Financialisation of Natural Resources & Instability Caused by Risk Transfer in Commodity Markets

Author 1* Author 2† Author 3‡

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Abstract

Understanding the connectedness of financial markets and hence possible sources of systematic risk is central to the debate on the process of *financialisation* and its consequences for financial stability. In this study, we examine the connectedness between commodity spot and futures prices by applying a novel frequency connectedness framework on data from January 1979 to December 2019 to measure the connectedness among financial variables. Focusing on the seven most widely traded commodities, including gold, silver, crude oil (WTI and BRENT), corn, soya and iron, we find that (i) volatility of the commodity derivatives (futures) contribute to the spot volatility and hence influence spot prices of the underlying commodities in international markets (ii) volatility spillover effects are stronger in the first four days of the shock, suggesting that shocks to the underlying asset volatility caused by its own fundamental are more prevalent and persistent in the long-term (iii) commodities futures volatility transmission is higher than spot price volatility transmission to the futures prices. Our findings shed new light on the relationship between the actual spot price of commodities and their derivatives and have crucial socio-economic implications in terms of financialisation of important commodities.

Keywords: Derivatives, Futures, Oil market, Gold, Silver, Commodities, Volatility transmission

JEL Classification: C5, F4, G1

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1 Introduction

Financialisation has encompassed almost every aspect of contemporary society in developed as well as developing economies. Financialization, which refers to the growing importance of a country's financial sector entails facilitation of exchange of goods, services as well as various forms of risks through financial intermediation and by use of financial instruments. Boyer et al. (2012); Krippner (2005) described financialisation as a *pattern of accumulation which involves profits accruing mainly through financial channels rather than through commodity production and trade.* Hence the in expectation of dividends, interest and capital gains, the underlying financial activities relate to the provision or transfer of liquid capital. While some scholars such as Michael Hudson has called it a lapse back into the pre-industrial usury and rent economy of European feudalism[1], the accelerating pace of financialisation has dwarfed the size of any real sector of the real economy.

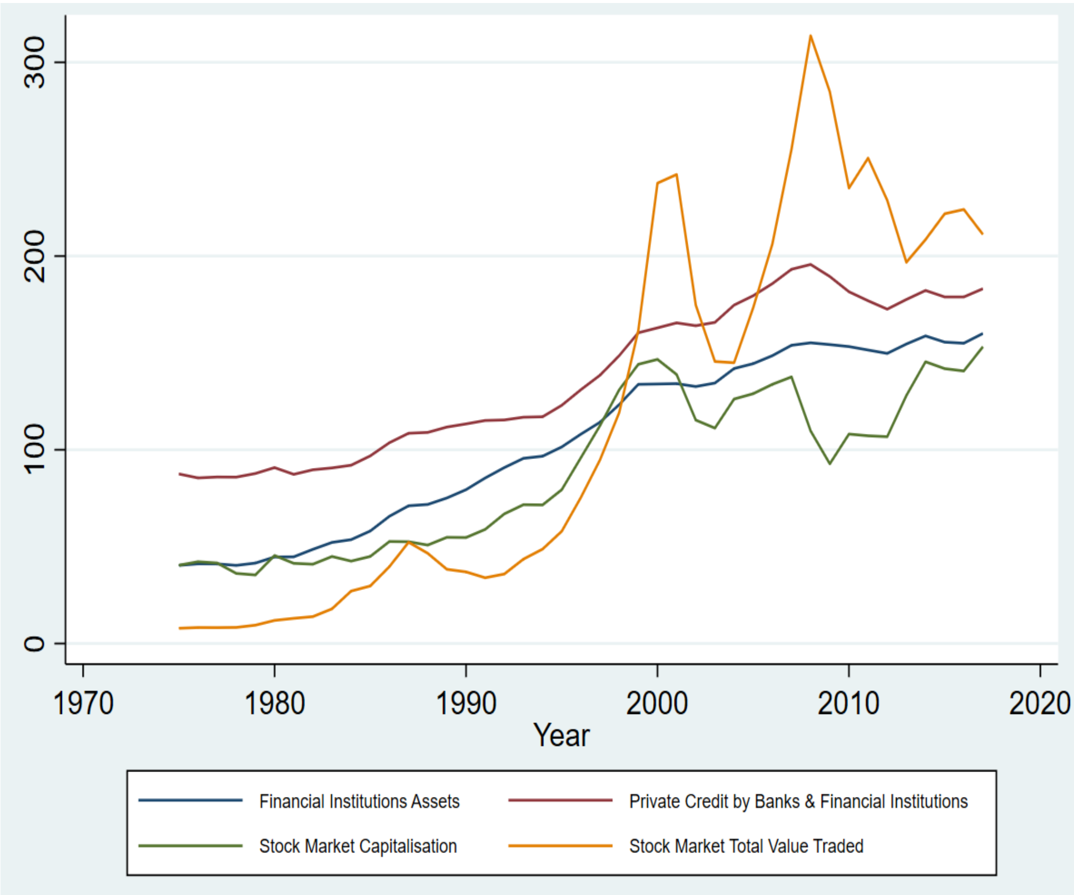


Figure 1: USA Financial Development and Structure 1960s to 2017
Notes: The Y axis % of GDP and our data are retrieved from World Bank

Analogous to the countries which host the global financial hubs including the USA (New York), UK (London) and Japan (Tokyo), the role and size of the financial sector has in-

[1]See: https://www.counterpunch.org/2003/08/29/who-benefited-from-the-tech-bubble-an-interview-with-michael-hudson/.

creased in almost every economy around the world, even in developing countries. In the U.S. alone, the GDP share of the financial industry increased during the period 1950 to 2012 from 2.8 to 7.9%. which illustrates the growing importance of the financial sector in the U.S. The growing financial services sector often considered as "financial development" is perceived by an important source of exports of financial services and can also contribute to the growth of other sectors since large and liquid financial markets make it easier and more efficient for companies to fund investments and facilitate international trade by reducing transaction costs. In addition, as a typical textbook argument is often made, financial sector helps channeling resources from savers to investors. Moreover, financial sectors provide a risk transfer mechanism by facilitating cost-efficient *derivatives trading*, readily available to institutional as well as retail investors.

Despite the argued benefits of financialisation, on the flip side, it has been criticized for myopic approach and focusing merely on short-term profits, resulting in monopolistic structures, disrupting an economy's long-term goals, thereby reducing product quality and social cohesion. This has been particularly evident during the global financial crisis 2008-09 which adversely affected the global economy as well as revived the debate on the role of finance in the economy and society. Scholars have vigorously started to debate on whether the financial sector helps or hinders economic growth. In order to explore the role of finance and financialisation on the real economy. People looked at the impact of variables such as money supply (Sawyer, 2013), bank credit (Aitken, 2013; Langley, 2008; Montgomerie, 2006), and commodity markets (Adams & Glück, 2015), stock and bond and foreign exchange markets (Nasir et al., 2015). Some studies also include other factors such as institutional compliance quality and the role of financial regulation (Ertürk, 2016; Kotz, 2010). However, given the fact the financialisation is a multifaceted phenomenon and to reiterate, financialisation comes in various forms, one of the crucial aspects of financialisation is the increasing size and significance of derivative markets for the real economy.

A Distinguished feature of financialisation has been the development of exotic financial instruments such as derivatives whose value is derived from the value of the underlying real or financial asset. These financial instruments, whose initial purpose was hedging and risk management, have become widely traded financial assets in their own right. This, in turn, had a significant impact on the environment and dynamics of the underlying assets including the commodities markets. The growing interest of both institutional and retail investors in commodity investing, encouraged by Greer (2000) and Gorton & Rouwenhorst (2006), who theoretically underpinned the perception of commodities having beneficial diversification properties in the context of modern portfolio theory. Furthermore, the deregulation of the derivatives market and the emergence of new investment products such as exchange-traded funds lead to a transformation of the commodity market that is often and appropriately referred to as "Financialisation of commodity markets". From 2003 to the midst of 2008, investment inflows to commodity futures increased from $13 billion to about $260 billion (CFTC, 2008). In 2017, assets under management in commodity products exceeded $400 billion for the first time in more than a year (H. Mayer et al., 2017). Commodity futures markets have gained an unprecedented size which reflects its significance and shows how important the market of commodity futures trading has become in terms of resource allocation.

While most commodities are indispensable to the industry and economy, the enormous size of speculative activities in recent years has led to a growing debate, as it also poses enormous social, political and economic challenges. More specifically, the original role of the derivative market is to transfer risk and provide a hedge to those who want to hedge against risks. But if the volatility in this gigantic market causes volatility in the actual market of underlying commodities, then instead of causing stability, the commodity derivative market can actually cause instability. This means that there is a flip side or side effect of financialising the commodities. Therefore, this paper looks at the debate from a novel perspective by examining the spillover of volatility from the derivative market which may cause instability in the actual market of underlying asset/commodities that are used by household and firms in every economy. While most previous studies focus on a rather limited set of commodities or time period (for example, H. Mayer et al. (2017) use a timeframe from January 1993 to December 2013, while Du et al. (2011) use a dataset consisting of crude oil, corn and wheat futures only), we provide an extensive analysis of the seven most commonly traded commodities, including gold, silver, crude oil (WTI and BRENT), corn, soya and iron. Thereby, our results are relevant for a larger group of investors and policy makers, and also provide stronger empirical evidence. In addition, for measuring connectedness among commodity spot and futures prices that arise due to heterogeneous frequency responses to shocks, we employ a novel framework based on a recent study from Baruník & Křehlík (2018). The connectedness of financial markets became a central area of research in the past decade, as standard correlation-based measures have proven to be unsuitable, particularly during times of increased market distress as experienced during the 2008-2009 period. Therefore, it is crucial to understand the properties of connectedness between commodity spot and futures prices and global natural resource challenges by better understanding the underlying mechanisms that link future contracts and commodity spot prices and their interaction with economic, social and political processes. Concomitantly, applying a novel frequency connectedness framework on data from January 1979 to December 2019 to measure the connectedness among financial variables. Focusing on the seven most widely traded commodities, including gold, silver, crude oil (WTI and BRENT), corn, soya and iron, we find that (i) volatility of the commodity derivatives (futures) contribute to the spot volatility and hence influence spot prices of the underlying commodities in international markets (ii) volatility spillover effects are stronger in the first four days of the shock, suggesting that shocks to the underlying asset volatility caused by its own fundamental are more prevalent and persistent in the long-term (iii) commodities futures volatility transmission is higher than spot price volatility transmission to the futures prices. Our findings shed new light on the relationship between the actual spot price of commodities and their derivatives and have crucial socio-economic and policy implications in terms of financialisation of important commodities. Future policy measurements should include mechanisms and controls that might tame the speculative aspects of the derivatives market, which in turn cause elevated volatility in the real commodities market. Potential levers could be prudential regulations and policies as well as disincentivising excessive speculative behaviour through tax policy.

The remainder of this paper is structured as follows. Section 2 reviews the existing literature regarding the influence of financialisation on commodity prices. Section 3 summarizes the data and introduces our main methodology. Section 4 discusses the empirical results. Finally, section 5 concludes.

2 Literature review

In this section, we acknowledge the current literature on the relationship between spot and futures prices, particularly their price building interaction and the causal chain they are following within that mechanism. In addition, we summarize the literature on the influence on volatility. Finally, we review the literature about the effect of financialisation on commodity markets.

The impact of spot and futures markets on the price discovery process of the underlying market is crucial and received some attention in the literature. However, it is important to draw a distinction between price and price volatility. As suggested by Kavussanos et al. (2008), if volatility spillovers actually occur from one market to the other, investors can use the spreading of volatility as a means of price discovery. Rong & ZHENG (2008) were among the first to examine the lead-lag relationship between *current futures prices and spot prices*, finding that the futures market are leading spot markets in the event of new information. In the same vein, Fassas & Siriopoulos (2019) used high-frequency data of Athens stock exchange to confirm the previous findings that futures markets tend to lead spot markets in the price discovery process. While the majority of studies have focused on developed countries, a limited number of studies examined emerging derivatives markets, basically coming to the same conclusion. For example, Miao et al. (2017) confirmed the lead-lag relationship for the Chinese stock market, while Thampanya (n.d.) analysing the relationship between spot and futures price in the Thai market. Employing Bayesian Vector Autoregressions (Bayesian VAR) model, the results indicate that there is a bivariate relation between spot and futures markets for all contango periods. Lastly, Songyoo (2012) studied the price lead-lag relationship between stocks, stock index futures and the underlying asset using ten-minute tick data. The results again confirmed that futures prices of single stocks lead their spot prices. To reiterate, these studies preliminary focused on the price rather the spillover of price volatility.

Yet, in a nutshell, it is fair to argue that there is a general agreement in the literature that a significant interaction of spot and futures markets exists. As a consequence, the question about the causal chain has been raised and it has been argued that price building in spot markets triggered by futures markets follows the following chain – an increase in futures trading due to reasons mentioned above leads to changes in futures prices, which then indirectly influence the price (and volatility) of the underlying spot market H. Mayer et al. (2017). Again, this can be attributed to the following channels. The first channel follows the theory of storage. Simultaneous buying and selling of a commodity in different markets by arbitrageurs links spot and futures prices and adjust prices based on interest rates, inventory costs, and the nature of storage itself (Cheng & Xiong, 2014; Fama & French, 2016). The second channel builds on the risk-sharing mechanism in the futures markets. Because commodity producers are selling short in the market and are subject to strong hedging pressure, there are typically fewer market participants willing to take the opposite short position. This results in a risk premium for taking long positions and links future and spot prices (Cheng & Xiong, 2014; Hicks, 2017; Keynes, 1923). The last channel is based on the theory of asymmetric information, showing that future prices should react faster to new information than spot prices, thereby serving as a pricing signal for the underlying asset and linking both markets (H. Mayer et al., 2017). Irwin & Sanders (2012) introduce the so-called "Masters Hypothesis", arguing that the massive buy-side demand due to the commodity index investments in the futures markets causes physical spot price distortions (Masters, 2008, 2009; Masters & White, 2008). While the hypothesis has become extremely popular, it also has not been unanimously accepted. For instance, as the studies by Gulley & Tilton (2014); Tilton et al. (2011) showed, while it requires the market to be in contango, the oil market on which they focused was found backwardation most of the time.

Most of the current literature focuses on the relationship between futures and spot prices. However, the contribution of the derivative to the volatility of the underlying asset is another interesting, yet underexplored venue of scholarly inquiry (Gorton & Rouwenhorst, 2006; Kaufmann & Ullman, 2009). To this day, there is no consensus about the effects of financialisation of the commodity market on the volatility of the underlying market. for instance, while Brunetti et al. (2016) argued that the increase in non-commercial traders lead to further liquidity in the futures market, thereby enabling market forces to correct irrational prices and reducing volatility, others are rather worried about the stability of the market (Cheng et al., 2014; Cheng & Xiong, 2014; Henderson et al., 2014). They argue that, although institutional and retail investors have embraced commodities as a profitable asset class, the increase in capital to commodity futures markets would be hurtful to individual investors as well as the total economy in the long-run due to the high correlation between commodity prices and inflation (Büyüksahin et al., 2009; Chong & Miffre, 2010;

Gorton & Rouwenhorst, 2006; Kat & Oomen, 2006). When it comes to the volatility for measuring the price stability, the earlier literature by Hartzmark (1986) does not find the link between margin changes and volatility in a future contract. Meanwhile, the investors might suffer from risk by calling margin when the volatility of futures contracts increases (e.g. for metal market, see Chatrath et al., 2001 and / or for agricultural products, see Adrangi & Chatrath, 1999). Then, why does the future volatility influence the spot prices? The main reason for this mechanism is the available information as well as transaction cost. Indeed, when the future volatility increases, investors tend to be attracted by lower cost (relative to the spot markets) of transactions relative in the future market. Hence, the spread of bid-ask in spot prices will be larger; thus, the market will come into the illiquidity trap, which bears the spot market. Edwards (1988) claimed that future trading also increases the spot volatility, which is considered as the risk-premium to positively influence the spot price. It is clearly evident that volatility would be risk leverage to increase expected return because of risker premium (Christie, 1982). This theoretical framework as well as the empirical analysis was documented in prior papers such as Bekaert & Wu (2000) and Campbell & Hentschel (1992).

Next, we acknowledge the literature on the impact of financialisation on commodity prices.[2] To begin with, Fattouh et al. (2013) have argued that the financialisation of commodity assets further increased the linkage between futures and spot prices. The explanation for this phenomenon is based and can be condensed into six strands of literature on financialisation. First, there exist co-movement between the commodity prices itself (Büyüksahin et al., 2009; Büyükşahin & Robe, 2014; Silvennoinen & Thorp, 2013). Second, trading behavior, as well as the number of participants, also contribute to spot commodity prices (Kim, 2015; Lehecka, 2015; Mutafoglu et al., 2012). Third, the economic conditions are a crucial factor (Alquist et al., 2013; Peck, 1985). Fourth, inventory with large storage costs is one more reason that generates the linkage between future and spot prices (Alquist & Kilian, 2010; Geman & Smith, 2013; Hamilton, 2009). Fifth, the structural economic model also influences the relationship between future and spot prices (Juvenal & Petrella, 2015; Kilian & Murphy, 2014; Knittel & Pindyck, 2016). Sixth, risk-premia appears because of the influence of time-varying changes (Acharya et al., 2013; Etula, 2013; Hamilton & Wu, 2014). Furthermore, the financialisation of soft commodities such as corn, soya or wheat has been analysed (Gilbert, 2010; Irwin & Sanders, 2010). The study by Sanders et al. (2004) investigated the financialisation of energy commodities (oil, gas), while metals have been studied relatively more recently by Gilbert et al. (2010); H. Mayer et al. (2017); J. Mayer (2012); Xiao et al. (2019). One of the earliest empirical studies investigating the link between commodity futures trading and spot price volatility is Antoniou & Foster (1992). Using weekly data for futures and spot prices of the Brent Crude market, they find that the introduction of futures markets improved the quality

[2]For an extensive literature review on the impact of financialisation on commodity prices, the reader is referred to Fattouh et al. (2013).

of information flow to spot markets, but no evidence to suggest that there is spillover of volatility from futures to spot market. There are quite a few papers that examine the spillover effects in developing countries. Sehgal et al. (2013) study the price discovery and volatility spill-over relationship for Indian commodity markets, showing that spill-over effects are confirmed for only three commodities and none of the indices. Interestingly, the study by Srinivasan et al. (2012) shows that the spillovers of certain information actually go in the opposite direction, namely from spot markets to futures markets. Finally, Ajoy Kumar & Shollapur (2015) find contradicting evidence, namely that futures lead spot prices. Overall, there is hardly any consensus yet in the literature about the directional relationship. These studies focused on a smaller group of metals and limited time frames. Yet, the better understanding the connectedness of financial markets and hence possible sources of systematic risk is of utmost importance. However, in the light of the existing literature, there is no consensus on the connectedness between commodity spot and futures prices and more specifically a lack of evidence on the volatility spillovers. This study attempts to fill this caveat.

3 Methodology

We employed the interconnectedness method to capture the spillovers and volatility transmission, devised by Diebold & Yilmaz (2009) as well as Baruník & Kocenda (2019). The fundamental concept is based on variance decomposition, extracted in the estimates of Vector Auto-Regressions (VAR).[3] By doing this, VAR allows us to generate the future error variance of a variable i to another variable k. To generalize the total process, we assume that there are N assets, which interprets as $N-$dimensional vector conveying the realized volatilities, which are used to estimate the volatility spillovers. Therefore, we denote the vector of realized volatilities as $RV_t = (RV_{1,t}, ..., RV_{N,t})'$.

In the following part, we model the volatility spillover for $N-$dimensional vector RV_t by using a weakly stationary Vector Auto-Regression VAR(p).

$$RV_t = \sum_{i=1}^{p} \Phi_i RV_{t-i} + \epsilon_t, \quad where\ \epsilon_t \sim N(0, \sum_{\epsilon}) \tag{1}$$

In which, ϵ_t is vector of independent and identically distributed random variables and Φ_i stands for p coefficients matrices. As study of Baruník & Kocenda (2019), the moving average representation has the following form:

[3] In this study, we employ a VAR model in favor of other models for three main reasons. First, VAR models have the advantage that the results are not hidden by a large and complicated “black box” structures, but are easily interpretably and available. Second, they have good forecasting capabilities. And lastly, there is no question on the endogeneity or exogeneity of variables, since all variables are endogenous.

$$RV_t = \sum_{i=1}^{\infty} \Psi_i \epsilon_{t-i} \tag{2}$$

After estimating Equation 2, we have the $N \times N$ matrices holding coefficients Ψ_i. In the following step, the recursion will be extracted as follows $\Psi_i = \sum_{j=1}^{p} \Phi_j \Psi_{i-j}$ where $\Psi_0 = I_N$ and $\Psi_i = 0$ for $i < 0$. This recursion process is referred to the VAR system's dynamics because one of the whole processes allows isolating the forecast errors to compute the connectedness of the system as the previous studies such as (Koop et al., 1996; Pesaran & Shin, 1998).

Drawing on the work of Diebold & Yilmaz (2012) and Baruník & Kocenda (2019), we briefly summarize the total spillovers index by using H-step-ahead generalized forecast error variance decomposition matrix, having the following elements for $H = 1, 2...$

$$\Theta_{jk}^{H} = \frac{\sigma_{kk}^{-1} \sum_{h=0}^{H-1} (e_j' \Psi_h \sum_{\epsilon} e_k)^2}{\sum_{h=0}^{H-1} (e_j' \Psi_h' \sum_{\epsilon} \Psi_h e_k)'}, \quad where\ j, k = 1, ..., N \tag{3}$$

In which, Ψ_h is the matrix conveying the moving average coefficients, forecasted at time t while $\sum_{\epsilon}$ denotes the variance matrix for the error vector, ϵ_t, σ_{kk} is the $k-$th diagonal element of $\sum_{\epsilon}$. In addition, e_j and e_k are selection errors with one as the $j-$th and $k-$th element and zero otherwise. Afterwards, the normalization will be performed by summing the row as the following equation.

$$\tilde{\Theta}_{jk}^{H} = \frac{\Theta_{jk}^{H}}{\sum_{k=1}^{N} \Theta_{jk}^{H}} \tag{4}$$

Therefore, Diebold & Yilmaz (2012) indicated that each variable would contribute to the contribution of connectedness from volatility shocks to the total forecast error variance.

$$S^H = 100 \cdot \frac{1}{N} \sum_{\substack{j,k=1 \\ j \neq k}}^{N} \tilde{\Theta}_{jk}^{H} \tag{5}$$

In Equation 5, $\sum_{k=1}^{N} \Theta_{jk}^{H} = 1$ and $\sum_{j,k=1}^{N} \Theta_{jk}^{H} = N$. Saying differently, this is the process to standardize the total forecast error variance into the connectedness from volatility shocks. In summary, the total connectedness represents how shocks in volatility of one asset are transmitted to another asset throughout this system. The study of Diebold & Yilmaz (2012) also introduced the method to measure directional spillovers from asset j to asset k as the following equation.

$$S_{N,j\leftrightarrow\bullet}^{H} = 100 \cdot \frac{1}{N} \sum_{\substack{k=1 \\ j \neq k}}^{N} \tilde{\Theta}_{jk}^{H} \tag{6}$$

To calculate the receiving effect, we will sum all numbers in rows j except the terms on a diagonal that interprets that its effect is an impact on itself. Conversely, the sending effect will be measured by the sum of numbers in the column and, of course, without the numbers on the diagonal term.

4 Data

The spot prices and future prices for seven common commodities trading on the exchange such as gold, silver, crude oil (WTI and BRENT), corn, soya and iron are used. The main reason for us to choose these assets is the top trading future commodities from The Chicago Mercantile Group. In addition, the reconciliation with the previous literature is done with the study of Serra & Zilberman (2013). The daily data was extracted from Thomson Reuters. To be more specific, in order to have better memory of data return, we obtained the different spanning time for each asset. Table 1 presents the summary of descriptive statistics.

Table 1: Descriptive statistics

Variables	**Time**	**Mean**	**SD**	**Skew**	**Kurt**	**JB**	**DF**
Future Gold	Jan 1995	0.00021	0.0102	-0.096	10.59	16000***	-72.19***
Spot Gold	Dec 2019	0.00021	0.0099	-0.265	10.32	15000***	-73.94***
Future WTI	Mar 1983	0.000073	0.02132	-0.725	17.88	89000***	-94.56***
Spot WTI	Dec 2019	0.000071	0.02448	-0.854	24.95	19000***	-100.90***
Future Silver	Jan 1979	0.000094	0.01861	-0.693	10.81	28000***	-93.98***
Spot Silver	Dec 2019	0.000095	0.02042	-1.224	34.60	45000***	-96.79***
Future corn	Nov 2008	0.00028	0.0137	-0.460	11.42	8670***	-43.40***
Spot corn	Dec 2019	-0.00003	0.0182	0.000	1.79	1634***	-48.29***
Future BRENT	Sep 2003	0.0002	0.0204	0.058	6.16	1776***	-63.90***
Spot BRENT	Dec 2019	0.00018	0.0211	0.148	7.77	4050***	-58.42***
Future Soya	Nov 2008	0.000046	0.0124	0.295	8.80	4092***	-45.48***
Spot Soya	Dec 2019	0.000071	0.0178	0.113	4.06	142.2***	-58.26***
Future Iron	Sep 2015	0.00069	0.1499	0.434	172.25	13000***	-31.23***
Spot Iron	Dec 2019	0.00035	0.0218	-0.139	55.50	13000***	-25.92***

Note: SD is standard deviation, Skew is skewness, Kurt is Kurtosis, JB is the Jarque-Bera test of normality and reports adjusted chi-squared test statistics. DF is the augmented Dickey-Fuller test for non-stationarity. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

As seen in the Table 1, we do reject the null hypothesis of Jarque-Bera test for normal distribution. Therefore, we can observe that all future and spot returns experience non-normal distribution. In addition, all variables are stationary at the original level at 1% significance level. It is worth noting that only corn has the reversed phenomenon, which means that the spot return is negative while the future return is positive. Only spot corn return has the marginal heavy-tail phenomenon while the remaining variables have the severe fat tail, which implies the sudden extreme loss in both markets. Apart from iron, we can observe that spot returns in the majority of assets have higher standard deviation than future returns.

5 Empirical results

In this part, we present the volatility spillovers measured by Diebold & Yilmaz (2012) as well as the total connectedness among future returns and spot returns.

5.1 Volatility spillover effects

In Table 2, we assess the directional spillovers between future prices and spot prices by presenting the aggregate effects of how future returns transmit and receive spillovers or, saying differently, how the shocks to spot returns impact future returns. Inspired by Baruník & Kocenda (2019), we performed two kinds of test, particularly the volatility transmission from one day to four days as well as after 4 days to infinite days. To be more specific, we can see that the highest values on the diagonal present the volatility of spot (or future) return influence its own subsequent volatility. Other values in the specific matrix (it means time impact, 1 day to 4 days and 4 days to infinite days) demonstrate the volatility spillover impact between future and spot.

There are three main points worth to be noted from the results presented in Table 2. Primarily, the volatility spillover effect seems to become weaker after four days. It means that in the first four days, the shocks in asset volatility will strongly transmit to itself while this effect is not persistent for the long-term period. Our results and underlying empirical approach outperform the previous studies, which suggested restrictive persistence effect due to relying on a linear model (such as Ball, 2014; Beaudry & Koop, 1993; Hosseinkouchack & Wolters, 2013). Secondly, we found a shred of evidence that the futures volatility contributes to the spot volatility, which implies that the futures price instability can cause instability in spot prices. Therefore, the spot prices could be driven by the volatility of futures prices as well as their volatility, which is well explained by the joint assumption of risk neutrality and rationality in the studies by Beckmann & Czudaj (2013a,b). Our results are also in inline with the previous studies on the equity market by Worthington et al. (2005); Yang et al. (2012). However, we also witnessed the differences between these assets. Further analysis will be systematically discussed in detail.

Table 2: Volatility connectedness for all commodities

GOLD		1 day to 4 days		4 days to ∞	
		Future (From)	Spot (From)	Future (From)	Spot (From)
1 days to 4 days	Future (To)	76.1	0.02		
	Spot (To)	16.03	59.33		
4 days to ∞	Future (To)			23.88	0.01
	Spot (To)			9.1	15.53

WTI		1 day to 4 days		4 days to ∞	
		Future (From)	Spot (From)	Future (From)	Spot (From)
1 days to 4 days	Future (To)	76.32	0.2		
	Spot (To)	54.49	23.78		
4 days to ∞	Future (To)			23.4	0.08
	Spot (To)			17.26	4.48

Silver		1 day to 4 days		4 days to ∞	
		Future (From)	Spot (From)	Future (From)	Spot (From)
1 days to 4 days	Future (To)	73.18	0.1		
	Spot (To)	11.89	62.24		
4 days to ∞	Future (To)			26.64	0.08
	Spot (To)			9.71	16.16

Corn		1 day to 4 days		4 days to ∞	
		Future (From)	Spot (From)	Future (From)	Spot (From)
1 days to 4 days	Future (To)	67.12	0.51		
	Spot (To)	5.1	70.63		
4 days to ∞	Future (To)			32.27	0.09
	Spot (To)			2.73	21.54

BRENT		1 day to 4 days		4 days to ∞	
		Future (From)	Spot (From)	Future (From)	Spot (From)
1 days to 4 days	Future (To)	77.53	0.07		
	Spot (To)	34.46	40.5		
4 days to ∞	Future (To)			22.38	0.02
	Spot (To)			20.92	4.12

SOYA		1 day to 4 days		4 days to ∞	
		Future (From)	Spot (From)	Future (From)	Spot (From)
1 days to 4 days	Future (To)	71.88	0.12		
	Spot (To)	11.98	71.42		
4 days to ∞	Future (To)			27.92	0.07
	Spot (To)			4.52	12.09

IRON		1 day to 4 days		4 days to ∞	
		Future (From)	Spot (From)	Future (From)	Spot (From)
1 days to 4 days	Future (To)	87.96	0.27		
	Spot (To)	0.12	75.13		
4 days to ∞	Future (To)			11.75	0.02
	Spot (To)			0.01	24.75

Note: The numbers were calculated based on the study of Baruník and Kočenda (2019) to estimate the level of volatility connectedness and spillovers. The detail of the calculation was mentioned in Equation 6.

Thirdly, it is observable that the future volatility transmission itself is higher than spot volatility. It means the risk in the derivative products is clearly larger than the underlying asset market. Perhaps, given the fact that the derivative is derived from an actual asset rather an asset per see, it is logically inherited with the lack of intrinsic value. Nonetheless, derivatives use is also debatable for the purpose of risk-sharing or risk-taking from underlying assets (Biais et al., 2016). Therefore, the use of derivatives might cause higher volatility in spot returns, which induces an increase in the volatility of underlying prices.

When taking a closer look at the individual assets, we can observe the different patterns in volatility transmission. To be more precise, oil is likely to be the highly volatile asset because the magnitudes of volatility from future contract to underlying asset obtained are highest in value. It is intuitive to see this phenomenon because both WTI and BRENT are widely traded in many financial exchanges. In addition, crude oil is quite sensitive to news and other macroscopic determinants. In doing so, the volatility-transmitted channel from future contracts to spot prices would be easy to have more shocks while iron seems to be the calmest commodity in the list. It means that the trading shocks in future contracts of iron do not cause directly to the status of underlying assets. Perhaps, not as much as the other commodities. One of the reasonable explanations for the lowest volatility of iron could be due to the liquidity and turnover (Etienne, 2017). It is likely to see that iron has a relatively low trading volume; therefore, the volatility-transmitted channel does not work well. In addition, when it comes to agricultural products such as soya, corn, etc., it can be seen that these commodities futures contracts are linked to the investors' expectations rather than speculations (Gardner, 1976). In contrast, the moving patterns of derivatives in precious metals such as gold, silver, etc. experience from the speculation as well as the investors' trading behaviors for safe-haven under recession or financial turbulence. Thus, the magnitude of volatility-transmitted in the precious metal market seemed to be higher than the agricultural market.

5.2 Total interconnectedness and impact of future volatility on spot return

Table 3: The impact of volatility on spot returns

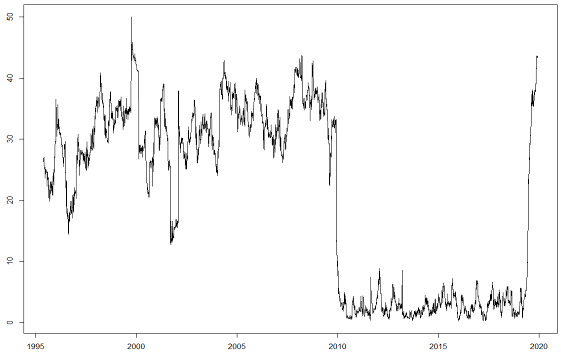
Spot return	**Gold**	**WTI**	**Silver**	**Corn**
Intercept	0.0002* [1.83]	0.0002* [1.76]	0.00016 [0.88]	-0.00003 [-0.11]
Volatility	0.00004*** [39.25]	0.0003*** [111.60]	0.00013*** [42.99]	0.00005*** [14.63]
R-squared	19.14	56.55	14.75	6.86

Spot return	**BRENT**	**Soya**	**Iron**
Intercept	0.00043* [1.69]	0.00004 [0.15]	0.00035 [0.54]
Volatility	0.00024*** [51.50]	0.00008*** [22.30]	0.00007 [1.08]
R-squared	38.48	14.67	0.02

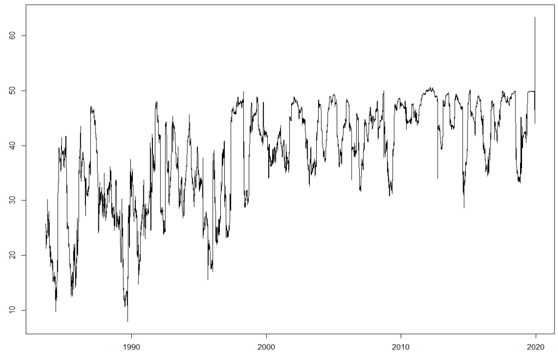
Note: Beside the volatility estimated by variance decomposition from Vector Auto-regression, we also calculated Volatility measure of future return based on Generalized Autoregressive Conditional Heteroscedasticity (GARCH (1, 1)). Afterwards, we would test if the volatility futures will positively cause the spot return. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

In Figure 2, we present plots of the frequency connectedness. The frequencies in these figures used the rolling window as the default selection. Except for the iron, the pattern of volatility interconnectedness is quite smooth due to the lack of observations as well as the low liquidity characteristics. There are two main comments on the total interconnectedness over the period. First, we can observe that the total volatility interconnectedness decreased at the beginning of 2010 in the majority of commodities. To be more specific, gold and silver have similar patterns, which sharply decrease due to homogeneous preferences choices in the precious metal market. Meanwhile, in the crude oil market, it can be seen that the BRENT crude oil market has a higher volatility transmission in 2014 because of the drop in crude oil prices. As after a large slump due to the Global Financial Crisis 2008, the price of oil started to creep up from its trough in Feb 2009 to its highest post-crisis point in June 2014. However, the sluggish demand and increased supply caused a sharp decline in oil prices.[4] Regarding the agricultural commodity, soya volatility is likely to be less rough than corn. Second, based on the total interconnectedness results in

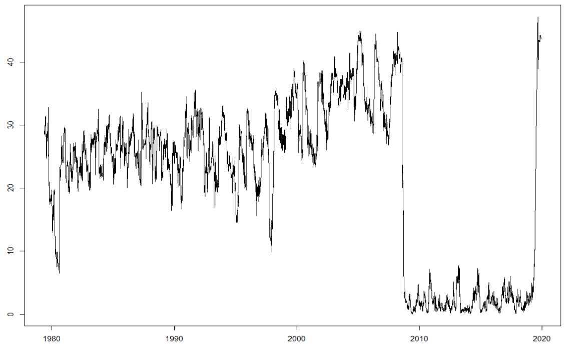
[4]Key facts about the great oil crash of 2014 (Samuelson, 2014).



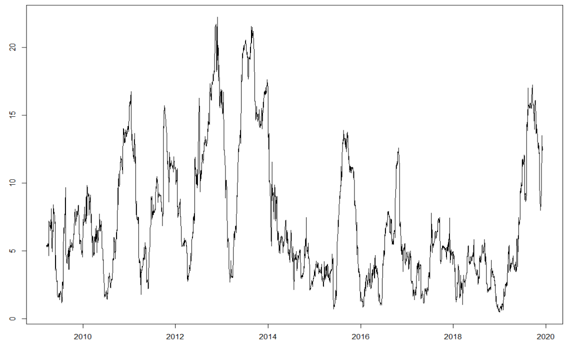
(a) Gold



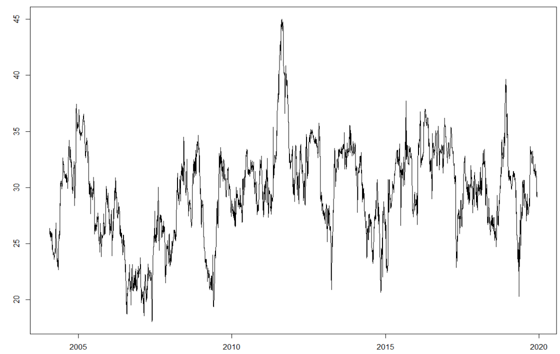
(b) WTI



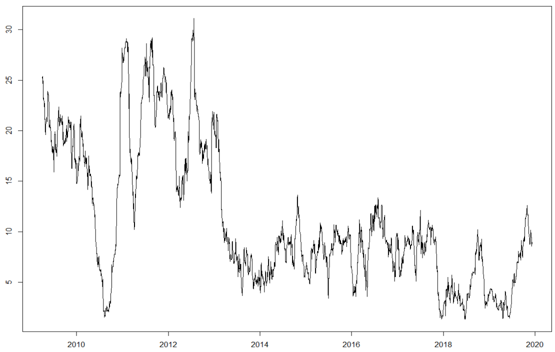
(c) Silver



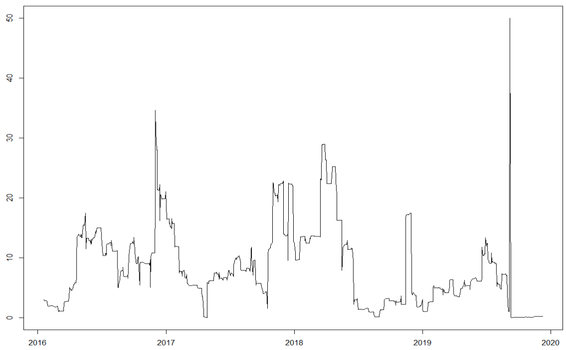
(d) Corn



(e) Brent



(f) Soya



(g) Iron

Figure 2: Frequency connectedness. The figure presents plots of the frequency connectedness. The frequencies in these figures used the rolling window as the default selection.

the commodity market, we can observe the different investors' behaviour over the business cycle, which was suggested in the earlier studies such as Gorton & Rouwenhorst (2006). In addition, the commodity futures markets also impose the tail dependence as well as negative and extreme events, which represents the rough shape of volatility in Figure 2 (Delatte & Lopez, 2013).

Apart from Iron due which might be considered as a comparatively less liquid asset class, confirmed by the study of Etienne (2017), the remaining assets have one common feature that the volatility in future contracts positively contribute to an increase in spot return (return or return volatility?). This conclusion is drawn from the positive and significant coefficients of six over seven commodities in our sample at 1% significance level. It means that the shock transmission from the futures contract is going to shake the underlying asset's prices. Interestingly, the explanatory power of volatility for spot returns (returns or returns volatility?) seems to be higher for crude oil and fewer shocks in agricultural products, which is a similar pattern to the frequency interconnectedness in the previous figures. Our finding is also in line with the evidence of Kohlscheen et al. (2016). The study also reveals that the variation in commodity prices will contribute to the global risk. Clearly, Samii (1992) also indicated that future volatility should be considered as the unbiased predictor for spot prices in the future. In addition, the volatility future is also one of the elements which cause instability in financial markets. The theoretical framework to explain the relationship between future and spot is a combination of the expected risk premium and the forecast of future spot prices. Therefore, if the macroscopic determinants suffer from the uncertainties, the investors tend to increase their expected risk premium. Hence, the higher volatility in the futures market may influence the underlying asset prices.

6 Conclusion

Financial deregulation in recent decades has transformed the global financial system as well as the commodities and natural resources and the wave of financialisation has overwhelmingly turned them into financial assets. The speculative activities and the gigantic scale of speculation pose enormous social, political and economic challenges, especially with regard to energy and resource security. Unfortunately, our understanding of these challenges and thus the optimal resource policy responses are quite limited. This study attempts to shed new light on the discussion by examining the connectedness and bivariate spillover-effects of commodity derivatives (futures) market volatility and underlying asset classes (commodity) spot. It thereby helps to identify crucial implications of financialisation of natural resources and unveiling structural sources of systematic risk. More precisely, to capture spillover between commodity spot and futures prices, we employed the novel and most recently developed approaches to analyse the frequency connectedness and drew on a higher frequency dataset spanning over forty years. Focusing on seven of the most traded commodity futures (gold, silver, crude oil WTI and BRENT, corn, soya and iron), we find that the volatility of the commodity derivative (futures) contributes to spot volatility and thus influences the spot prices of the underlying commodities on the international markets. This finding has a crucial implication as the prime reason of the derivative market is risk transfer in a supposedly fair manner. Concomitantly, the financialisation of commodities shall harbour stability by transferring risk to those who prefer hedge to those who have the ability to absorb it. However, it seems that this process yields instability as the volatility spillovers to the underlying assets.

Our empirical results also showed that the volatility spillover effects are stronger in the first four days of the shock. This leads us to conclude that the shocks to the volatility of the underlying asset caused by its own economic fundamentals more persistent over long-term time. However, the spillovers from the derivative markets have a huge impact in the short-run as the volatility of commodity futures can exacerbate the volatility of the underlying asset's market. Nonetheless, seemingly a short period of four days means a lot in the contemporary world of finance. Lastly, our results also lead us to conclude that the transfer of volatility from commodity futures contracts is higher than the transfer of spot price volatility to futures prices. This implies that the derivative markets with its speculative characteristics is more influential as a source of volatility for the actual underlying asset's market than the other way around. Its tail wagging the dog! The results of this study have important implications for a wide range of stakeholders, including resource managers, financial and commodity market regulators, governments and members of the society concerned about the challenges associated with the global natural resource management and difficulty added by the process of Financialisation.

Due to data availability, this study is limited in terms of time-frame and data frequency. Future research might investigate and validate the results by either expanding the time-sample or using higher frequency data. In addition, it would be interesting to see the impact on other commodities, such as rice or coffee and whether they exhibit similar patterns. Lastly, further research can also focus on the role of regulation in mitigating volatility spillover from derivatives to the assets' underlying markets.

References

Acharya, V. V., Lochstoer, L. A., & Ramadorai, T. (2013). Limits to arbitrage and hedging: Evidence from commodity markets. *Journal of Financial Economics*, *109*(2), 441–465.

Adams, Z., & Glück, T. (2015). Financialization in commodity markets: A passing trend or the new normal? *Journal of Banking & Finance*, *60*, 93–111.

Adrangi, B., & Chatrath, A. (1999). Margin requirements and futures activity: Evidence from the soybean and corn markets. *Journal of Futures Markets: Futures, Options, and Other Derivative Products*, *19*(4), 433–455.

Aitken, R. (2013). The financialization of micro-credit. *Development and Change*, *44*(3), 473–499.

Ajoy Kumar, M., & Shollapur, M. R. (2015). Price discovery and volatility spillover in the agricultural commodity futures market in india. *IUP Journal of Applied Finance*, *21*(1).

Alquist, R., & Kilian, L. (2010). What do we learn from the price of crude oil futures? *Journal of Applied econometrics*, *25*(4), 539–573.

Alquist, R., Kilian, L., & Vigfusson, R. J. (2013). Forecasting the price of oil. In *Handbook of economic forecasting* (Vol. 2, pp. 427–507). Elsevier.

Antoniou, A., & Foster, A. J. (1992). The effect of futures trading on spot price volatility: evidence for brent crude oil using garch. *Journal of Business Finance & Accounting*, *19*(4), 473–484.

Ball, L. (2014). Long-term damage from the great recession in oecd countries. *European Journal of Economics and Economic Policies: Intervention*, *11*(2), 149–160.

Baruník, J., & Kocenda, E. (2019). Total, asymmetric and frequency connectedness between oil and forex markets. *The Energy Journal*, *40*(Special Issue).

Baruník, J., & Křehlík, T. (2018). Measuring the frequency dynamics of financial connectedness and systemic risk. *Journal of Financial Econometrics*, *16*(2), 271–296.

Beaudry, P., & Koop, G. (1993). Do recessions permanently change output? *Journal of Monetary economics*, *31*(2), 149–163.

Beckmann, J., & Czudaj, R. (2013a). The forward pricing function of industrial metal futures–evidence from cointegration and smooth transition regression analysis. *International Review of Applied Economics*, *27*(4), 472–490.

Beckmann, J., & Czudaj, R. (2013b). Non-linearities in the relationship of agricultural futures prices. *European Review of Agricultural Economics*, *41*(1), 1–23.

Bekaert, G., & Wu, G. (2000). Asymmetric volatility and risk in equity markets. *The review of financial studies*, *13*(1), 1–42.

Biais, B., Heider, F., & Hoerova, M. (2016). Risk-sharing or risk-taking? counterparty risk, incentives, and margins. *The Journal of Finance*, *71*(4), 1669–1698.

Boyer, R., Streeck, W., & Swedberg, R. (2012). Greta r. krippner capitalizing on crisis: The political origins of the rise of finance. cambridge, ma, harvard university press, 2011. *Socio-Economic Review*, *10*(2), 403–418.

Brunetti, C., Büyükşahin, B., & Harris, J. H. (2016). Speculators, prices, and market volatility. *Journal of Financial and Quantitative Analysis*, *51*(5), 1545–1574.

Büyüksahin, B., Haigh, M. S., & Robe, M. A. (2009). Commodities and equities: ever a "market of one"? *The Journal of Alternative Investments*, *12*(3), 76–95.

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

Campbell, J. Y., & Hentschel, L. (1992). No news is good news: An asymmetric model of changing volatility in stock returns. *Journal of financial Economics*, *31*(3), 281–318.

CFTC. (2008). Staff report on commodity swap dealers & index traders with commission recommendations. *Commod. Futures Trading Comm.*

Chatrath, A., Adrangi, B., & Allender, M. (2001). The impact of margins in futures markets: evidence from the gold and silver markets. *The Quarterly Review of Economics and Finance*, *41*(2), 279–294.

Cheng, I.-H., Kirilenko, A., & Xiong, W. (2014). Convective risk flows in commodity futures markets. *Review of Finance*, *19*(5), 1733–1781.

Cheng, I.-H., & Xiong, W. (2014). Financialization of commodity markets. *Annu. Rev. Financ. Econ.*, *6*(1), 419–441.

Chong, J., & Miffre, J. (2010). Conditional return correlations between commodity futures and traditional assets. *Journal of Alternative Investments*, *12*(3), 61–75.

Christie, A. A. (1982). The stochastic behavior of common stock variances: Value, leverage and interest rate effects. *Journal of financial Economics*, *10*(4), 407–432.

Delatte, A.-L., & Lopez, C. (2013). Commodity and equity markets: Some stylized facts from a copula approach. *Journal of Banking & Finance*, *37*(12), 5346–5356.

Diebold, F. X., & Yilmaz, K. (2009). Measuring financial asset return and volatility spillovers, with application to global equity markets. *The Economic Journal*, *119*(534), 158–171.

Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. *International Journal of Forecasting*, *28*(1), 57–66.

Du, X., Cindy, L. Y., & Hayes, D. J. (2011). Speculation and volatility spillover in the crude oil and agricultural commodity markets: A bayesian analysis. *Energy Economics*, *33*(3), 497–503.

Edwards, F. R. (1988). Does futures trading increase stock market volatility? *Financial Analysts Journal*, *44*(1), 63–69.

Ertürk, I. (2016). Financialization, bank business models and the limits of post-crisis bank regulation. *Journal of Banking Regulation*, *17*(1-2), 60–72.

Etienne, X. L. (2017). Irrational exuberance in the chinese iron ore market? *Applied Economics Letters*, *24*(16), 1161–1166.

Etula, E. (2013). Broker-dealer risk appetite and commodity returns. *Journal of Financial Econometrics*, *11*(3), 486–521.

Fama, E. F., & French, K. R. (2016). Commodity futures prices: Some evidence on forecast power, premiums, and the theory of storage. In *The world scientific handbook of futures markets* (pp. 79–102). World Scientific.

Fassas, A. P., & Siriopoulos, C. (2019). Intraday price discovery and volatility spillovers in an emerging market. *International Review of Economics & Finance*, *59*, 333–346.

Fattouh, B., Kilian, L., & Mahadeva, L. (2013). The role of speculation in oil markets: What have we learned so far? *The Energy Journal*, 7–33.

Gardner, B. L. (1976). Futures prices in supply analysis. *American Journal of Agricultural Economics*, *58*(1), 81–84.

Geman, H., & Smith, W. O. (2013). Theory of storage, inventory and volatility in the lme base metals. *Resources Policy*, *38*(1), 18–28.

Gilbert, C. L. (2010). How to understand high food prices. *Journal of agricultural economics*, *61*(2), 398–425.

Gilbert, C. L., et al. (2010). Speculative influences on commodity futures prices 2006-2008..

Gorton, G., & Rouwenhorst, K. G. (2006). Facts and fantasies about commodity futures. *Financial Analysts Journal*, *62*(2), 47–68.

Greer, R. J. (2000). The nature of commodity index returns. *The Journal of Alternative Investments*, *3*(1), 45–52.

Gulley, A., & Tilton, J. E. (2014). The relationship between spot and futures prices: An empirical analysis. *Resources Policy*, *41*, 109–112.

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

Hamilton, J. D., & Wu, J. C. (2014). Risk premia in crude oil futures prices. *Journal of International Money and Finance*, *42*, 9–37.

Hartzmark, M. L. (1986). The effects of changing margin levels on futures market activity, the composition of traders in the market, and price performance. *Journal of Business*, S147–S180.

Henderson, B. J., Pearson, N. D., & Wang, L. (2014). New evidence on the financialization of commodity markets. *The Review of Financial Studies*, *28*(5), 1285–1311.

Hicks, J. R. (2017). From 'value and capital'. In *Bond duration and immunization* (pp. 57–61). Routledge.

Hosseinkouchack, M., & Wolters, M. H. (2013). Do large recessions reduce output permanently? *Economics Letters*, *121*(3), 516–519.

Irwin, S. H., & Sanders, D. R. (2010). The impact of index and swap funds on commodity futures markets.

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

Juvenal, L., & Petrella, I. (2015). Speculation in the oil market. *Journal of Applied Econometrics*, *30*(4), 621–649.

Kat, H. M., & Oomen, R. C. (2006). What every investor should know about commodities, part ii: multivariate return analysis. *Alternative Investment Research Centre Working Paper*(33).

Kaufmann, R. K., & Ullman, B. (2009). Oil prices, speculation, and fundamentals: Interpreting causal relations among spot and futures prices. *Energy Economics*, *31*(4), 550–558.

Kavussanos, M. G., Visvikis, I. D., & Alexakis, P. D. (2008). The lead-lag relationship between cash and stock index futures in a new market. *European Financial Management*, *14*(5), 1007–1025.

Keynes, J. M. (1923). Some aspects of commodity markets. *Manchester Guardian Commercial: European Reconstruction Series*, *13*, 784–786.

Kilian, L., & 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.

Kim, A. (2015). Does futures speculation destabilize commodity markets? *Journal of Futures Markets*, *35*(8), 696–714.

Knittel, C. R., & Pindyck, R. S. (2016). The simple economics of commodity price speculation. *American Economic Journal: Macroeconomics*, *8*(2), 85–110.

Kohlscheen, E., Avalos, F. H., & Schrimpf, A. (2016). When the walk is not random: commodity prices and exchange rates.

Koop, G., Pesaran, M. H., & Potter, S. M. (1996). Impulse response analysis in nonlinear multivariate models. *Journal of econometrics*, *74*(1), 119–147.

Kotz, D. M. (2010). Financialization and neoliberalism. *Relations of global power: Neoliberal order and disorder*, *1*(1).

Krippner, G. R. (2005). The financialization of the american economy. *Socio-economic review*, *3*(2), 173–208.

Langley, P. (2008). Financialization and the consumer credit boom. *Competition & Change*, *12*(2), 133–147.

Lehecka, G. V. (2015). Do hedging and speculative pressures drive commodity prices, or the other way round? *Empirical Economics*, *49*(2), 575–603.

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

Masters, M. W. (2009). Testimony before the commodity futures trading commission. *T able*.

Masters, M. W., & White, A. K. (2008). The accidental hunt brothers: How institutional investors are driving up food and energy prices. *The Accidental Hunt Brothers Blog, special report posted July*, *31*, 2009.

Mayer, H., Rathgeber, A., & Wanner, M. (2017). Financialization of metal markets: Does futures trading influence spot prices and volatility? *Resources Policy*, *53*, 300–316.

Mayer, J. (2012). The growing financialisation of commodity markets: Divergences between index investors and money managers. *Journal of Development Studies*, *48*(6), 751–767.

Miao, H., Ramchander, S., Wang, T., & Yang, D. (2017). Role of index futures on china's stock markets: Evidence from price discovery and volatility spillover. *Pacific-Basin Finance Journal*, *44*, 13–26.

Montgomerie, J. (2006). The financialization of the american credit card industry. *Competition & Change*, *10*(3), 301–319.

Mutafoglu, T. H., Tokat, E., & Tokat, H. A. (2012). Forecasting precious metal price movements using trader positions. *Resources Policy*, *37*(3), 273–280.

Nasir, M. A., Ahmad, M., Ahmad, F., & Wu, J. (2015). Financial and economic stability as 'two sides of a coin' non-crisis regime evidence from the uk based on vecm. *Journal of Financial Economic Policy*, *7*(4), 327–353.

Peck, A. E. (1985). The economic role of traditional commodity futures markets. *Futures Markets: Their Economic Role. Washington, DC: American Enterprise Institute for Public Policy Research*, 1–81.

Pesaran, H. H., & Shin, Y. (1998). Generalized impulse response analysis in linear multivariate models. *Economics letters*, *58*(1), 17–29.

Rong, C., & ZHENG, Z.-l. (2008). Unbiased estimation, price discovery, and market efficiency: futures prices and spot prices. *Systems Engineering-Theory & Practice*, *28*(8), 2–11.

Samii, M. V. (1992). Oil futures and spot markets. *OPEC review*, *16*(4), 409–417.

Samuelson, R. J. (2014). Key facts about the great oil crash of 2014. *The Washington Post*.

Sanders, D. R., Boris, K., & Manfredo, M. (2004). Hedgers, funds, and small speculators in the energy futures markets: an analysis of the cftc's commitments of traders reports. *Energy Economics*, *26*(3), 425–445.

Sawyer, M. (2013). Endogenous money, circuits and financialization. *Review of Keynesian Economics*, *1*(2), 230–241.

Sehgal, S., Rajput, N., & Deisting, F. (2013). Price discovery and volatility spillover: Evidence from indian commodity markets. *The International Journal of Business and Finance Research*, *7*(3), 57–75.

Serra, T., & Zilberman, D. (2013). Biofuel-related price transmission literature: A review. *Energy Economics*, *37*, 141–151.

Silvennoinen, A., & Thorp, S. (2013). Financialization, crisis and commodity correlation dynamics. *Journal of International Financial Markets, Institutions and Money*, *24*, 42–65.

Songyoo, K. (2012). Optimal positioning in thailand's spot and future market. *Procedia-Social and Behavioral Sciences*, *40*, 741–745.

Srinivasan, P., Ibrahim, P., et al. (2012). Price discovery and asymmetric volatility spillovers in indian spot-futures gold markets. *International Journal of Economic Sciences and Applied Research*, *5*(3), 65–80.

Thampanya, N. (n.d.). Spot-futures price relations under heterogeneous market mechanisms: New evidence from bayesian var. *Working paper*.

Tilton, J. E., Humphreys, D., & Radetzki, M. (2011). Investor demand and spot commodity prices. *Resources Policy*, *36*(3), 187–195.

Worthington, A., Kay-Spratley, A., & Higgs, H. (2005). Transmission of prices and price volatility in australian electricity spot markets: a multivariate garch analysis. *Energy Economics*, *27*(2), 337–350.

Xiao, B., Yu, H., Fang, L., & Ding, S. (2019). Estimating the connectedness of commodity futures using a network approach. *Journal of Futures Markets*.

Yang, J., Yang, Z., & Zhou, Y. (2012). Intraday price discovery and volatility transmission in stock index and stock index futures markets: Evidence from china. *Journal of Futures Markets*, *32*(2), 99–121.