac{\lambda}{\delta}\right) - (1-2\lambda) \frac{\sigma_\eta^2}{\sigma_\varepsilon^2} s, \tag{21}$$

$$H^o = \lambda q \frac{1}{\delta} + 2\lambda \frac{\sigma_\eta^2}{\sigma_\varepsilon^2} s. \tag{22}$$

Based on our empirical analysis that for all realizations of the shocks, the right sides of (21) and (22) are positive. In keeping with our empirical finding that outsiders play a relatively small role in futures markets for commodities we will assume that the measure of outsiders, $1-2\lambda$, is small, so that λ is not too far from $1/2$. Formally, we will capture the idea that the measure of outsiders is small by assuming

$$1 - \frac{1}{\delta} + \frac{\lambda}{\delta} > 0. \tag{23}$$

Proposition 1. *Suppose $H^b, H^o > 0$ for all realizations of shocks and that (23) holds. Then, $cov\,(oi, R) > cov\,(n, R)$. Furthermore, given a set of values for the other parameters, a value of the variance of the shock to outsiders' hedging demand, σ_s^2, exists such that $cov\,(n, R) = 0$.*

Remark 1. Clearly, if $cov\,(n, R) = 0$, the Proposition implies that $cov\,(oi, R) > 0$.

Thus, our model is consistent with the empirical finding that open interest and returns are positively correlated while net financial flows and futures returns are uncorrelated. The economic mechanism that produces these results is straightforward. Open interest tends to be high when production is high, that is when demand for bread is high. In our model, this realization is associated with high values of the demand shock θ. Such a situation is also associated with higher levels of volatility in the revenues of the insiders because their revenues are proportional to production. Since agents are risk averse, such a situation implies that expected returns must rise.

The relationship between net financial flows and returns is weaker than that between open interest and returns because the hedging demand of outsiders fluctuates. Holding all other shocks at their mean values, a higher than average value of the correlation shock s induces an increase in hedging demand by outsiders (see (14) and an associated fall in expected returns to induce insiders to take on offsetting position. This force tends to make net financial flows and returns negatively correlated. Of course, shocks to demand θ, holding other shocks fixed, tends to increase hedging demand by insiders and drives up returns to induce outsiders to take offsetting positions. Funds flow in from outsiders to meet the insiders' hedging needs. This force tends to induce a positive correlation between returns and net financial flows. If these forces offset each other, the correlation between net financial flows and returns is zero.

7. The Effect of Outsiders on the Volatility of Spot Prices

Our data analysis indicates that, across commodities, there is no systematic relationship between the extent of outsiders' participation in futures markets and the volatility of spot prices. We ask whether our model can produce this absence of a systematic relationship. We assume that commodity markets differ in the variability of shocks. We begin by assuming that the extent of outsiders' participation across different commodity markets varies in a way that is unrelated to market characteristics. We compare markets which are otherwise identical, but have different levels of outsiders' participation. We show that whether markets with higher levels of outsider participation have higher or lower variability of spot prices depends on market characteristics. In particular, the impact on volatility depends on which side of the market, the insiders or the outsiders, have larger shocks to their hedging demand. If market characteristics are such that outsiders have larger shocks, then higher participation by them is associated with higher volatility of spot prices, while if outsiders have smaller shocks then the volatility of spot prices is lower. Thus,

when variations in participation by outsiders is exogenous, our model is consistent with the absence of a systematic relationship between spot price volatility and outsider participation across commodities.

We then endogenize the participation decision of outsiders. We assume that outsiders face a fixed cost to enter a commodity market, and that this cost is distributed randomly across potential entrants. Outsiders enter if the welfare gain associated with participation exceeds the fixed cost. We compare markets with different characteristics. In particular, we examine markets in which the variability of spot prices would be different if the extent of outsiders' participation were exogenously specified to be the same across these markets. We provide sufficient conditions under which, with endogenous entry, the difference in the variability of spot prices is lower than with exogenous entry. In this sense, endogenous entry can offset systematic differences in the volatility of prices induced by differences in market characteristics.

Taken, these arguments suggest that our model is consistent with the observation that there is no systematic relationship between spot price volatility and outsiders' participation.

7.1. Exogenous Participation

In the appendix, we show that

$$var\left(P\right)=\left(\frac{c+\lambda\alpha\sigma_{\varepsilon}^{2}/\delta}{c+D_{q}+\lambda\alpha\sigma_{\varepsilon}^{2}/\delta}\right)^{2}\sigma_{\theta}^{2}+\left(\frac{D_{q}\left(1-2\lambda\right)\alpha\sigma_{\eta}^{2}}{c+D_{q}+\lambda\alpha\sigma_{\varepsilon}^{2}/\delta}\right)^{2}\sigma_{s}^{2}+\sigma_{\varepsilon}^{2}. \tag{24}$$

We then have the following results.

Proposition 2. *Suppose σ_{η}^{2} is sufficiently small, so that fluctuations in hedging demand arise primarily from insiders. Then, $var\left(P\right)$ falls as the measure of outsiders increases.*

Proof. Suppose $\sigma_{\eta}^{2}=0$. Inspecting (24), we see that the variance of spot prices, $var\left(P\right)$, increases in λ. The result follows by continuity. □

The intuition for this result is that production, q, becomes more responsive to fluctuations in θ as the measure of outsiders increases. From (11) the greater responsiveness of q offsets the direct effect of a rise in θ on the spot price, P. To understand this responsiveness suppose θ rises and initially hold q fixed. The expected price, P, then rises, increasing demand for futures by outsiders, thereby driving up futures prices, F. The larger is the measure of outsiders, the greater is the increased demand for futures and the larger is the rise in F in response to a given rise in θ. Since producers set q by equating marginal cost to F (see (6)), it follows that the quantity of production increases more in response to a rise in θ, the greater is the measure of outsiders. This rise in production mutes the rise in prices associated with a rise in θ. Thus, an increase in the measure of outsiders stabilizes spot prices.

Proposition 3. *Suppose σ_θ^2 is sufficiently small, so that fluctuations in hedging demand arise primarily from outsiders. Then, $var(P)$ increases as the measure of outsiders increases.*

Proof. Suppose $\sigma_\theta^2 = 0$. Inspecting (24), we see that the variance of spot prices, $var(P)$, decreases in λ. The result follows by continuity. □

The intuition for this result is that production, q, becomes more responsive to fluctuations in s as the measure of outsiders increases. From (11) these fluctuations in q result in fluctuations in the spot price, P. To understand why, suppose that s rises. Then, the total demand for futures contracts by outsiders rises relatively more as the measure of outsiders increases. This rise in total demand raises futures prices, F. Since producers set q by equating marginal cost to F (see (6)), it follows that the quantity of production increases more in response to a rise in s, the greater is the measure of outsiders. This rise in production results in a fall in P. Thus, an increase in the measure of outsiders increases the variance of spot prices.

Suppose that in the cross section of commodity markets, there are some markets in which parameters satisfy the condition of Proposition 2 and some markets that satisfy the condition of Proposition 3. In this case, the model predicts that there is no systematic pattern between the extent of participation of outsiders in commodity futures markets and the degree of spot price volatility.

When we study endogenous participation, it is useful to examine how $var(P)$ changes in response to the variance of the shocks, $\sigma_\theta^2, \sigma_s^2$ and σ_ε^2 holding outsiders' participation fixed. Inspection of (24) immediately yields the following lemma:

Lemma 2. *Holding λ fixed, an increase in σ_θ^2 or σ_s^2 increases $var(P)$. Furthermore, if λ is sufficiently close to $1/2$ or σ_η^2 is sufficiently small then an increase in σ_ε^2 increases $var(P)$.*

7.2. Endogenous Participation

We assume that each outsider has a fixed cost, k, of participating in each market. This cost is drawn from a strictly increasing cumulative distribution function, $G(k)$. The fixed cost is paid before any random variable is realized. Let U^P and U^{np} denote the utility of an outsider who participates and does not participate in the futures market, respectively. An outsider chooses to participate in the futures market if the surplus from participation, $U^p - U^{np}$, satisfies

$$U^P - U^{np} \geq k.$$

Let k^* be defined as the fixed cost associated with the marginal participant, namely the value of$k$ that satisfies $U^p - U^{np} = k^*$. Then, in equilibrium the measure of outsiders who participate in futures markets,

must satisfy:

$$G\left(U^P - U^{np}\right) = (1-2\lambda)/\lambda. \tag{25}$$

Given any λ, we can solve the exogenous participation model, to determine the surplus, $U^P - U^{np}$. Equation (25) therefore defines a map to another value of λ. An equilibrium is a fixed point for this map.

Next, from (13) we see that $U^{np} = -\frac{\alpha}{2}s^2\sigma_\eta^2$, so that

$$\begin{aligned} U^P - U^{np} &= ERH^o - \frac{\alpha}{2}\left[\sigma_\varepsilon^2 (H^o)^2 - 2sH^o\sigma_\eta^2\right] \\ &= \alpha\sigma_\varepsilon^2 \left\{\frac{ER}{\alpha\sigma_\varepsilon^2}H^o - \frac{1}{2}H^o\left[H^o - 2s\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\right]\right\}, \end{aligned}$$

after rearranging. Substituting for $ER/(\alpha\sigma_\varepsilon^2)$ from (14), we obtain that the surplus from participation is given by

$$U^P - U^{np} = \frac{1}{2}\alpha\sigma_\varepsilon^2 E_0 (H^o)^2 = \frac{1}{2}\alpha\sigma_\varepsilon^2\left[(E_0H^o)^2 + var_0(H^o)\right],$$

where E_0 denotes the unconditional mean and var_0 denotes the unconditional variance.

In the appendix, we prove the following lemma:

Lemma 3. *Holding the measure of participating outsiders,* $(1-2\lambda)/\lambda$, *fixed, the surplus from participation,* $U^P - U^{np}$, *is increasing in* σ_θ^2 *and* σ_s^2. *Furthermore, if* $\bar{s}$ *is sufficiently large and* λ *is sufficiently close to* $1/2$, *then the surplus is decreasing in* σ_ε^2.

Next, we turn to the main results of this section.[16] To do so, we decompose the *overall effect* on $var(P)$ of a change in σ_θ^2, σ_s^2 and σ_ε^2 into a direct effect and an entry effect. The *direct effect* holds λ fixed and the entry effect refers the effect on $var(P)$ that arises due to the change in λ. We say that the overall effect is *ambiguous* if the direct and entry effects have opposite signs. Notice that given any direct and entry effects, we can always choose a distribution function G so that the overall effect is zero.

From (25), we see that an increase in the surplus from participation increases the measure of participating outsiders. Thus, for a given F, the entry effect can be determined by examining how the surplus responds to changes in σ_θ^2, σ_s^2 and σ_ε^2. In order to understand how the overall effect is determined, consider the effect of an increase in σ_θ^2 or σ_s^2. From (2) the direct effect of such an increase is to increase the variance of spot prices. From (3) such an increase increases surplus and therefore increases the measure of outsiders. If the conditions of (2) are satisfied, the indirect effect is to reduce the volatility of spot prices. Thus, we have the following Proposition:

Proposition 4. *Suppose* σ_η^2 *satisfies the condition of Proposition 2. Then, an increase in* σ_θ^2 *or* σ_s^2 *has an ambiguous effect on the variance of spot prices,* $var(P)$.

[16] In proving the results of this section, we consider the effects of small changes in parameters and we assume that equilibrium outcomes change continuously with these parameters.

Similar logic yields the following Proposition:

Proposition 5. *Suppose σ_θ^2 is satisfies the condition of Proposition 3 and suppose that $\bar{s}$ and λ satisfy the conditions of lemma 3. Then, an increase in σ_ε^2 has an ambiguous effect on the variance of spot prices, $var\left(P\right)$.*

8. Conclusion

We have shown that there is no empirical link between financialization and spot price behavior. We have argued that the data are inconsistent with the conventional one-way insurance view of the economic role of futures markets and are consistent with an alternative mutual insurance view, and have developed a model of the mutual insurance view. The model is consistent with the data in four respects. The first is that net financial flows are small relative to open interest. The second is that net financial flows are unrelated to futures returns. The third is that high levels of open interest are associated with high futures returns. The fourth is that there is no relationship between financialization and spot price behavior across sectors. We emphasize that the absence of a link between financialization and spot price behavior does not mean that policy or technological changes have no effect on either financialization or spot price volatility. Indeed, in our model policy affects both. The welfare effects of such policies can be analyzed in a model like ours. (See Chari et al. (1990) for an analysis in a somewhat different model.) We leave further such analyses to future work.

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A Appendix: Proofs of Results for Model

A1. Share of Commodities in Production

In the text, we adopt the following production function for the final good,Q, as a function of the commodity,q :

$$Q = q^{\delta},\ \frac{1}{2} < \delta < 1.$$

Our assumption on the size of δ may give the impression that the share of the commodity in the production of final goods must be very high for our analysis to be relevant. Here, we point out that our δ is consistent with the notion that the share of commodities in production is quite low. To do this, we extend the model to include another input, say x. Thus, suppose that the production function for$Q$ is given by

$$Q = q^{\tilde{\delta}} x^{\omega},\ \omega, \tilde{\delta} \geq 0,\ 0 < \omega + \tilde{\delta} < 1. \tag{A.1}$$

The market price of q and x are P and w, respectively. Note that the technology exhibits decreasing returns to scale, which affects our implicit assumption that in addition to q and x, the producer also possesses a fixed amount of another factor (e.g., managerial talent). Profits represent the return on that factor.

Profits are given by

$$P^{Q} g\left(q, x\right) - Pq - wx.$$

Profit maximization leads to the following first order conditions:

$$\tilde{\delta} P^{Q} Q = Pq \tag{A.2}$$

$$\omega P^{Q} Q = wx, \tag{A.3}$$

so that, after taking ratios,

$$\frac{\omega}{\tilde{\delta}} Pq = wx.$$

Using this and (A.2), we can express profits as follows

$$P^{Q} Q - Pq - wx = \left(\frac{1}{\delta} - 1\right) Pq,$$

where

$$\delta \equiv \frac{\tilde{\delta}}{1 - \omega}.$$

Thus, $\delta \in (1/2, 1)$ is consistent with a small share of the commodity, q, in final good production.

A2. Deriving Equilibrium Pricing Functions

Substituting for H^w,H^b and H^o into (15) from (7), (12) and (14), respectively, we obtain

$$\frac{E\left(P-F\right)}{\alpha var\left(P-F\right)}-\lambda q\frac{1}{\delta}+\left(1-2\lambda\right)s\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}=0. \tag{A.4}$$

Reproducing (11) we have,

$$P=D_0-D_q q+\theta+\varepsilon. \tag{A.5}$$

We guess that

$$F=F_0+F_\theta\theta+F_s s, \tag{A.6}$$

where F_0, F_θ, F_s are to be determined.

Substituting for P and F from (A.5) and (A.6) into (A.4), using $var\left(P-F\right)=\sigma_\varepsilon^2$, we obtain

$$D_0-F_0+\left(1-F_\theta\right)\theta-dq+\left[\left(1-2\lambda\right)\alpha\sigma_\eta^2-F_s\right]s=0, \tag{A.7}$$

where

$$d\equiv D_q+\lambda\alpha\sigma_\varepsilon^2/\delta. \tag{A.8}$$

We guess that $q=q_0+q_\theta\theta+q_s s$. We use the first order condition for q, (6), to express q_0, q_θ and q_s in terms of the equilibrium future's pricing function given in (A.6):

$$F_0+F_\theta\theta+F_s s=\bar{c}+cq_0+cq_\theta\theta+cq_s s$$

From this we see that

$$q_0=\frac{F_0-\bar{c}}{c},\ q_\theta=\frac{F_\theta}{c},\ q_s=\frac{F_s}{c}. \tag{A.9}$$

Substituting, from (A.9) into (A.7) and solving for the future's pricing function:

$$D_0-F_0-d\frac{F_0-\bar{c}}{c}+\left(1-F_\theta-d\frac{F_\theta}{c}\right)\theta+\left[\left(1-2\lambda\right)\alpha\sigma_\eta^2-F_s-d\frac{F_s}{c}\right]s=0$$

or, after using (A.8),

$$\begin{aligned}F_0&=\frac{cD_0+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta\bar{c}}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\\ F_\theta&=\frac{c}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\\ F_s&=\frac{c\left(1-2\lambda\right)\alpha\sigma_\eta^2}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta},\end{aligned} \tag{A.10}$$

Substituting from (A.10) and (A.8) into (A.9), we have

$$q_0 = \frac{D_0 - \bar{c}}{c + D_q + \lambda\alpha\sigma_\varepsilon^2/\delta},\ q_\theta = \frac{1}{c + D_q + \lambda\alpha\sigma_\varepsilon^2/\delta},\ q_s = \frac{(1-2\lambda)\,\sigma_\eta^2\alpha}{c + D_q + \lambda\alpha\sigma_\varepsilon^2/\delta}. \tag{A.11}$$

We now develop the equilibrium price function. Substituting the equilibrium q function from (A.11) into (A.5), we obtain

$$P = P_0 + P_\theta\theta + P_s s + \varepsilon, \tag{A.12}$$

where

$$\begin{aligned} P_0 &= \frac{D_0\,(c+d) - D_q\,(D_0 - \bar{c})}{c + D_q + \lambda\alpha\sigma_\varepsilon^2/\delta} \\ P_\theta &= \frac{c + \lambda\alpha\sigma_\varepsilon^2/\delta}{c + D_q + \lambda\alpha\sigma_\varepsilon^2/\delta} \\ P_s &= -\frac{D_q\,(1-2\lambda)\,\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\alpha\sigma_\varepsilon^2}{c + D_q + \lambda\alpha\sigma_\varepsilon^2/\delta}, \end{aligned} \tag{A.13}$$

where d is defined in (A.7). Also,

$$R = EP - F = R_0 + R_\theta\theta + R_s s. \tag{A.14}$$

where

$$\begin{aligned} R_0 &= \frac{(D_0 - \bar{c})\,\lambda\alpha\sigma_\varepsilon^2/\delta}{c + D_q + \lambda\alpha\sigma_\varepsilon^2/\delta} \\ R_\theta &= \frac{\lambda\alpha\sigma_\varepsilon^2/\delta}{c + D_q + \lambda\alpha\sigma_\varepsilon^2/\delta} \\ R_s &= -\frac{(D_q + c)\,(1-2\lambda)\,\alpha\sigma_\eta^2}{c + D_q + \lambda\alpha\sigma_\varepsilon^2/\delta}. \end{aligned} \tag{A.15}$$

We now provide a proof of Lemma 1, which we restate here for readability,

The equilibrium return and production rules given in (16) and (17) satisfy: $R_\theta > 0$, $R_s < 0$, and $q_\theta, q_s > 0$.

Proof: Substituting for d from (A.8) into (A.15), we have that

$$R_\theta = \frac{\lambda\alpha\sigma_\varepsilon^2/\delta}{c + D_q + \lambda\alpha\sigma_\varepsilon^2/\delta} > 0.$$

Inspection of (A.15) shows that $R_s < 0$.

Substituting from (A.10) into (A.9), we obtain,

$$q_0 = \frac{D_0 - \bar{c}}{c+d},\ q_\theta = \frac{1}{c+d},\ q_s = \frac{(1-2\lambda)\left(1 - \frac{\sigma_\nu^2}{\sigma_\varepsilon^2}\right)\alpha\sigma_\varepsilon^2}{c+d}.$$

Clearly, $q_\theta, q_s > 0$. Q.E.D.

A3. Proof of Proposition1

Proof:

Under the assumption $H^b, H^o > 0$, we have, from (18),

$$oi = \lambda H^b + n,$$

so that

$$cov\left(oi, R\right) = \lambda cov\left(H^b, R\right) + cov\left(n, R\right).$$

Thus, $cov\left(oi, R\right) > cov\left(n, R\right)$ if and only if $cov\left(H^b, R\right) > 0$.

Using (21) and the equilibrium rule for q, (17),

$$H^b = H_0^b + q_\theta\left(1 - \frac{1}{\delta} + \frac{\lambda}{\delta}\right)\theta + q_s\left(1 - \frac{1}{\delta} + \frac{\lambda}{\delta}\right)s - (1-2\lambda)\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}s,$$

where H_0^b is a constant. Using (16), the covariance between H^b and$R$ is

$$cov\left(H^b, R\right) = q_\theta\left(1 - \frac{1}{\delta} + \frac{\lambda}{\delta}\right)R_\theta\sigma_\theta^2 + \left[q_s\left(1 - \frac{1}{\delta} + \frac{\lambda}{\delta}\right) - (1-2\lambda)\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\right]R_s\sigma_s^2.$$

From Lemma 1, q_θ,$R_\theta > 0$, so that under (23) it follows that the first term in the covariance is positive. Also from Lemma 1 $R_s < 0$, so that $cov\left(H^b, R\right) > 0$ if the expression in square brackets is negative. To show that the expression in square brackets is negative, substitute for q_s from (A.11) to obtain

$$q_s\left(1 - \frac{1}{\delta} + \frac{\lambda}{\delta}\right) - (1-2\lambda)\frac{\sigma_\eta^2}{\sigma_\varepsilon^2} = -(1-2\lambda)\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\left[\frac{\alpha\sigma_\varepsilon^2(1-\delta) + \delta(c+D_q)}{\delta(c+D_q) + \alpha\lambda\sigma_\varepsilon^2}\right] < 0,$$

so that $cov\left(H^b, R\right) > 0$.

To show that a value for σ_s^2 exists that sets $cov\left(n, R\right) = (1-2\lambda)\,cov\left(H^o, R\right) = 0$, substitute for equilibrium production, q, from (17) into (22) to obtain

$$H^o = H_0^o + \left[\lambda q_\theta\frac{1}{\delta}\theta + \lambda q_s\frac{1}{\delta}s + 2\lambda\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}s\right], \tag{A.16}$$

where H_0^o is a constant. Using (A.14) and (A.16), we have

$$cov\left(H^o, R\right) = \lambda q_\theta \frac{1}{\delta} R_\theta \sigma_\theta^2 + \left[\lambda q_s \frac{1}{\delta} + 2\lambda \frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\right] R_s \sigma_s^2. \tag{A.17}$$

Since $q_\theta, R_\theta, q_s > 0$ and $R_s < 0$, it follows immediately that there exists a value for σ_s^2 that sets $cov\left(n, R\right) = 0$. Q.E.D.

A4. Proof of Lemma 3

For readability, we reproduce the statement of Lemma 3 here.

Lemma 3. Holding the measure of participating outsiders, $\left(1-2\lambda\right)/\lambda$, fixed, the surplus from participation, $U^P - U^{np}$, is increasing in σ_θ^2 and σ_s^2. Furthermore, if $\bar{s}$ is sufficiently large and λ is sufficiently close to $1/2$, then the surplus is decreasing in σ_ε^2.

Proof. We begin by proving the first part of the lemma. Consider $var_0\left(H^o\right) : R_\theta = \frac{\lambda\alpha\sigma_\varepsilon^2/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}$

$$\begin{aligned}
var_0\left(H^o\right) &= var_0\left(\frac{ER}{\alpha\sigma_\varepsilon^2} + s\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\right) \\
&= \left(\frac{R_\theta}{\alpha\sigma_\varepsilon^2}\right)^2 \sigma_\theta^2 + \left[\frac{R_s}{\alpha\sigma_\varepsilon^2} + \frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\right]^2 \sigma_s^2 \\
&= \left(\frac{\lambda/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right)^2 \sigma_\theta^2 + \left[-\frac{\left(D_q+c\right)\left(1-2\lambda\right)\sigma_\eta^2/\sigma_\varepsilon^2}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta} + \frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\right]^2 \sigma_s^2 \\
&= \left(\frac{\lambda/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right)^2 \sigma_\theta^2 + \left[\frac{-\left(D_q+c\right)\left(1-2\lambda\right)+c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right]^2 \left(\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\right)^2 \sigma_s^2 \\
&= \left(\frac{\lambda/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right)^2 \sigma_\theta^2 + \left[\frac{\left(D_q+c\right)2\lambda+\lambda\alpha\sigma_\varepsilon^2/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right]^2 \left(\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\right)^2 \sigma_s^2
\end{aligned}$$

Substituting from (A.14), we have, after some manipulation,

$$\begin{aligned}
var_0\left(H^o\right) &= \left(\frac{R_\theta}{\alpha\sigma_\varepsilon^2}\right)^2 \sigma_\theta^2 + \left[\frac{R_s}{\alpha\sigma_\varepsilon^2} + \frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\right]^2 \sigma_s^2 \\
&= \left(\frac{R_\theta}{\alpha\sigma_\varepsilon^2}\right)^2 \sigma_\theta^2 + \left[\frac{R_s}{\alpha\sigma_\varepsilon^2} + \frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\right]^2 \sigma_s^2
\end{aligned}$$

$$var_0\left(H^o\right) = \left[\frac{2\lambda\left(c+D_q\right)+\lambda\alpha\sigma_\varepsilon^2/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right]^2 \frac{\sigma_\eta^2\sigma_s^2}{\sigma_\varepsilon^2} + \left[\left(\frac{\lambda/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right)\right]^2 \sigma_\theta^2. \tag{A.18}$$

Consider next $E_0 H^o$

$$E_0 H^o = \bar{s}\frac{\sigma_\eta^2}{\sigma_\varepsilon^2} + \frac{R_0 + R_s\bar{s}}{\alpha\sigma_\varepsilon^2}.$$

Substituting from (A.14), after some manipulation we have

$$E_0 H^0 = \left[\frac{\sigma_\eta^2}{\sigma_\varepsilon^2}\left(\frac{2\lambda\left(c+D_q\right)+\lambda\alpha\sigma_\varepsilon^2/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right)\right]\bar{s}+\frac{\left(D_0-\bar{c}\right)\lambda/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}. \tag{A.19}$$

From (A.18), we see that $var_0(H^o)$ is increasing in σ_θ^2 and σ_s^2. From (A.19) does not dependent on σ_θ^2 and σ_s^2. It follows immediately that surplus is increasing in σ_θ^2 and σ_s^2.

To prove the second part of the lemma, it is convenient to let $h = \sigma_\varepsilon H^o$. We show that the derivative of $(E_0 h)^2$ can be made arbitrarily negative by setting $\bar{s}$ sufficiently large and λ sufficiently close to $1/2$. Note that this derivative is given by

$$2E_0\left(h\right)\times\frac{dE_0\left(h\right)}{d\sigma_\varepsilon^2},$$

where from (A.19) we have

$$E_0 h = \left[\frac{\sigma_\eta^2}{\sigma_\varepsilon}\left(\frac{2\lambda\left(c+D_q\right)+\lambda\alpha\sigma_\varepsilon^2/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right)\right]\bar{s}+\frac{\sigma_\varepsilon\left(D_0-\bar{c}\right)\lambda/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}.$$

Clearly, $E_0 h$ is increasing in $\bar{s}$. Next, note that if $\lambda = 1/2$, then the derivative of Eh can be made arbitrarily negative if$\bar{s}$ is sufficiently large. By continuity this derivative is arbitrarily negative forλ sufficiently close to $1/2$. Thus, the derivative of $(E_0 h)^2$ can be made arbitrarily negative.

Consider next $var_0\left(h\right)$. From (A.18) we have

$$var_0\left(h\right) = \left[\frac{2\lambda\left(c+D_q\right)+\lambda\alpha\sigma_\varepsilon^2/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right]^2\sigma_\eta^2\sigma_s^2+\left[\frac{\sigma_\varepsilon\lambda/\delta}{c+D_q+\lambda\alpha\sigma_\varepsilon^2/\delta}\right]^2\sigma_\theta^2.$$

The derivative of $var_0\left(h^o\right)$ with respect to σ_ε^2 is independent of $\bar{s}$. Thus, it follows that the surplus of participating outsiders is decreasing σ_ε^2 if $\bar{s}$ is sufficiently large and λ is sufficiently close to $1/2$. □

Figure 1: Aggregate Price Index

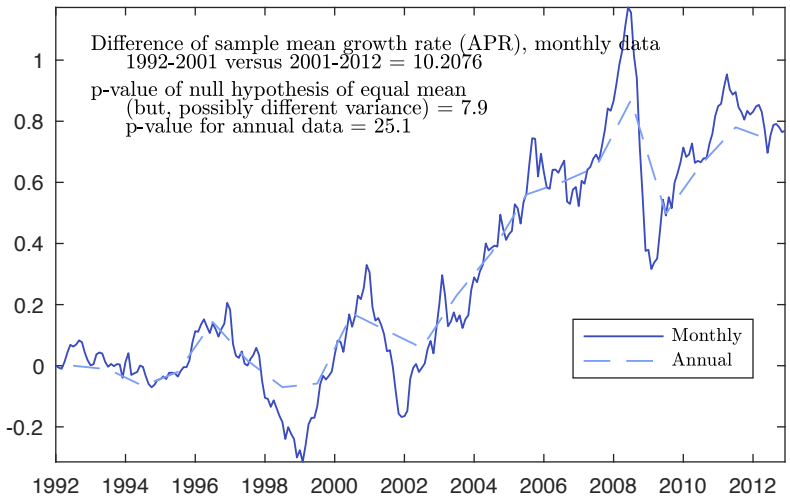


Figure 2: Indices of Commodity Trade Volume

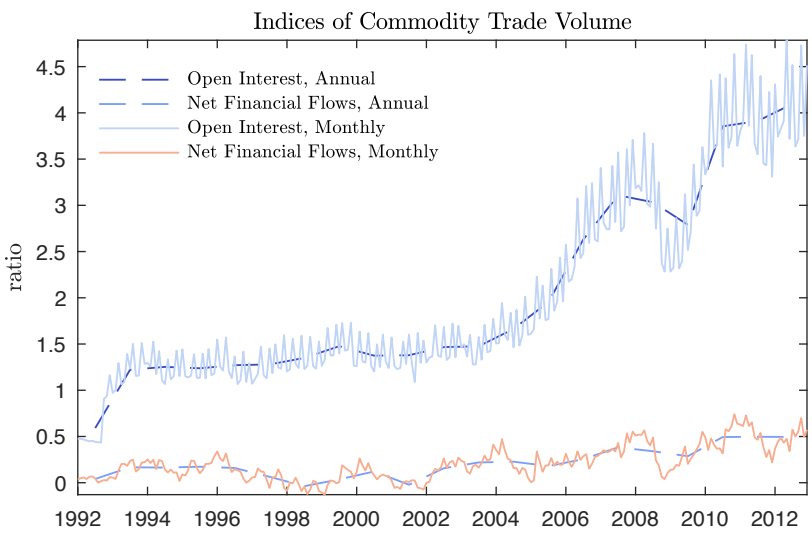
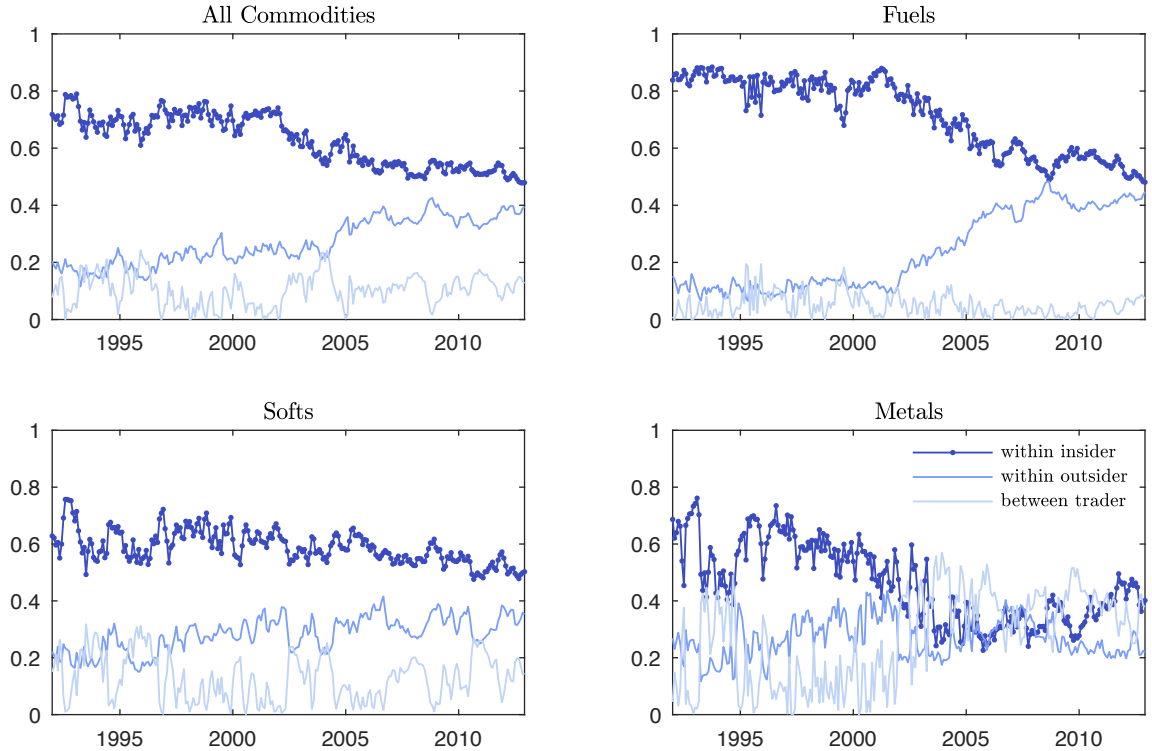


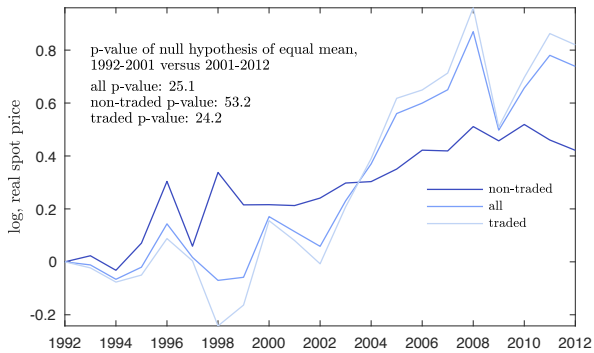
Figure 3: Decomposition of Open Interest Into Insurance Among Various Trader Types



Notes: Figure displays insurance, scaled by open interest (i.e., total insurance). Share of insurance provided among insiders -$min\left[H^L, H^s\right]/oi$, share of insurance provided among outsiders -$min\left[S^L, S^s\right]/oi$, share of insurance provided between insiders and outsiders -$|nff|/oi$. Here,H^L denotes our index of insider long contracts. The index is constructed by scaling the insider long contracts for each commodity by world production of that commodity and weighting the ratio by the share of that commodity in the value of world production for the commodity group. The other objects,H^s,S^L, andS^s are constructed analogously. See text for further details.

Figure 4: Aggregate Price Index and Components

(a) Annual



(b) Monthly

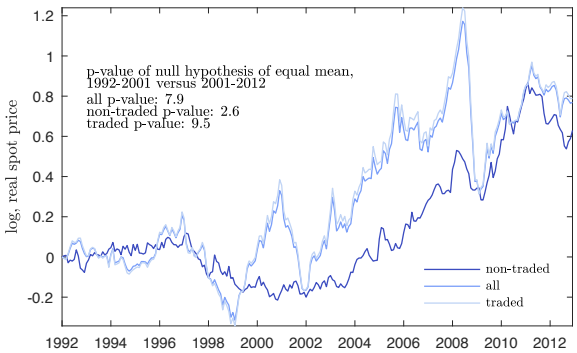


Figure 5: Empirical Density Functions of Commodity Growth Rates, First and Second Part of Data

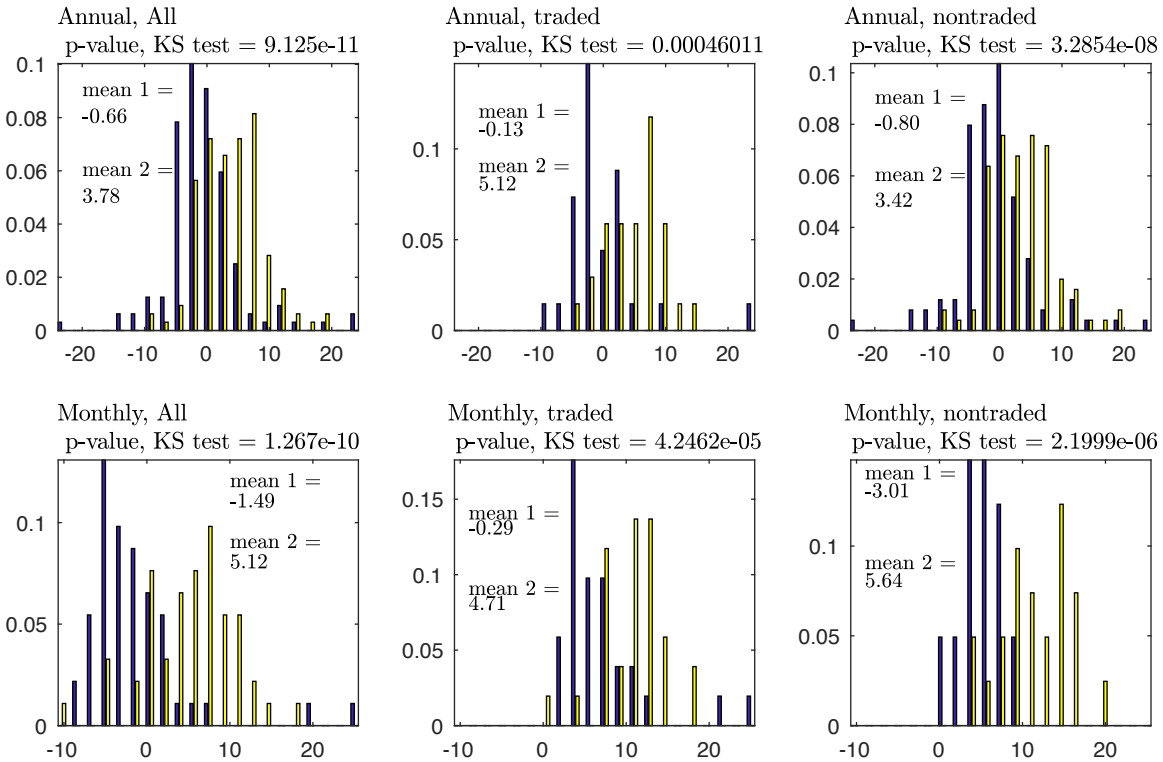
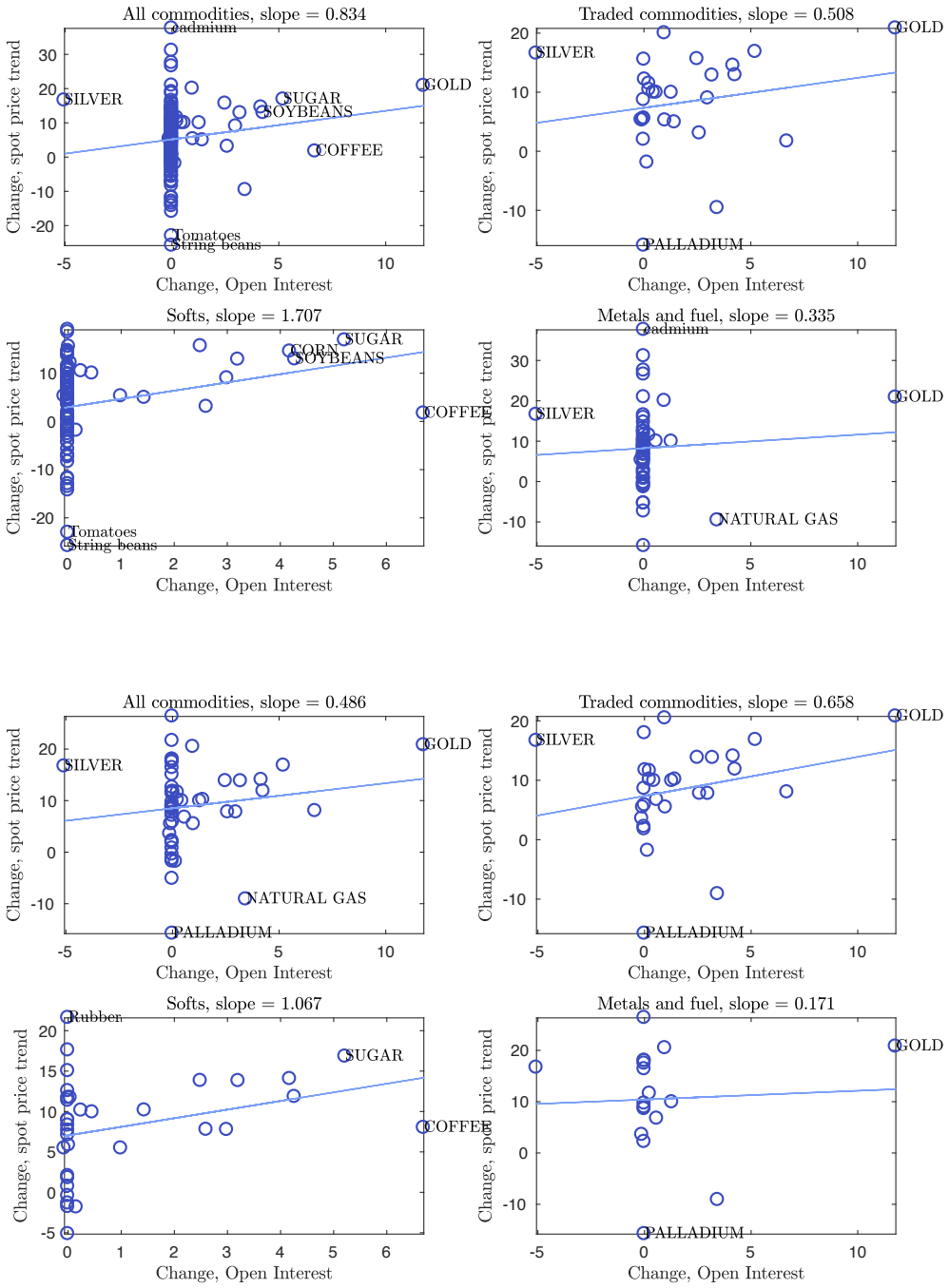


Figure 6: Change in Trend against change in Open Interest

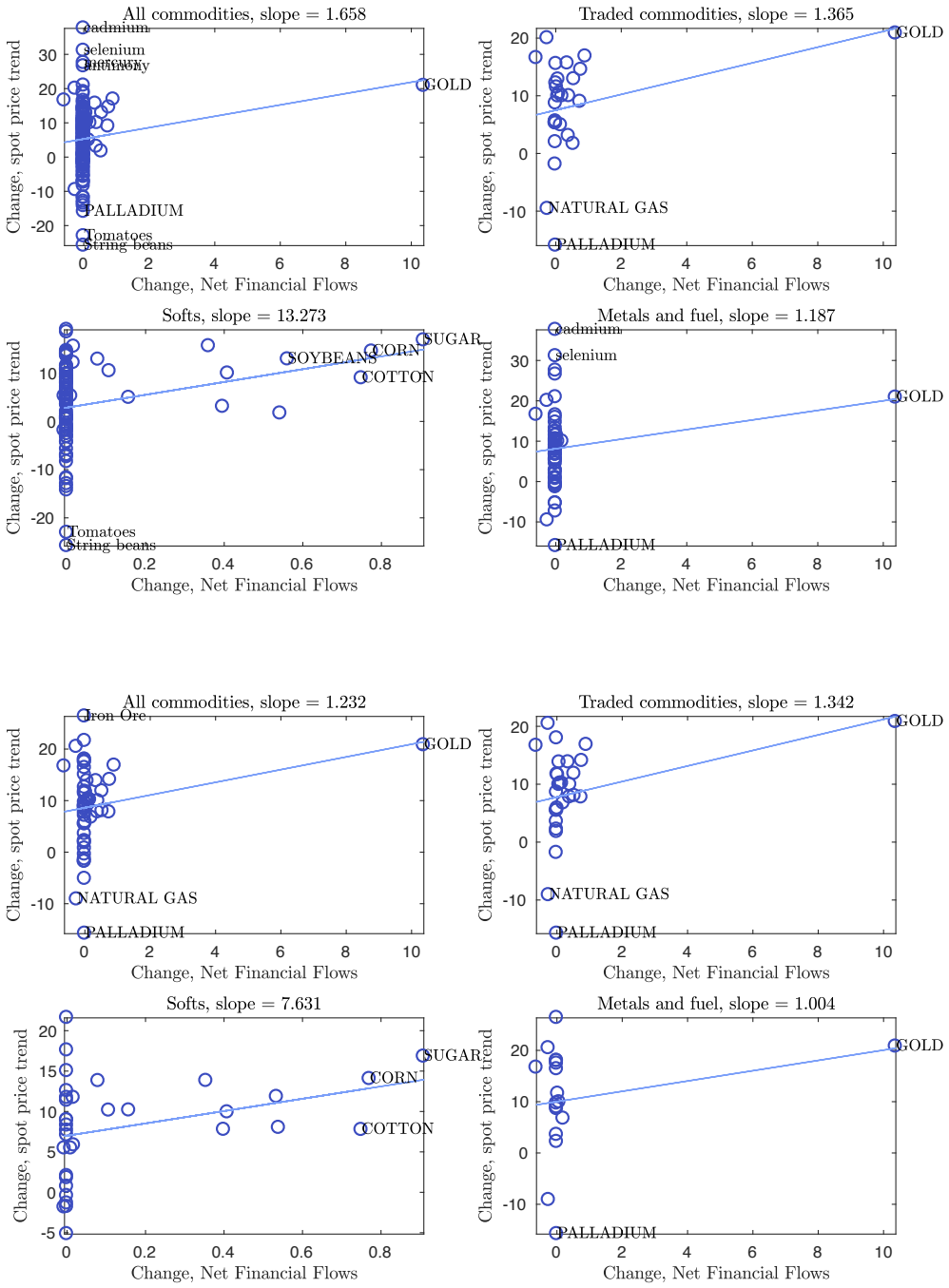
(a) Annual (change multiplied by 100)



(b) Monthly (change multiplied by 1200)

Figure 7: Change in Trend against change in Net Financial Flows

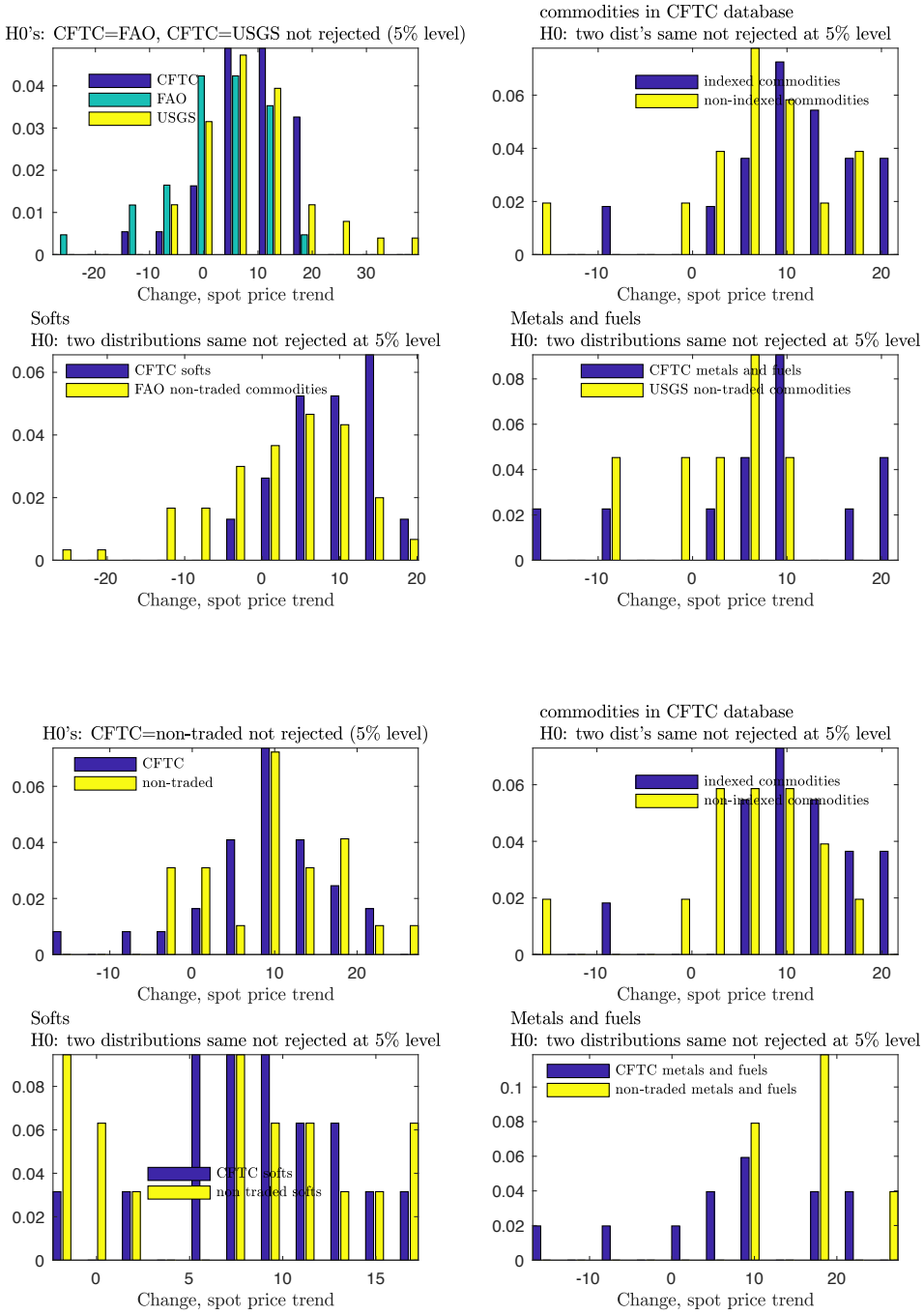
(a) Annual (change multiplied by 100)



(b) Monthly (change multiplied by 1200)

Figure 8: Change in Trend and Net Financial Flows in Histogram

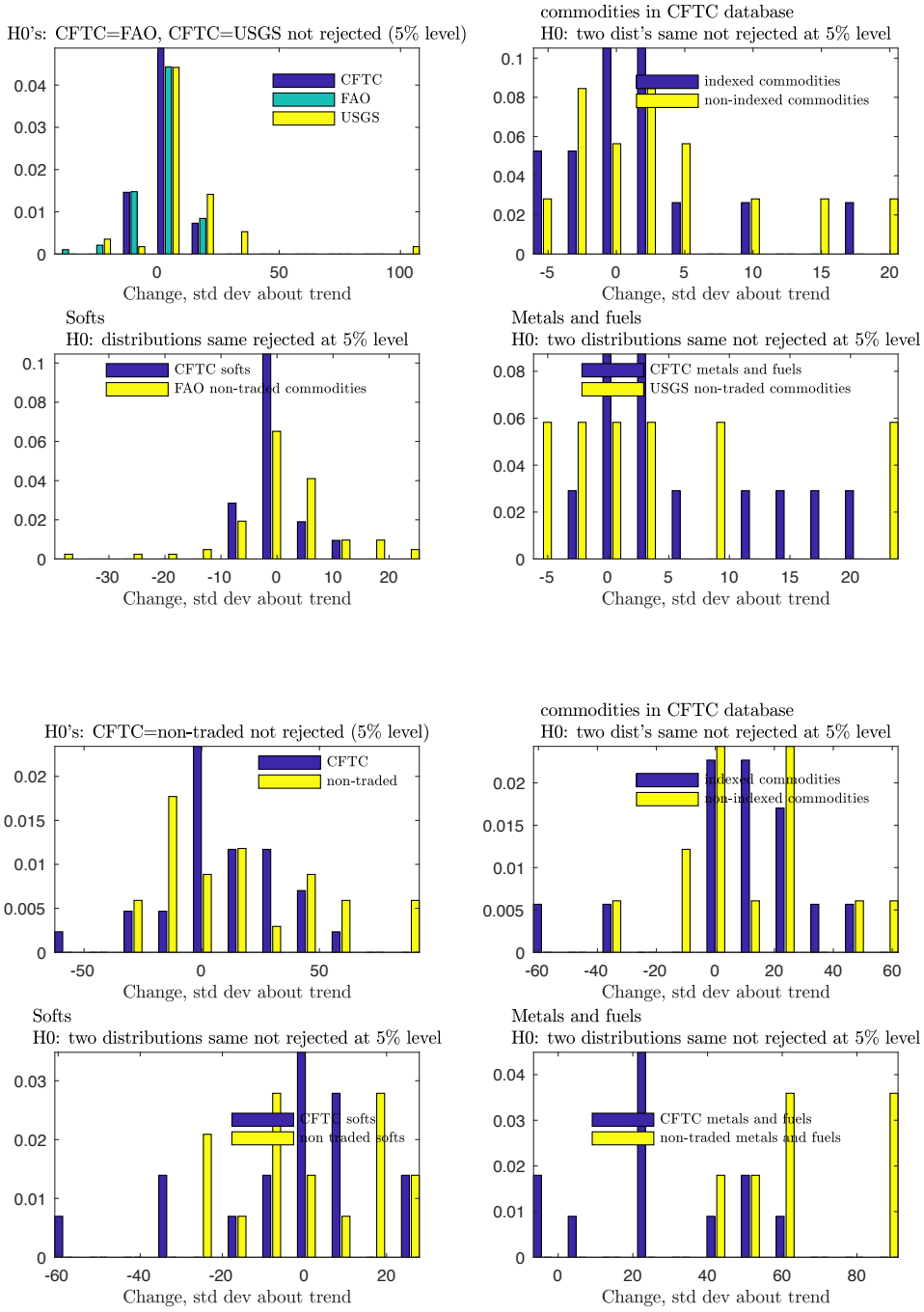
(a) Annual (change multiplied by 100)



(b) Monthly (change multiplied by 1200)

Figure 9: Change in Std Dev About Trend and Net Financial Flows in Histogram

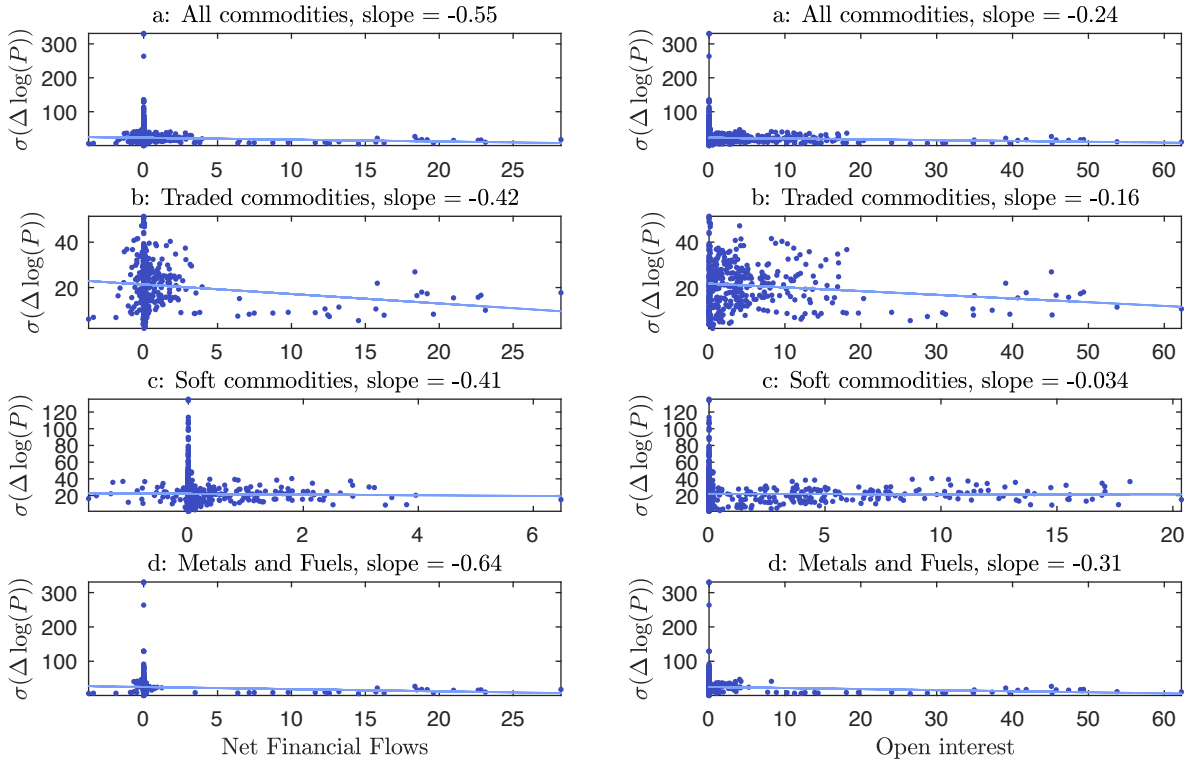
(a) Annual (change multiplied by 100)



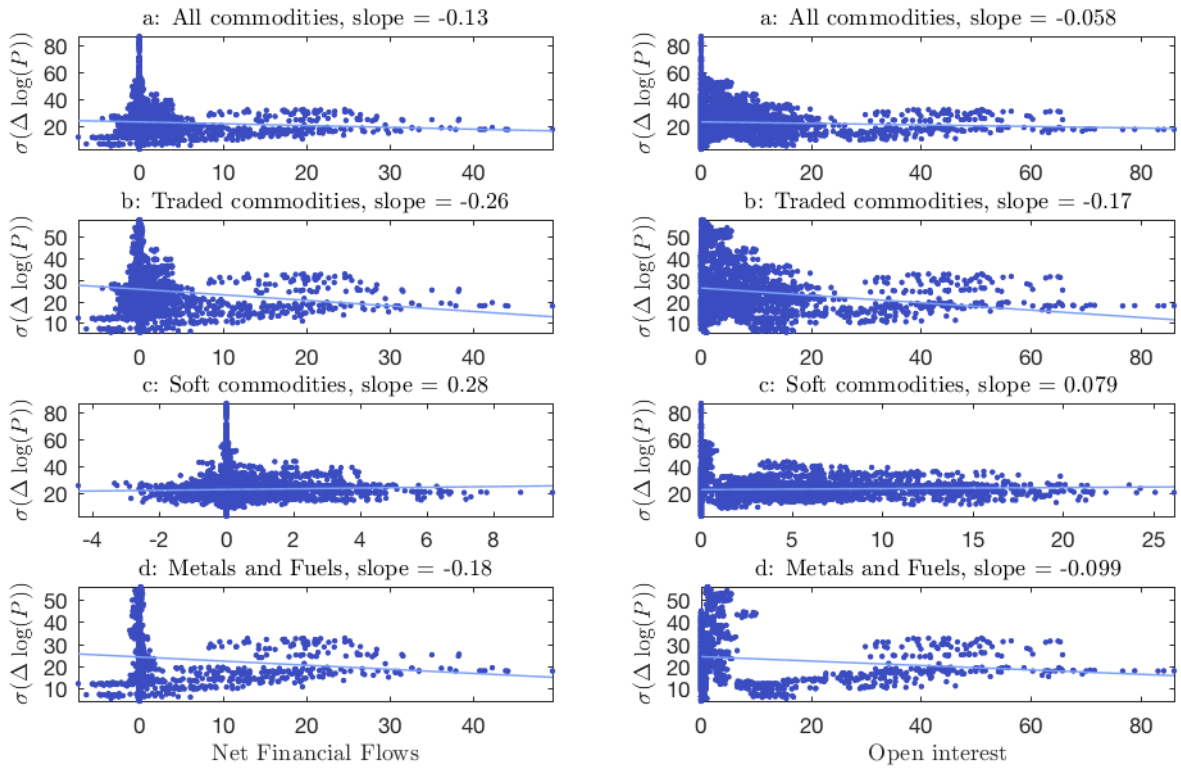
(b) Monthly (change multiplied by 1200)

Figure 10: Volatility and Financialization

(a) Annual Data



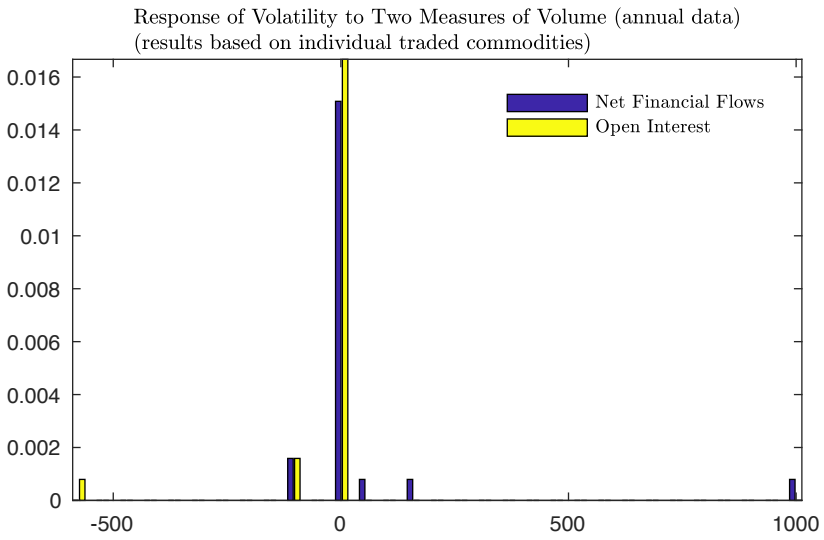
(b) Monthly Data



Panel (a): each observation is a price volatility, volume pair for a particular date and commodity. The volatility is the standard deviation of real commodity price growth, expressed in annual percent terms by multiplying by100. The volatility for a particular date is based on a centered plus or minus two year window of data on the logarithmic first difference of the commodity price. We use the level of our two measures of volume (scaled by world production), as indicated in the bottom of the two columns of graphs. Panel (b): same as in Panel , except that to convert the volatility data to annual percent terms we multiply each volatility observation by$100 \times \sqrt{12}$.

Figure 11: Response of Volatility to Volume of Trade

(a) Annual Data



(b) Monthly Data

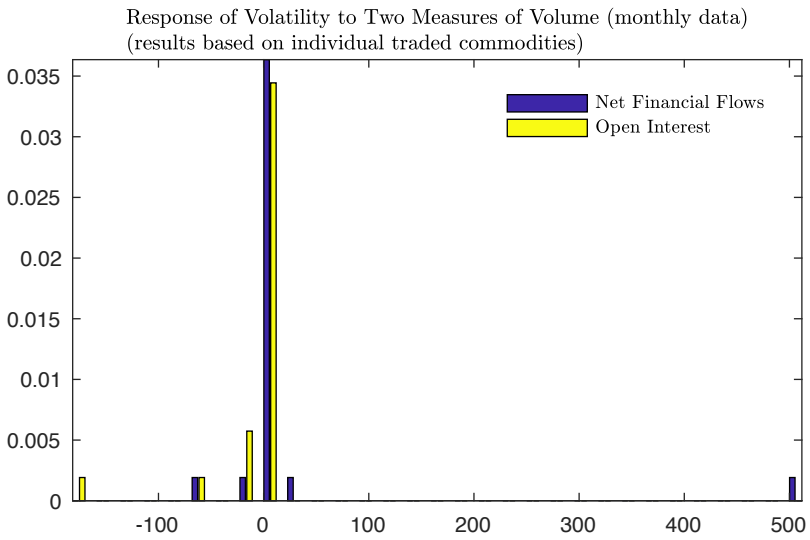
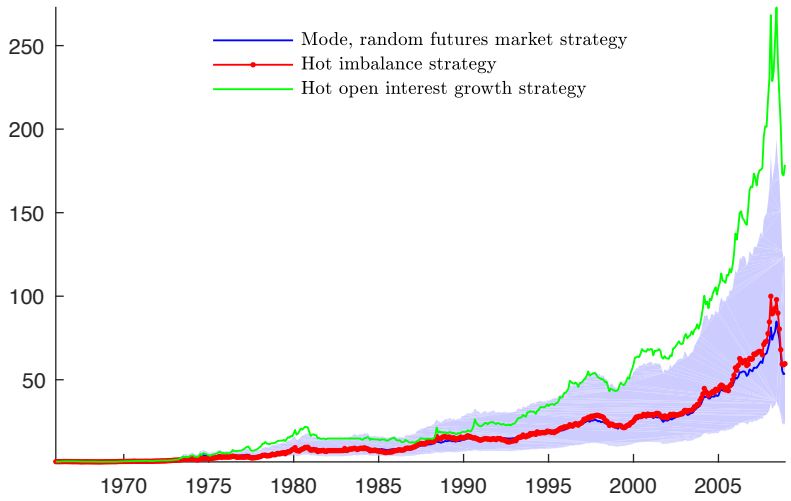


Figure 12: Cumulative Returns from 3 Futures Contract Strategies



Note : (i) hot open interest growth strategy invests in equally weighted basket of commodity futures which have the highest open interest growth in previous period; (ii) hot imbalance strategy is analogous to (i), except commodities are selected based on imbalance, a volume measure that is proportional to net financial flows; (iii) hot random strategy invests in an equally weighted, random set of commodities; (iv) shaded area is 90 percent confidence interval, constructed from 200,000 realizations of the hot, random futures market strategy. For additional details, see text.

Figure 13: Sharpe Ratio for Portfolios

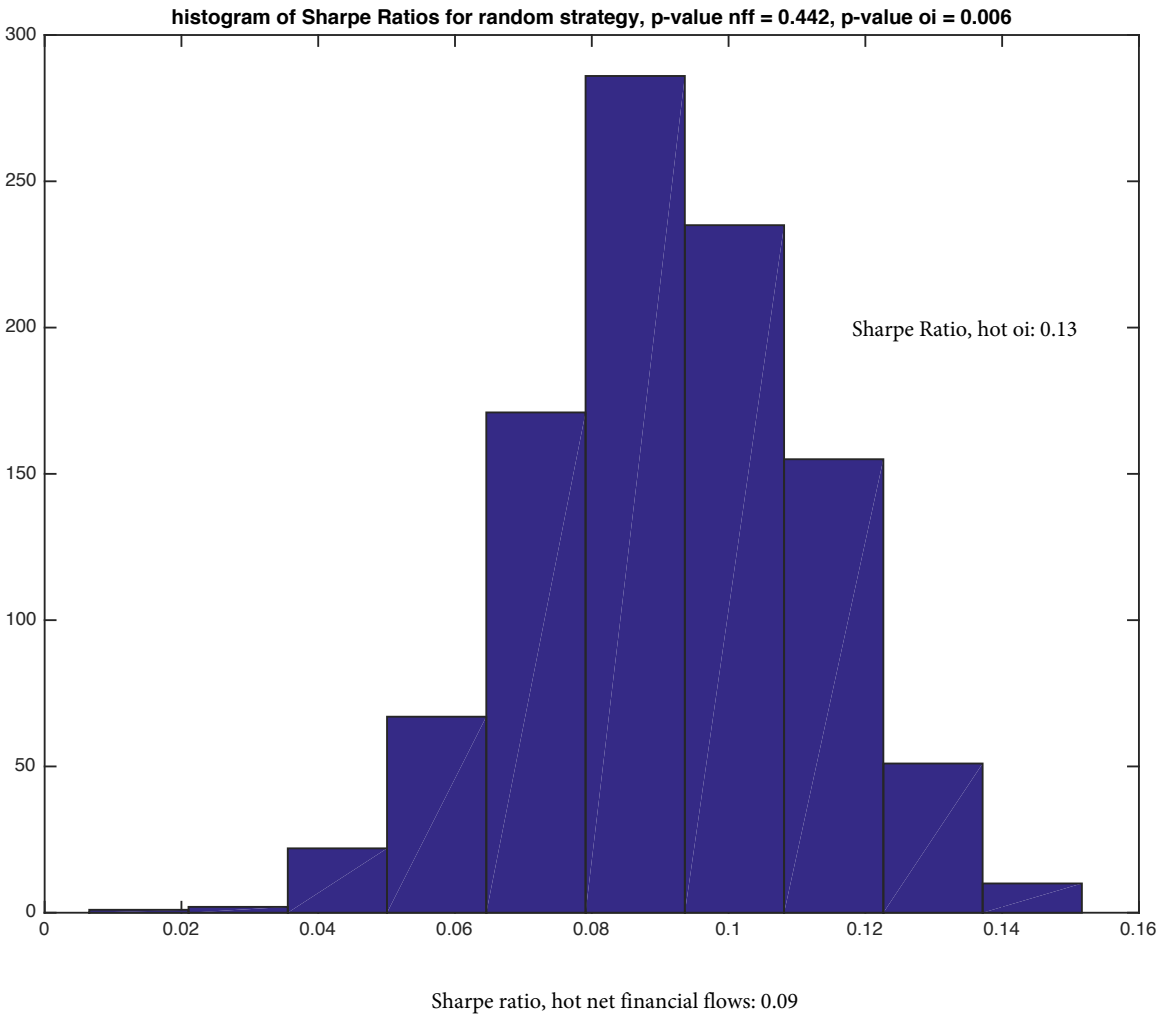
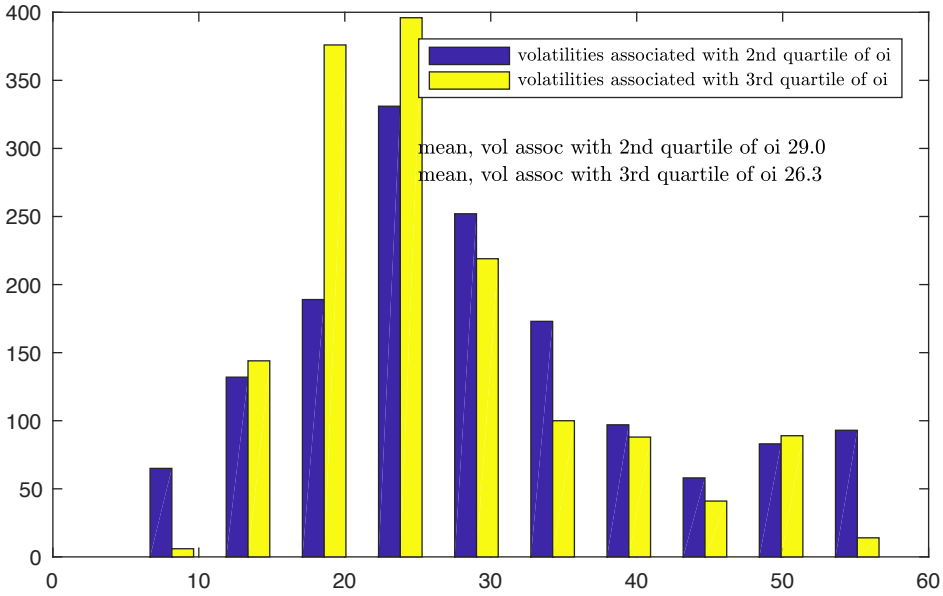


Figure 14: Histograms of Volatility Drawn from 2nd and 3rd Quartiles of Volume

(a) Sorting on Open Interest



(b) Sorting on Net Financial Flows

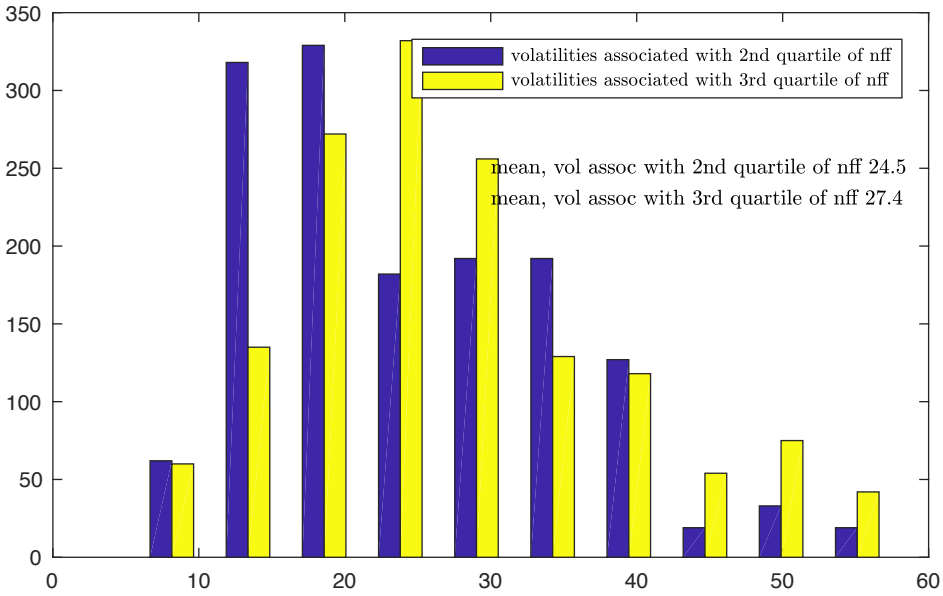


Figure 15: Impact of Temporal Aggregation on Pairwise Correlations Among Commmodity Futures

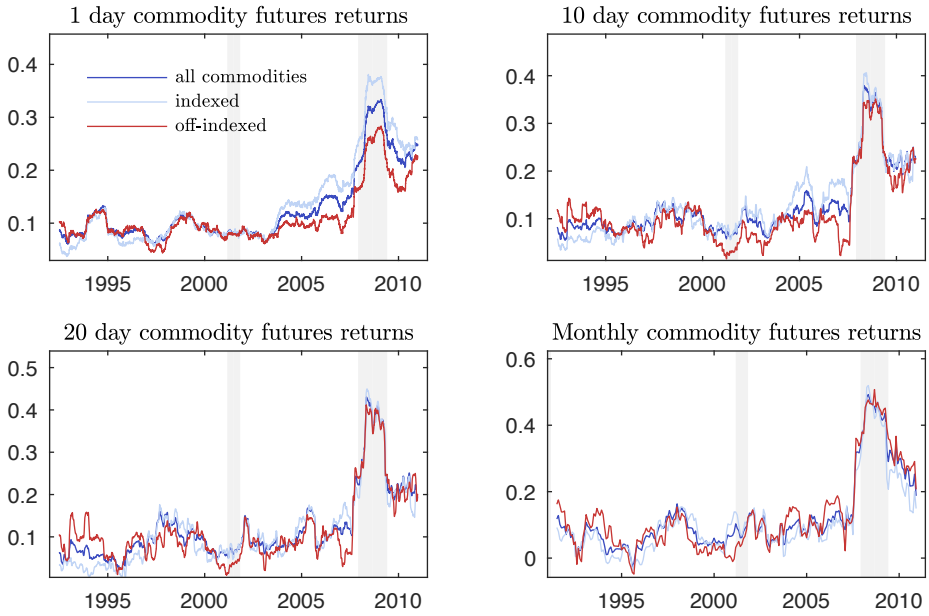
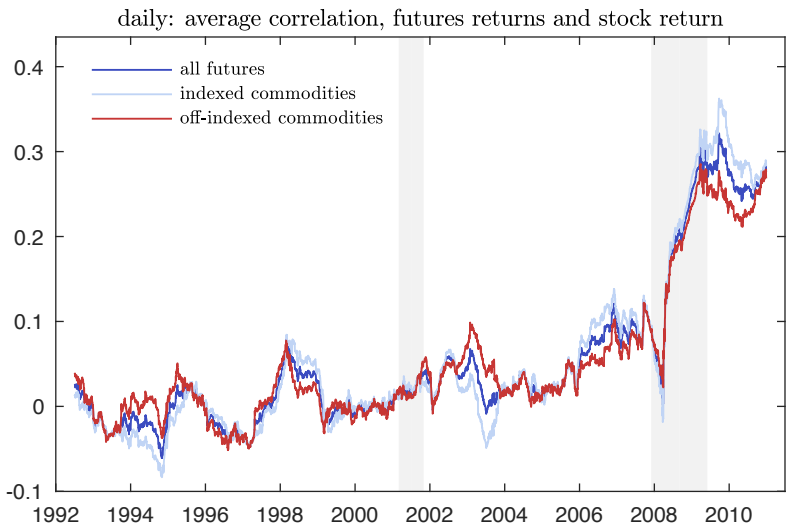
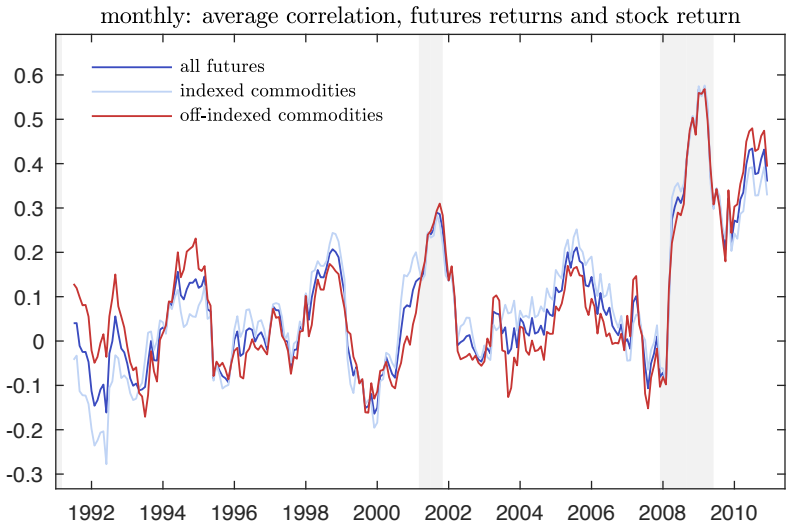


Figure 16: Correlation, Futures Returns and Stock Returns

(a) Daily Data





(b) Monthly Data

Table 1: Annual Spot Prices and World Production for Commodities in CFTC Data

Commodity in CFTC Data	Commodity in Quantity and Price Data	World production Source	Price Source	Value Source	Share 1992-2012
		Panel (a)			
oil	CRUDE OIL	BP	BP	derived	28.11
coal	COAL	BP	BP	derived	7.12
natural gas	NATURAL GAS	BP	BP	derived	9.66
propane	PROPANE	EIA	EIA	derived	0.86
distillate fuel oil	HEATING OIL	EIA	EIA	derived	9.54
gasoline	GASOLINE	EIA	EIA	derived	8.83
		Panel (b)			
gold	GOLD	USGS	USGS	derived	1.12
silver	SILVER	USGS	USGS	derived	0.14
copper	COPPER	USGS	USGS	derived	1.24
platinum	PLATINUM	USGS	USGS	derived	0.11
aluminum	ALUMINUM	USGS	USGS	derived	1.4
palladium	PALLADIUM	USGS	USGS	derived	0.05
		Panel (c)			
cotton	COTTON	USDA	USDA	derived	0.87
roundwood	LUMBER	FAOSTAT	FAOSTAT	derived	2.6
sugar	SUGAR	USDA	Trading Economics	derived	1.01
pig crop	PORK BELLIES	USDA	FAOSTAT	derived	2.61
calves	CATTLE	USDA	FAOSTAT	derived	4.6
rice	RICE	FAOSTAT	FAOSTAT	derived	3.43
cowmilk	BUTTER	FAOSTAT	derive	FAOSTAT	4.65
oats	OATS	FAOSTAT	FAOSTAT	FAOSTAT	0.1
wheat	WHEAT	FAOSTAT	FAOSTAT	FAOSTAT	2.88
soybeans	SOYBEANS	FAOSTAT	FAOSTAT	FAOSTAT	1.3
coffee, green	COFFEE	FAOSTAT	FAOSTAT	FAOSTAT	0.21
cocoabean	COCOA	FAOSTAT	FAOSTAT	FAOSTAT	0.1
oranges	ORANGE JUICE	FAOSTAT	FAOSTAT	FAOSTAT	0.43
corn	CORN	FAOSTAT	FAOSTAT	FAOSTAT	2.84
soybean oil	SOYBEAN OIL	FAOSTAT	USDA	derived	0.48
soybean meal	SOYBEAN MEAL	IMF	USDA	derived	1.09

Notes: (i) Variables in first column are the names of the traded commodities according to the CFTC database; (ii) a variable in the second column is the commodity for which we have output and price data, and which is closest to the variable in the first column; (iii) sources: BP - British Petroleum, USDA - United States Department of Agriculture, FAOSTAT - United Nations Food and Agriculture Organization, USGS - United States Geological Survey, EIA - United States Energy Information Administration, IMF - International Monetary Fund, 'derived' - value derived from other two sources, e.g., a price is derived if it is obtained from the ratio of value to quantity produced; (iv) share - share in world production, sum of shares equals unity; (v) we used 'pig crop' as a measure of each of HOGS and PORK BELLIES.

Name	Range	Source	Description
Crude_oil	1959/1-2015/12	Trading Economics	
Coal	1980/1-2015/12	IMF	Australian thermal coal, 12,000- btu/pound, Less than 1% sulfur, 14% ash, FOB Newcastle/Port Kembla
Natural_gas	1990/4-2015/12	Trading Economics	
Cotton	1959/6-2015/12	Trading Economics	
Soft Sawnwood	1980/1-2015/12	IMF	Average export price of Douglas Fir, U.S. Price, US$ per cubic meter
Sugar	1959/1-2015/12	Trading Economics	
Swine (pork)	1980/1-2015/12	IMF	51-52% lean Hogs, U.S. price, US cents per pound.
Beef	1980/1-2015/12	IMF	Australian and New Zealand 85% lean fores, CIF U.S. import price
Rice	1981/4-2015/12	Trading Economics	
raw_milk	1959/1-2015/12	FRED	Producer Price Index by Commodity for Farm Products: Raw Milk
Oat	1979/1-2015/12	Trading Economics	
Wheat	1982/3-2015/12	Trading Economics	
Soybeans	1959/7-2015/12	Trading Economics	
Coffee	1972/7-2015/12	Trading Economics	
Cocoa	1959/7-2015/12	Trading Economics	
Oranges	1980/1-2015/12	IMF	Miscellaneous oranges CIF French import price
Corn	1959/1-2015/12	Trading Economics	
Gold	1968/1-2015/12	Trading Economics	
Silver	1975/1-2015/12	Trading Economics	
Copper	1980/1-2015/12	IMF	Grade A cathode, LME spot price, CIF European ports
Platinum	1968/3-2015/12	Trading Economics	
Aluminum	1986/3-2015/12	Index Mundi	
Soybean Oil	1980/1-2015/12	IMF	Chicago Soybean Oil Futures (first contract forward) exchange approved grades
propane	1977/6-2015/12	FRED	Producer Price Index by Commodity for Fuels and Related Products and Power
heating_oil	1986/6-2015/12	FRED	No. 2 Heating Oil Prices: New York Harbor
gasoline	1967/1-2015/12	FRED	Consumer Price Index for All Urban Consumers: Gasoline (all types)
Palladium	1987/1-2015/12	Trading Economics	
Soybean Meal	1980/1-2015/12	IMF	Chicago Soybean Meal Futures (first contract forward) Minimum 48 percent protein

Table 3: Monthly Prices and World Production of Non-Traded Commodities

	source of price data	Definition	source of production data
Fishmeal	IMF	Peru Fish meal/pellets 65% protein	IndexMundi, 16 biggest producer countries
Palm Oil	IMF	Malaysia Palm Oil	IndexMundi, 16 biggest producer countries
Rubber	IMF	Rubber, Singapore Commodity Exchange, No. 3 Rubber Smoked Sheets	FAOSTAT
Tea	IMF	Tea, Mombasa, Kenya, Auction Price, From July 1998, Kenya auctions, Best Pekoe Fannings.Prior, London auctions, c.i.f. U.K. warehouses	FAOSTAT
Uranium	IMF	Uranium, NUEXCO, Restricted Price	United Nations Energy Statistics Database
Wool	Trading Economics		Greasy wool, FAOSTAT
Bananas	IMF	Bananas, Central American and Ecuador, FOB U.S. Ports	FAOSTAT
Barley	IMF	Canadian no.1 Western Barley	FAOSTAT
Rapeseed	IMF	Rapeseed oil, crude, fob Rotterdam	FAOSTAT
Groundnuts	IMF	Groundnuts (peanuts), 40/50 (40 to 50 count per ounce), cif Argentina	FAOSTAT
Hides	IMF	Hides, Heavy native steers, over 53 pounds, wholesale dealer's price, Chicago	FAOSTAT
Iron Ore	IMF	Iron Ore, China import Iron Ore Fines 62% FE spot (CFR Tianjin port)	USGS
Tin	Trading Economics		USGS
Zinc	Trading Economics		USGS
Nickel	Trading Economics		USGS
Lead	Trading Economics		USGS
Olive Oil	IMF	extra virgin less than 1% free fatty acid, ex-tanker price U.K.	International Olive Council
Chicken	IMF	Poultry (chicken), Whole bird spot price, Ready-to-cook, whole, iced, Georgia docks	FAOSTAT
Lamb	IMF	Lamb, frozen carcass Smithfield London	FAOSTAT
Sunflower Oil	IMF	Sunflower Oil, US export price from Gulf of Mexico	FAOSTAT
Hard Sawnwood	IMF	Hard Sawnwood, Dark Red Meranti, select and better quality	Sawnwood (NC), FAOSTAT
Shrimp	IMF	Shrimp, No.1 shell-on headless, 26-30 count per pound, Mexican origin, New York port	Fisheries and Aquaculture Department, UN
Salmon	IMF	Farm Bred Norwegian Salmon, export price	Fisheries and Aquaculture Department, UN

Table 4: Mean and Volatility Properties of Commodity Price Growth

(a) Annual

Commodity	$n^{(i)}$	Mean, spot price growth ($\times 100$)			Standard deviation ($\times 100$)		
		1992-2000	2001-2012	diff (p-values$^{(ii)}$: theory$^{(iii)}$, boot)	1992-2000	2001-2012	diff (p-values : theory, boot)
All	136	-0.66	3.8	4.4 (10,10)	22	25	3.2 (8.6,22)
Indexed	15	-0.51	6.2	6.7 (12,12)	19	21	2.1 (26,38)
Non indexed	14	0.28	3.9	3.6 (20,20)	19	22	3.3 (7,16)
Traded	29	-0.13	5.1	5.2 (14,14)	19	22	2.6 (12,26)
Non trade	107	-0.8	3.4	4.2 (12,12)	22	26	3.4 (9.1,21)

(b) Monthly

Commodity	$n^{(iii)}$	Mean$^{(i)}$			Standard Deviation$^{(ii)}$		
		1992-2000	2001-2012	diff (p-values$^{(iv)}$: theory, boot)	1992-2000	2001-2012	diff (p-values$^{(iv)}$: theory, boot)
All	52	-1.5	5.1	6.6 (2.9,2.9)	22	25	3.2 (7.5,9)
Indexed	15	-0.35	5.6	5.9 (10,10)	24	26	2.9 (15,18)
Non indexed	14	-0.22	3.8	4 (17,17)	22	27	4.1 (3.1,5.3)
Traded	29	-0.29	4.7	5 (11,11)	23	26	3.5 (5.3,7.5)
Non traded	23	-3	5.6	8.7 (0.8,0.83)	20	23	2.8 (27,28)

Note for (a): (i)n denotes the number of commodities in the specified group. (ii)p-value indicates the probability, under the null hypothesis of no difference, of getting an even higher difference than was realized in the data. (iii)p-values are reported using a particular sampling theory and by a bootstrap procedure for robustness (see appendix for details).
Note for (b): (i) Monthly log difference of spot prices, converted to annual percent by multiplying by 1200; (ii) Standard deviation converted to annual percent by multiplying by $100\times\sqrt{12}$; statistics apply to standard standard; $(iii)n$ denotes the number of commodities in the specified group; $(iv)p$-value indicates the probability, under the null hypothesis of no difference, of obtaining an even higher difference than was realized in the data; the sampling theory underlying our$p$-values is based on asymptotic theory and on a bootstrap, as reported in the appendix.

Table 5: Decadal Change in Spot Price Behavior Versus Decadal Change in Financialization

Annual

$$z_i = \alpha + \gamma q_i + u_i$$

left-hand variable, z_i	$\Delta std\left(log\frac{P_i}{P_{i,-1}}\right)$		$\Delta\beta_i$		$\Delta\sigma_i$	
right-hand variable, q_i	Δnff_i	Δoi_i	Δnff_i	Δoi_i	Δnff_i	Δoi_i
Variable group	γ ($p-$value)	γ ($p-$value)	γ ($p-$value)	γ ($p-$value)	γ ($p-$value)	γ ($p-$value)
All	-0.26 (45)	-0.34 (38)	1.7 (15)	0.83 (7.8)	-0.87 (24)	-0.66 (17)
Indexed	-0.054 (48)	-0.15 (37)	1.1 (16)	0.12 (42)	-0.55 (21)	-0.38 (18)
Non-indexed	-21 (13)	-2.4 (25)	14 (15)	1.8 (25)	-15 (11)	-1.5 (29)
Traded	-0.19 (44)	-0.31 (29)	1.4 (14)	0.51 (17)	-0.68 (19)	-0.5 (12)
Softs	7.2 (22)	0.99 (24)	13 (0.93)	1.7 (1.9)	-2 (33)	-0.34 (31)
Metals	-0.97 (28)	-0.75 (28)	1.1 (24)	0.7 (23)	-1.2 (22)	-0.74 (26)
Fuels	-26 (24)	-1.5 (39)	48 (7)	-4.7 (11)	-43 (12)	2.4 (26)

Monthly

All	0.015 (45)	-0.33 (25)	1.2 (16)	0.49 (16)	-2.4 (25)	-2.8 (6.8)
Indexed	0.023 (45)	-0.48 (19)	1 (16)	0.22 (33)	-1.7 (27)	-2.4 (12)
Non-indexed	6.8 (31)	0.76 (40)	17 (11)	2.5 (17)	-51 (13)	-7.4 (19)
Traded	-0.023 (43)	-0.43 (18)	1.3 (14)	0.66 (11)	-2 (25)	-2.5 (8)
Softs	6.9 (12)	0.29 (39)	7.6 (3.7)	1.1 (4.5)	2.3 (44)	-1.8 (19)
Metals	-0.57 (17)	-0.41 (16)	0.81 (26)	0.52 (29)	-5 (17)	-3 (15)
Fuels	23 (17)	-3 (13)	40 (13)	-5.5 (10)	-85 (14)	5.6 (26)

NOTE : (i) table reports γ and $p-$value for null hypothesis, $\gamma = 0$, obtained by 1,000,000 bootstrap simulations; for each bootstrap simulation we construct a data set having the same length as the actual data by randomly drawing with replacement from the empirical data; the left and right hand variables were drawn independently to ensure consistency with the null hypothesis; (ii) Δ denotes value of variable in second half of data minus value in first half; (iii)σ_i denotes standard deviation of error in regression of log, i^{th} commodity price, on constant and time trend; (iv) β_i denotes coefficient on time of the regression of log, i^{th} commodity price, on constant and time trend; (v) $std\,(\Delta logP_i)$ denotes standard deviation of log, first difference of ith commodity price; (v) non-traded goods are not included because in this case $q_i = 0$ for all i; (vi) because the number of traded metals is relatively small, a tiny fraction of bootstrap-simulated regressions produced non-invertible $X'X$ matrices and these were ignored in computing the $p-$values.

Table 6: Regression, Volatility of Spot Price Growth on Volume of Futures Trades[1]

(a) Annual

	$volatility_t = constant + \gamma \times volume_t$	
Variables	Net Financial Flows	Open Interest
All	-0.55	-0.24
	(-0.71,-0.072)	(-0.33,-0.07)
Traded	-0.42	-0.16
	(-0.55,0.097)	(-0.24,0.043)
Softs	-0.41	-0.034
	(-1.7,0.73)	(-0.42,0.15)
Metals & Fuels	-0.64	-0.31
	(-0.85,-0.14)	(-0.4,-0.088)

(b) Monthly

	$volatility_t = constant + \gamma \times volume_t$	
Variables	Net Financial Flows	Open Interest
All	-0.13	-0.058
	(-0.25,-0.052)	(-0.12,-0.02)
Traded	-0.26	-0.17
	(-0.36,-0.15)	(-0.22,-0.11)
Softs	0.28	0.079
	(-0.25,0.35)	(-0.11,0.14)
Metals & Fuels	-0.18	-0.099
	(-0.3,-0.082)	(-0.15,-0.043)

Notes: (1) the table reports our least squares estimates of γ, the (common) slope coefficient in a regression of volatility (a two-year moving, centered standard deviation of one-period real spot price growth) on our two measures of volume (net financial flows and open interest); in all cases, the standard deviation is multiplied by 100 to convert to percent terms, and in the case of monthly data, the standard deviations are in addition multiplied by $\sqrt{12}$ to convert to annual units; (2) numbers not in parentheses are the least squares estimate value of γ; (3) numbers in parentheses are the boundaries of 95 percent intervals, computed using 5,000 bootstrap simulations under the null hypothesis that the left and right-side variables are independent; (4) in each simulation: (i) the commodity price growth and volume data were sampled independently with replacement from the actual data, (ii) the volatility data were computed by applying the centered moving window procedure to the artificial commodity price growth data, and (iii) the regression performed on the actual data was computed on the artificial data; (5) “All” means the analysis is done using all commodities, “traded” means only commodities in our CFTC data included in the analysis; ”softs” and “metals & fuels” means only commodities classified as softs and metals and fuels included in the analysis (see text for further discussion).

Table 7: Futures Returns and Financialization

	$correlation_t = c + \beta \times volume_t$			
	Correlation of Futures Returns with:			
	Equity Returns		3 month T-bill	
Measure of Volume	Monthly	Daily	Monthly	Daily
Net financial flows	3.6	4	0.88	0.17
	(-2.7,2.8)	(-4.6,11)	(-1.9,2.5)	(-0.3,0.54)
Open interest	1	1.4	1.1	0.25
	(-1.7,2.1)	(-5,5.7)	(-0.94,1.3)	(-0.19,0.28)

	$volatility_t = c + \beta \times volume_t$	
	Volatility of Futures Returns	
Measure of Volume	Monthly	Daily
Net financial flows	-0.065	0.0014
	(-0.29,0.38)	(-0.049,0.058)
Open interest	-0.11	-0.004
	(-0.15,0.28)	(-0.02,0.049)

Notes: see text for a discussion of estimates of β, which are the number not in parentheses. Numbers in parentheses are 95 confidence intervals under the null hypothesis, $\beta = 0$.

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