Financialization and Commodity Price Volatility: The Case of Grains

Devraj Basu, Olivier Bauthéac, Ameeta Jaiswal Dale

2020-02-18

Contents

1 Abstract **5**

2 Introduction **7**

3 Data and methods **13**

4 Results & discussion **17**

5 Conclusion **21**

Chapter 1

Abstract

The early 2000s have witnessed a dramatic increase in long-only institutional investments in commodity markets. This surge and its accompanying effects are commonly referred to as the financialization of commodity markets. This paper studies the impact of this phenomenon on price volatility in the grain markets where we focus on CBOT corn, wheat & soybeans and KCBOT wheat. Our results suggest that increases in trading volume and open interest, a consequence of financialization, appear to have changed the nature of grains volatility and seem consistent with the model of Stein (1987) and Goldstein and Yang (2015) where the entry of new traders could lower the information content of price for existing traders. Our findings further suggest that the increase in market depth has a generally destabilizing effect on grains volatility which provides some support for the concerns of regulators. However this destabilizing effect does not seem to be driven by the action of speculators. Our analysis is thus overall more supportive of Singleton (2013) and Stein (1987) in that disagreement and difference of opinion are more likely to have caused changes in the nature of grains volatility than excess speculation.

Chapter 2

Introduction

In the early 2000s, against a backdrop of a low yield environment and poor stock market performance, the investment industry developed financial products designed for providing individuals and institutions with buy-side exposure to commodities through over-the-counter (OTC) swaps, exchange-traded funds (ETFs), and exchange-traded notes (ETNs), all of which are linked to popular commodity indexes such as the Goldman Sachs Commodity Index (S&P-GSCI). As these products grew in popularity investment in long-only commodity index funds rapidly soared[1]. Some refer to this large inflow of mostly institutional capital and its impact as the financialization of commodity markets (Domanski and Heath, 2007). The issue has had a wide impact on areas ranging from financial[2] and agricultural[3] economics to public policy[4] and revived the long-standing "adequacy of speculation" debate. Agricultural commodities have been the forefront of the controversy over whether "excess speculation", allegedly brought about by financialization, has contributed to price spikes in commodity markets[5]. On one side, championed by hedge fund manager Michael Masters, are those who argue that index investor driven buying pressure created a massive bubble in

[1]Assets allocated to commodity index replication strategies grew from $13bn in 2003 to over $300bn in 2008 (Masters and White, 2011).

[2]For example Tang and Xiong (2012), Singleton (2013), Basak and Pavlova (2016), Henderson et al. (2015).

[3]Irwin and Sanders (2012a) study the impact on agricultural markets, Irwin and Sanders (2011) and Hamilton and Wu (2015) on commodity markets in general, Büyükşahin and Robe (2014) study the oil market while Korniotis et al. (2009) considers the metals market.

[4]The first responses to the 2007/2008 crisis of escalating food and energy prices took the form of policy reports, many of which reasoned that the growth of commodity index funds came along with an influx of largely speculative capital that was responsible for driving commodity prices beyond their historic highs (Senate, 2009; UNCTAD and Cooperation, 2009; Herman et al., 2011; De Schutter, 2010; Schumann, 2011).

[5]Irwin and Sanders (2011); Rouwenhorst and Tang (2012); Cheng and Xiong (2014a) and Bos and van der Molen (2012) survey the literature and summarize the policy and academic debates.

commodity prices[6], particularly in the grain and energy markets (Masters, 2008; Masters and White, 2011; Caballero et al., 2008; Petzel, 2009; Hamilton, 2009; Du and Zhao, 2017). Others, advocated by the academic duo formed by Dwight Sanders and Scott Irwin, are dismissive of this contention and point out inconsistencies as well as contradictory facts in the bubble arguments (Krugman, 2008; Pirrong, 2008, 2010; Sanders and Irwin, 2008; Irwin et al., 2009; Korniotis et al., 2009; Harris and Buyuksahin, 2009; Till, 2009; Stoll and Whaley, 2010). A number of academic studies attempted to sort out which side of the debate is correct using a variety of economic tools[7]. The majority of these studies does not support, and some of them even refute, the bubble hypothesis suggesting that there is no direct link between commodity institutional investments and commodity prices. Nonetheless, the impact of financialization on commodity price volatility, in the grain markets in particular, is still a source of concern both from an academic as well as a regulatory perspective[8] and has not been thoroughly investigated yet[9].

In this study we examine the nature of this impact[10]. We focus on Chicago Board of Trade (CBOT) corn, soybeans and soft red winter wheat (SRW) as well as Kansas City Board of Trade (KCBOT) hard red winter wheat (HRW), four major global commodities of which the U.S. are a major producer. As financialization is largely a U.S. based phenomenon it seems appropriate to study its effect on them. Besides, these markets are regarded as classic hedging markets where speculation tends to follow hedging volume (Working, 1953, 1954, 1960, 1962; Sanders and Baker, 2012) and are thus good candidates for assessing the impact of financialization, where speculation plays a central role. Also, the prices of these commodities tend to be driven by similar fundamentals as they can be substitutes and/or complements on the production and use sides. This makes it easier to isolate the effect of financialization by examining the differences in volatility patterns before and during financialization. Finally,

[6]This contention is commonly referred to as the Masters' Hypothesis.

[7]While Gilbert (2010b), Gilbert (2010a), Phillips et al. (2011), Phillips and Yu (2011), Tang and Xiong (2012) are supportive of the bubble argument, Harris and Buyuksahin (2009), Brunetti and Buyuksahin (2009), Sanders et al. (2010), Stoll and Whaley (2010), Sanders and Irwin (2010), Sanders et al. (2010), Sanders and Irwin (2011), Irwin and Sanders (2012b), Büyükşahin and Robe (2014), Kilian and Murphy (2014) dismiss it.

[8]Concerns over the consequences of financialization were behind Rule 76 FR 4752 issued by the U.S. Commodity Futures Trading Commission (CFTC) on January 26, 2011. This provision emanates from the Dodd-Frank Wall Street and Consumer Protection Act of 2010 (Title VII, Section 737) that mandates the CFTC to use position limits to restrict the flow of speculative capital into a number of commodity markets. The Rule was approved in a close 3-2 vote and the ensuing rule-making process was extremely contentious with several commissioners expressing reservations about the lack of supporting evidence and the Rule also triggering thousands of comment letters as well as a lawsuit against the CFTC. See remarks of ex CFTC Chairman Gary Gensler before the International Monetary Fund Conference (www.cftc.gov) as well as remarks of Commissioner Bart Chilton (www.cftc.gov).

[9]Bohl and Stephan (2013) is one of the few studies that investigate this issue.

[10]Our paper fits into the broad area of modeling changes in volatility and volatility transmission. See for example: Gannon (2010), Jiang et al. (2017), Li (2016), Fung et al. (2003), Smith and Bracker (2003), Nishina et al. (2012).

corn, soybeans, HRW and SRW wheat are constituents of major commercial commodity indexes and are thus particularly suitable in this context.

We study the volatility of the futures front month returns as well as that of the basis for each individual commodity considered over the 1992-2007 period using a set of volatility estimators that includes the classic "close-to-close" as well as a number of range-based estimators that account for intra-day price action. We define the 1992-2003 period as the pre-financialization phase and the 2003-2007 as the financialization phase with the 2003 cut-off based on earlier studies[11]. We find a moderate increase in futures average volatility (from 10% to 25% depending on the estimator) and a much larger increase in basis average volatility (from 30% to over 100% depending on the estimator). Although uniform, the increase in average futures volatility is perhaps not as high as proponents of the Masters' Hypothesis might have believed while that for basis volatility suggests potentially stronger effects due to financialization.

The relationship between volatility, volume and open interest has been investigated quite extensively in the finance literature with some studies suggesting that increases trading volume and open interest, via the entry of new traders, could have a stabilizing effect on volatility (Bessembinder and Seguin, 1993; Kyle, 1985; Stoll and Whaley, 1987) while others, particularly in some recent studies, argue it could have a destabilizing effect (Goldstein and Yang, 2015; Singleton, 2013; Sockin and Xiong, 2015). We investigate the issue by running regressions of volatility on contemporaneous and lagged volume and open interest.

For futures volatility we observe an increase in R^2 over the financialization period in most cases, sometimes dramatically[12] as well as an overall increase in slope coefficient[13] for both open interest and volume, contemporaneous and lagged. The pattern of results is similar for basis volatility. These results suggest that the relationship between volatility and both volume and open interest has changed and taken together with the large increase in level for both variables, suggest that financialization has affected grains volatility. Open interest and volume seem to have switched from a stabilizing to a destabilizing role during financialization for corn and both HRW and SRW wheat while for soybeans, the opposite seems to have happened. Overall our results suggest that increases in trading volume and open interest, a consequence of financialization, appear to have had a destabilizing influence on grain volatility and seem consistent with

[11] Most earlier studies locate the onset of financialization around the 2003-2004 period (Basak and Pavlova, 2016; Cheng and Xiong, 2014a; Hamilton and Wu, 2015; Irwin and Sanders, 2011, 2012a,b; Tang and Xiong, 2012).

[12] The increase is largest for corn, followed by soybeans and HRW wheat. Results are mixed for SRW wheat.

[13] For SRW and HRW wheat both open interest and volume switch from negative (as predicted by Kyle (1985), Stoll and Whaley (1987)) to positive (as predicted by most informational models; Karpoff (1987)) during financialization. For corn, open interest follows the same pattern while volume shows a positive relationship other the first period which gets stronger during financialization. Soybeans show the opposite pattern with a negative correlation for both open interest and volume which becomes more negative during financialization.

the models of Stein (1987)[14] Goldstein and Yang (2015)[15], Singleton (2013)[16] and Sockin and Xiong (2015)[17].

We try to assess the impact of speculators by running similar regressions with open interest of hedgers and speculators separately as allowed by the U.S. Commodity Futures Trading Commission (CFTC)'s Commitment of Traders (COT) reports data[18]. The results for speculators suggest a move towards a greater destabilizing effect for HRW wheat, corn and SRW wheat with no clear results for soybeans. The pattern is very similar for hedgers open interest which raises questions about the classification[19] and perhaps the nature of hedgers' activities[20] and also suggests that these may have been influenced by financialization. The pattern of results for basis volatility is very similar.

We investigate the speculation issue further by running similar regressions with the Working's T index, a measure of excess speculation[21]. The results show no clear pattern across commodities or periods with both positive and negative slope coefficients in the second period. There is thus no clear indication that the change in relationship between volatility and open interest has been driven by excess speculation or an increase in speculative open interest. We conclude with a Granger causality analysis that we implement in turn on each pair of the above-mentioned variables. The results are generally inconclusive with some evidence that futures volatility and volume Granger cause each other and futures volatility Granger causes hedger's open interest in the second period.

Overall our results point to an increase in grains volatility as well as a clear change in the relationship between grains volatility and open interest and volume

[14]He argues that entry of new traders could lower the information content of price for existing traders through noise in their signals.

[15]They argue that the negative information content effect is caused by the behaviors of those traders who are informed of the same information but respond to this information in opposite directions. Their model suggests that commodity financialization could make futures prices less informative (they refer to price informativeness as the amount of residual uncertainty uninformed traders face after conditioning on prices).

[16]He notes that learning about economic fundamentals with heterogeneous information may induce excessive price volatility, drift in commodity prices, and a tendency towards booms and busts. He argues that under these conditions the flow of financial index investments into commodity markets may harm price discovery and social welfare.

[17]They develop a model to analyze information aggregation in commodity markets. Their analysis highlights important feedback effects of informational noise originating from supply shocks and futures market trading on commodity demand and spot prices.

[18]A similar sort of analysis using the CFTC's classification was carried out in Wang (2003). See the CFTC's explanatory notes for details on the traders classification in the COT legacy format: www.cftc.gov

[19]The CFTC has now refined its classification and publishes a "disaggregated" COT report with data going back to June 2006. In this report, the commercial category is further subdivided into processors/merchants and swap dealers while the non-commercial category is split into money managers and other reportables (not captured in the other groups). See the CFTC's explanatory notes for details on the traders classification in the COT disaggregated format: www.cftc.gov

[20]See Cheng and Xiong (2014b).

[21]This measure originates in Working (1960) and is widely used in the agricultural economics literature to assess the impact of excess speculation.

as a result of financialization. However there is no clear evidence that this change was driven by the actions of speculators. Our findings provide some support for the concerns of regulators but are overall more supportive of Goldstein and Yang (2015), Singleton (2013) and Stein (1987) in that disagreement and difference of opinion[22] are more likely to have caused changes in the nature of grains volatility than excess speculation.

The rest of the paper is organized as follow: the data and methods are described in the next section with the results discussed in section 4, while section 5 concludes.

[22]This issue is also of relevance in the recent legal literature (Stout, 1998, Stout (2011)) where it is referred to as disagreement based trading based on differing subjective beliefs about future prices. Stout (2011) shows how this may be viewed as a sort of market failure.

Chapter 3

Data and methods

We study Chicago Board of Trade (CBOT) corn, soybeans and soft red winter wheat (SRW) as well as Kansas City Board of Trade (KCBOT) hard red winter wheat (HRW). The futures contract market quotes as well as volume and open interest data are from Bloomberg wile spot market price time series are from the Minneapolis Grain Exchange (MGEX).

Futures prices are observed every trading day at close while the daily values for cash prices are constructed as the average of high and low prices for the day due to the lack of open and close quotes in the cash markets. We consider the front month futures contract until the first week of the maturity month at which date the position is switched to the next most liquid contract. For each commodity we define open interest (volume) as the sum of all traders' positions (trading volume) for all contracts on the term structure up to a year ahead. We define the basis as the difference between the futures and cash (spot) price as follows:

$$B_{i,t} = F_{i,t} - S_{i,t}$$

$B_{i,t} \equiv$ basis for commodity i, at time t.
$F_{i,t} \equiv$ futures price for commodity i, at time t.
$S_{i,t} \equiv$ spot price for commodity i, at time t.

We observe the 1992-2007 period and define the 1992-2003 period as the pre-financialization phase and the 2003-2007 as the financialization phase (with the 2003 cut-off based on earlier studies[1]), and study the two periods independently.

For futures volatility we consider a set of estimators that includes the classic "close-to-close" as well as five range-based stochastic volatility estimators: Parkinson, Garman & Klass, Rogers & Satchell, Garman & Klass-Yang & Zhang

[1] Most earlier studies locate the onset of financialization around the 2003-2004 period (Basak and Pavlova, 2016; Cheng and Xiong, 2014a; Hamilton and Wu, 2015; Irwin and Sanders, 2011, 2012a,b; Tang and Xiong, 2012).

and Yang & Zhang. The Parkinson estimator estimates the volatility of the underlying based on high and low prices. The Garman & Klass estimator assumes Brownian motion with zero drift and no opening jumps and is 7.4 times more efficient than the "close-to-close" estimator. The Rogers & Satchell estimator allows for non-zero drift, but assumes no opening jump while the Garman & Klass-Yang & Zhang estimator, a modified version of the Garman & Klass estimator allows for opening jumps. The Yang & Zhang has minimum estimation error, and is independent of drift and opening gaps. It can be interpreted as a weighted average of the Rogers & Satchell estimator, the "close-open" volatility, and the "open-close" volatility. For futures the results are presented for volatility when estimated using the classic "close-to-close" estimator, as it is the most commonly used, and the Yang & Zhang estimator as it has the minimum estimation error, with the rest of the results available from the authors upon request. For basis volatility, the lack of open and close quotes restricts the set to the classic "close-to-close" and the Parkinson estimators. Yet, a straightforward construction of the Parkinson estimator is unworkable because of the few occurrences of the zero value in the time series of the basis leading to undefined volatility observations. As a result, we define the Parkinson estimate of basis volatility as the difference between that of the futures and that of the spot.

We study the relationship between volatility, volume and open interest with a set of factor models that include combinations of the latter. We construct four one-factor models where volatility is the response and both contemporaneous and one-week lagged open interest and volume are in turn the explanatory variable. We also construct four two-factor models where volatility is the response and the explanatory variables are in turn, contemporaneous and one-week lagged open interest, contemporaneous and one-week lagged volume, open interest and volume as well as one-week lagged open interest and one-week lagged volume. We conclude with a four-factor model that includes all the above-mentioned as explanatory variables.

The weekly CFTC COT report's format breaks down total open interest into three categories of traders, namely hedgers (commercial), speculators (non-commercial) and non-reportable with the latter gathering the remaining traders who do not fit in the previous two categories. This break down allows the construction of the Working's T index, a measure of excess speculation, as follows:

$$T_{i,t} = \begin{cases} 1 + \frac{SS_{i,t}}{HS_{i,t}+HL_{i,t}} & if \quad HS_{i,t} \geq HL_{i,t} \\ 1 + \frac{SL_{i,t}}{HS_{i,t}+HL_{i,t}} & if \quad HS_{i,t} < HL_{i,t} \end{cases}$$

$T_{i,t} \equiv$ Working's T index for commodity i, at time t.
$SS_{i,t} \equiv$ number of speculative short positions for commodity i, at time t.
$SL_{i,t} \equiv$ number of speculative long positions for commodity i, at time t.
$HS_{i,t} \equiv$ number of short hedging positions for commodity i, at time t.
$HL_{i,t} \equiv$ number of long hedging positions for commodity i, at time t.

We refine the analysis with a set of one factor models where volatility is the response and total open interest, open interest of hedgers, open interest of speculators, volume and Working's T index are in turn the explanatory variable. We conclude with two four-factor models with the first one including the contemporaneous time series of all the above and the second one their one-week lagged version.

We look deeper into the speculation issue with a careful Granger causality analysis. Phillips and Loretan (1990) showed that Granger causality testing can be unreliable in a context similar to financialization. We hence rely on a modified version of the procedure developed by Toda and Yamamoto (1995) that accounts for non-stationary time series. We implement the analysis at the daily frequency with futures volatility as measured by the Yang & Zhang estimator, open interest and volume as well as at the weekly frequency where we also include open interest of hedgers and speculators separately.

Robustness considerations lead us to implement the whole analysis above with a 1999 cut-off[2]. The pattern of results is similar although not as pronounced as with the 2003 cut-off suggesting that the effects of financialization were strongest over the 2003-2007 period as suggested in earlier studies.

[2]Some studies date the premise of financialization back to the very late 1990s/early 2000s (Bohl and Stephan, 2013; Stoll and Whaley, 2010; Büyükşahin and Robe, 2014).

Chapter 4

Results & discussion

Table 1 shows the mean futures front month and spot price levels, open interest and volume for the four commodities and two periods of interest. We observe a moderate increase of grain prices over the financialization period with an average mean futures price increase of 11.7%; 10.5% for mean spot price. SRW wheat shows the strongest increase with +17.2% for mean futures price and +20.3% for mean spot price while corn shows the lowest with a 2% and 0.8% increase respectively. For the basis the situation is not as clear with the wheat complex showing a relative stability in numerical terms (+$1.3 and +$0.4 respectively) while corn and soybeans show dramatic increases (+$6.4 or +138.5% and +$8.7 or +264.7% respectively). In contrast to prices, mean open interest and volume show a dramatic increase across the board with average increase of 95.4% and 63.5% respectively suggesting that the large increase of trading activity during financialization did not lead to a commensurate increase in grain prices.

Table 2 shows the average volatility levels for the four commodities and the two periods of interest. For futures average volatility, estimators include the classic "close-to-close" as well as the values for the five range-based estimators. The pattern of results is different across the various commodities and estimators but in all cases the average volatility is higher over the financialization period with the average mean increase for the set of estimators ranging from 11.3% for SRW wheat to 20.1% for HRW wheat. For basis average volatility, estimators include the classic "close-to-close" as well as Parkinson and show a dramatic increase over the financialization with the average increase for the two estimators ranging from 41.7% for SRW wheat to 155.6% for corn.

Table 3 shows the results for the regressions of volatility on contemporaneous and one-week lagged volume and open interest. For futures volatility, the slope coefficients of open interest for corn and both types of wheat change to positive during financialization from negative before indicating open interest changes from having a stabilizing effect on volatility in the first period consistent with

a classic hedging market (Working, 1960, 1962) to a destabilizing effect in the second for these commodities. The R^2s vary across the two periods with a sharp increase for corn (11% to 44%) and a decrease for HRW wheat (28% to 5%) suggesting that while the nature of the effect is uniform for the three commodities, the magnitude is not. For soybeans the sign of all slope coefficients is negative in both periods and the R^2 is higher in the financialization period indicating a greater stabilizing effect. The pattern and magnitude of the results is very similar when lagged open interest is used, suggesting that it is the expected component of open interest that is driving these results (Bessembinder and Seguin, 1993). For volume, the slope coefficients switch from negative to positive for SRW & HRW wheat while, in both periods, they are positive for corn with a substantially higher R^2 over the financialization period (2.8% to 24.2% for the Yang & Zhang estimator) and negative for soybeans with again a higher R^2 in the financialization phase. The pattern is very similar for lagged volume indicating that the results are driven by expected volume. The pattern of results is thus similar for both open interest and volume and indicates that over financialization they had a destabilizing effect on futures volatility for corn and the two types of wheat while having a more stabilizing effect for soybeans. Besides, soybeans showed the most pronounced increase in average futures volatility indicating that changes in the nature of volatility and the changes in the magnitude of volatility are not necessarily directly linked. Overall these findings provide evidence for the hypotheses advanced in Goldstein et al. (2014), Singleton (2013) and Stein (1987) where more trading arising from greater dispersions of beliefs or the entry of new traders increasing noise in signals could lead to changes in the nature of volatility and the information content of prices. Thus greater market depth may not always lead to more informative price signals and this may be due to the nature of trading (see also Stout (1998) & Stout (2011)) for a discussion of this issue from a legal standpoint). For basis volatility there does not appear to be a clear pattern and the results suggest that the nature of basis volatility is different from that of futures, with other factors perhaps driving the increases.

Combining volume and open interest produces a mixed pattern of results as shown in table 4. For futures volatility, corn and SRW wheat show a change in sign and increase in R^2 (Yang & Zhang estimator) during financialization while for HRW wheat, there is a change in sign for the open interest slope coefficient with the coefficient for volume positive in both periods and a lower R^2 for the financialization period. These results suggest that both factors jointly had a destabilizing influence on volatility. For soybeans, the two coefficients are negative in both periods with a higher R^2 for the financialization period indicating a greater stabilizing effect. The results for the four-factor model are shown in table 5. The clearest pattern is for corn where the R^2 for the Yang & Zhang estimator model increase from 18% pre-financialization to 44% during the financialization phase.

Table 6 shows the results for the Granger causality analysis where we observe a change in behavior between the two periods. For SRW wheat and corn open

interest Granger causes volatility (Yang & Zhang estimator), but not the other way round, in the pre-financialization period during financialization period the only causal relation established is for SRW wheat volatility (Yang & Zhang estimator) Granger causing volume. In contrast, over the same period, for HRW wheat, the smallest market, and soybeans, volume appears to Granger cause volatility. There is thus no clear pattern over the financialization period and the evidence is stronger in the first period for volume Granger causing volatility. Taken together these results provide further confirmation for a change in relationship between volatility and both volume and open interest, with some evidence that financialization may have driven volatility higher in the smallest grain market.

The mean Working's T index levels range from 1.05 (HRW wheat) to 1.18 (SRW wheat) over the first period while they range from 1.08 (HRW wheat) to 1.18 (SRW wheat) over the second period. The results indicate a very limited mean level increase from the first to the second period, 1.9% on average across commodities, ranging from no change for SRW wheat to a 2.9% increase for HRW wheat, suggesting that the level of "excess speculation" as defined by Working (1960) did not uncouple with historical levels during financialization[1].

Table 7 shows the results for the regressions of volatility on contemporaneous and one-week lagged total open interest, open interest of speculators, open interest of hedgers, volume and Working's T index. The pattern of results is very similar for both the open interest of hedgers and speculators in both periods indicating that the influence of hedgers and speculators on volatility is very similar and did not change over financialization. For SRW wheat, the slope coefficients for both hedgers and speculators are positive in both periods indicating a destabilizing effect, with a higher R^2 in the second period suggesting a greater destabilizing effect. The results for corn indicate a change from stabilizing, with both coefficients negative pre-financialization, to destabilizing with positive coefficients during financialization accompanied by a sharp increase in R^2. For HRW wheat, the evidence is mixed with some evidence of a greater stabilizing influence for both hedgers and speculators while for soybeans all slope coefficients are negative but with lower R^2 during financialization indicating a weaker stabilizing influence. The overall thrust of the evidence is towards a greater destabilizing influence of open interest on volatility with little difference between hedgers and speculators. These findings echo some of the issues raised in Cheng and Xiong (2014b) and raises issues about the classification system used by the CFTC. The results for basis volatility are similar except for HRW wheat for which open interest shows a trend towards greater destabilization influence on volatility. The results for the Working's T index provide no clear support for the hypothesis that excess speculation may have caused changes in the nature of commodity futures volatility. The slope coefficient for corn switches from positive to negative indicating that "excess speculation" seemed to have a stabilizing influence on volatility during financialization. The results are mixed

[1] As suggested in Sanders and Irwin (2010).

for wheat with a switch from stabilizing to destabilizing for SRW wheat and negative coefficients in both periods for HRW wheat albeit with lower R^2 over financialization while for soybeans there is evidence of a greater destabilizing effect. These results further reinforce the hypothesis that dispersion in beliefs or disagreement-based trading (Stout, 2011) could be one of the driving forces behind some of the effects observed over the financialization phase. For basis volatility there is no clear pattern with five out of eight coefficients negative for the financialization period.

Table 8 shows the results for a four-factor model where the response is volatility and the explanatory variables include contemporaneous and one-week lagged open interest of hedgers, open interest of speculators, volume and Working's T index. The results are strongest for corn with a dramatic increase in R^2 (20.9% to 52.2%) while all the others results are mixed, reinforcing the earlier findings above indicating that the effects of financialization seem to have been most pronounced in the corn market.

The results of the Granger causality analysis are shown in Table 9 and are generally inconclusive with the only clear evidence for SRW wheat where futures volatility and volume Granger cause each other and futures volatility Granger causes open interest of hedgers over the financialization period.

Chapter 5

Conclusion

Institutional investments in long-only commodity index funds soared in the early 2000s which led to a large increase in trading activity as measured by open interest and volume. This surge and its attendant impacts are commonly referred to as the "financialization" of commodity markets. In this paper, we investigate the effect of financialization on the volatility of grain futures markets. These markets have been classically regarded as hedging markets and have been at the forefront of the debate over whether financialization has contributed to price and volatility spikes. We find that all grains futures volatility increased in the period of financialization but that this increase is not as large as commonly believed. Nonetheless, we find that the increase in market depth has a generally destabilizing effect on grains volatility but that this destabilizing effect does not seem to be driven by the action of speculators. Our results generally support the findings of Stein (1987), Goldstein et al. (2014), Singleton (2013), and Sockin and Xiong (2015) which suggest that increased market depth that arises as a result of difference of opinion between traders could lower the information content of prices. Our results therefore add to the growing body of evidence that suggest that greater market depth may not always have a beneficial effect on markets.

Bibliography

Basak, S. and Pavlova, A. (2016). A model of financialization of commodities. *The Journal of Finance*, 71(4):1511–1556.

Bessembinder, H. and Seguin, P. J. (1993). Price volatility, trading volume, and market depth: evidence from futures markets. *Journal of Financial and Quantitative Analysis*, 28(1):21–39.

Bohl, M. T. and Stephan, P. M. (2013). Does futures speculation destabilize spot prices? new evidence for commodity markets. *Journal of Agricultural and Applied Economics*, 45(4):595–616.

Bos, J. W. and van der Molen, M. (2012). A bitter brew? futures speculation and commodity prices. *Futures Speculation and Commodity Prices*.

Brunetti, C. and Buyuksahin, B. (2009). Is speculation destabilizing? *Working paper*.

Büyükşahin, B. and Robe, M. A. (2014). Speculators, commodities and cross-market linkages. *Journal of International Money and Finance*, 42:38–70.

Caballero, R. J., Farhi, E., and Gourinchas, P.-O. (2008). Financial crash, commodity prices and global imbalances. Technical report, National Bureau of Economic Research.

Cheng, I.-H. and Xiong, W. (2014a). Financialization of commodity markets. *Annual Review of Financial Economics*, 6(1):419–441.

Cheng, I.-H. and Xiong, W. (2014b). Why do hedgers trade so much? *The Journal of Legal Studies*, 43(S2):S183–S207.

De Schutter, O. (2010). Food commodities speculation and food price crises: regulation to reduce the risks of price volatility. *United Nations Special Rapporteur on the Right to Food Briefing Note*, 2:1–14.

Domanski, D. and Heath, A. (2007). Financial investors and commodity markets. *Working Paper*.

Du, D. and Zhao, X. (2017). Financial investor sentiment and the boom/bust in

oil prices during 2003–2008. *Review of Quantitative Finance and Accounting*, 48(2):331–361.

Fung, H.-G., Leung, W. K., and Xu, X. E. (2003). Information flows between the u.s. and china commodity futures trading. *Review of Quantitative Finance and Accounting*, 21(3):267–285.

Gannon, G. L. (2010). Simultaneous volatility transmission and spillover effects. *Review of Pacific Basin Financial Markets and Policies*, 13(01):127–156.

Gilbert, C. L. (2010a). How to understand high food prices. *Journal of Agricultural Economics*, 61(2):398–425.

Gilbert, C. L. (2010b). Speculative influences on commodity futures prices 2006-2008. *UNCTAD, Geneva*.

Goldstein, I., Li, Y., and Yang, L. (2014). Speculation and hedging in segmented markets. *The Review of Financial Studies*, 27(3):881–922.

Goldstein, I. and Yang, L. (2015). Information diversity and complementarities in trading and information acquisition. *The Journal of Finance*, 70(4):1723–1765.

Hamilton, J. D. (2009). Causes and consequences of the oil shock of 2007-08. Technical report, National Bureau of Economic Research.

Hamilton, J. D. and Wu, J. C. (2015). Effects of index-fund investing on commodity futures prices. *International Economic Review*, 56(1):187–205.

Harris, J. H. and Buyuksahin, B. (2009). The role of speculators in the crude oil futures market. *Working paper*.

Henderson, B. J., Pearson, N. D., and Wang, L. (2015). New evidence on the financialization of commodity markets. *The Review of Financial Studies*, 28(5):1285–1311.

Herman, M.-O., Kelly, R., and Nash, R. (2011). Not a game, speculation v. food security: regulating financial markets to grow a better future. *Oxfam policy and practice: agriculture, food and land*, 11(7):127–138.

Irwin, S. H. and Sanders, D. R. (2011). Index funds, financialization, and commodity futures markets. *Applied Economic Perspectives and Policy*, 33(1):1–31.

Irwin, S. H. and Sanders, D. R. (2012a). Financialization and structural change in commodity futures markets. *Journal of Agricultural and Applied Economics*, 44(3):371–396.

Irwin, S. H. and Sanders, D. R. (2012b). Testing the masters' hypothesis in commodity futures markets. *Energy economics*, 34(1):256–269.

Irwin, S. H., Sanders, D. R., and Merrin, R. P. (2009). Devil or angel? the role of speculation in the recent commodity price boom (and bust). *Journal of Agricultural and Applied Economics*, 41(2):377–391.

Jiang, Y., Ahmed, S., and Liu, X. (2017). Volatility forecasting in the chinese commodity futures market with intraday data. *Review of Quantitative Finance and Accounting*, 48(4):1123–1173.

Karpoff, J. M. (1987). The relation between price changes and trading volume: a survey. *Journal of Financial and Quantitative Analysis*, 22(1):109–126.

Kilian, L. and Murphy, D. P. (2014). The role of inventories and speculative trading in the global market for crude oil. *Journal of Applied Econometrics*, 29(3):454–478.

Korniotis, G. M. et al. (2009). *Does Speculation Affect Spot Price Levels?: The Case of Metals with and Without Futures Markets*. Division of Research & Statistics and Monetary Affairs, Federal Reserve Board.

Krugman, P. (2008). More on oil and speculation. *New York Times*, 1:1–31.

Kyle, A. S. (1985). Continuous auctions and insider trading. *Econometrica*, 53(6):1315–1335.

Li, J. (2016). When noise trading fades, volatility rises. *Review of Quantitative Finance and Accounting*, 47(3):475–512.

Masters, M. W. (2008). Testimony before the committee on homeland security and governmental affairs. *U.S. Senate*, 20.

Masters, M. W. and White, A. (2011). The accidental hunt brothers: how institutional investors are driving up food and energy prices: executive summary. *Excessive Speculation in Agriculture Commodities*, pages 9–10.

Nishina, K., Maghrebi, N., and Holmes, M. J. (2012). Nonlinear adjustments of volatility expectations to forecast errors: evidence from markov-regime switches in implied volatility. *Review of Pacific Basin Financial Markets and Policies*, 15(03):1250007.

Petzel, T. E. (2009). Testimony before the commodity futures trading commission.

Phillips, P. C. and Loretan, M. (1990). Testing covariance stationarity under moment condition failure with an application to common stock returns. Technical report, Cowles Foundation for Research in Economics, Yale University.

Phillips, P. C., Wu, Y., and Yu, J. (2011). Explosive behavior in the 1990s nasdaq: When did exuberance escalate asset values? *International economic review*, 52(1):201–226.

Phillips, P. C. and Yu, J. (2011). Dating the timeline of financial bubbles during the subprime crisis. *Quantitative Economics*, 2(3):455–491.

Pirrong, C. (2008). Restricting speculation will not reduce oil prices. *The Wall Street Journal*, 11.

Pirrong, C. (2010). No theory? no evidence? no problem! *Regulation*, 33:38.

Rouwenhorst, K. G. and Tang, K. (2012). Commodity investing. *Annual Review of Financial Economics*, 4(1):447–467.

Sanders, D. J. and Baker, T. G. (2012). Marginal hedging in futures markets. *Working paper*.

Sanders, D. R. and Irwin, S. H. (2008). Futures imperfect. *New York Times*, 20.

Sanders, D. R. and Irwin, S. H. (2010). A speculative bubble in commodity futures prices? cross-sectional evidence. *Agricultural Economics*, 41(1):25–32.

Sanders, D. R. and Irwin, S. H. (2011). The impact of index funds in commodity futures markets: a systems approach. *The Journal of Alternative Investments*, 14(1):40–49.

Sanders, D. R., Irwin, S. H., and Merrin, R. P. (2010). The adequacy of speculation in agricultural futures markets: too much of a good thing? *Applied Economic Perspectives and Policy*, 32(1):77–94.

Schumann, H. (2011). The hunger-makers: how deutsche bank, goldman sachs and other financial institutions are speculating with food at the expense of the poorest. *Foodwatch, Berlin*.

Senate, U. (2009). Excessive speculation in the wheat market. *Majority and Minority Staff Report. Permanent Subcommittee on Investigations*, 24:107–108.

Singleton, K. J. (2013). Investor flows and the 2008 boom/bust in oil prices. *Management Science*, 60(2):300–318.

Smith, K. L. and Bracker, K. (2003). Forecasting changes in copper futures volatility with g.a.r.c.h. models using an iterated algorithm. *Review of Quantitative Finance and Accounting*, 20(3):245–265.

Sockin, M. and Xiong, W. (2015). Informational frictions and commodity markets. *The Journal of Finance*, 70(5):2063–2098.

Stein, J. (1987). Informational externalities and welfare-reducing speculation. *Journal of Political Economy*, 95(6):1123–1145.

Stoll, H. R. and Whaley, R. E. (1987). Program trading and expiration-day effects. *Financial Analysts Journal*, 43(2):16–28.

Stoll, H. R. and Whaley, R. E. (2010). Commodity index investing and commodity futures prices. *Journal of Applied Finance*, 20(1).

Stout, L. A. (1998). Why the law hates speculators: regulation and private ordering in the market for o.t.c. derivatives. *Duke Law Journal*, 48:701–786.

Stout, L. A. (2011). Uncertainty, dangerous optimism, and speculation: an inquiry into some limits of democratic governance. *Cornell Law Review*, 97:1177.

Tang, K. and Xiong, W. (2012). Index investment and the financialization of commodities. *Financial Analysts Journal*, 68(5):54–74.

Till, H. (2009). Has there been excessive speculation in the u.s. oil futures markets? what can we (carefully) conclude from new cftc data? *Working paper*.

Toda, H. Y. and Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics*, 66(1):225–250.

UNCTAD, S. T. F. o. S. I. and Cooperation, E. (2009). The global economic crisis: systemic failures and multilateral remedies. *UNCTAD, Geneva*.

Wang, C. (2003). The behavior and performance of major types of futures traders. *Journal of Futures Markets*, 23(1):1–31.

Working, H. (1953). Hedging reconsidered. *Journal of Farm Economics*, 35(4):544–561.

Working, H. (1954). Whose markets? evidence on some aspects of futurest trading. *Journal of Marketing*, 19(1):1–11.

Working, H. (1960). Speculation on hedging markets. *Food Research Institute Studies*, (02).

Working, H. (1962). New concepts concerning futures markets and prices. *The American Economic Review*, 52(3):431–459.