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Abstract

I develop and test a theoretical model to study the interaction between the commodity and stock markets. The article attempts to clarify the debate between the two conflicting empirical opinions about the effect of the financialization on commodity markets: one that claims there is an effect, and one that denies that effect. The theoretical model determines the futures risk premium by using three factors: the hedging pressure, the stock market returns, and the commodity-equity correlation. I test the futures risk premium in the era of the financialization for three commodities in the energy market: crude oil (WTI), natural gas, and heating oil in the period from 1995 to 2015. First, I empirically confirm that the hedging pressure is a strong explanatory variable for the futures risk premium. Second, the effect of stock market became significantly important for the futures risk premium in the period after the 2008 financial crisis.

JEL Classification: G10, G11, G12, G13, G17, G18

Keywords: Financialization, futures risk premium, hedging, diversification, energy, dynamic conditional correlation (DCC).

1 Introduction

Commercial traders consider the commodity futures markets as a shelter in which they can hedge their physical positions. Based on the traditional hedging theory, to avoid the risk of prices changing, hedgers take futures positions of the same magnitude as physical markets but in the opposite direction (Johnson (1960) and Ederington (1979)). However, noncommercial

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traders (speculators) offset the hedgers' net futures positions, and the hedgers remunerate these traders with a futures risk premium (Keynes (1930))[1]. Hence, the interactions between those two types of participants are responsible for determining the risk premium from the information that the hedgers bring from the physical and futures markets and that the speculators bring from the futures market (e.g., Ekeland et al. (2018)). In the last two decades, especially after 2002 and 2003, trading activities increased in the futures markets. These increases are attributed to the increase in the financial investors' participation in the futures markets[2]. By the beginning of the third millennium, financial investors started looking at the commodity futures as assets that needed to be included in their baskets to reduce their stock portfolio's risk (e.g., see Gorton and Rouwenhorst (2006)[3]). Based on Stoll and Whaley (2010) and Irwin and Sanders (2011), financial investors, whether they are institutions or individuals, tend to invest in commodity futures by using commodity indices as benchmarks, such as the Standard and Poor's-Goldman Sachs Commodity Index (S&P GSCI) and Dow Jones-UBS Commodity Index (DJ-UBSCI). They believe that these indices are well-diversified and therefore build portfolios that mimic one of these indices. Investors can directly build a futures portfolio but due to the investors' lack of experience in managing a commodity index portfolio, they resort to commodity investments vehicles such as commodity index funds and commodity return swaps. Recently, there has been a heavy demand for exchange-traded products (exchange-traded funds (ETFs) and exchange-traded notes (ETNs))[4].

Several papers debate the consequences of the financialization on the commodity markets[5]. Especially, the financialization coincided with several changes in the commodity markets; in particular, the surge in crude oil prices in the period from 2003 to 2008. In response, researchers began studying whether financial investors were responsible for the changes or not. Researchers' contributions varied. Some find no evidence of that impact such as Hamilton (2009), Fattouh et al. (2013) (for oil market), Buyukşahin and Harris (2011), Brunetti and Buyukşahin (2009), Sockin and Xiong (2015), and Knittel and Pindyck (2016). But, other contributions confirm the effect of financialization on commodity markets such as Masters (2008), Tang and Xiong (2012), Singleton (2014), Henderson et al. (2015), and Kyrtsou et al. (2016). Also, Hamilton and Wu (2015) find little evidence of the effect of index funds on commodity prices; they find no relations between 12 agricultural commodities and the index fund positions, while they find

[1]Speculation in commodities means only seeking profit from undertaken transactions and not as the normal course of conducting a business of producing, merchandising, or processing a commodity (Working (1960)).

[2]Figure 3 illustrates the speculative activities for WTI , heating oil, and natural gas.

[3]Although commodity equity linkage increased after the financialization, there are some papers confirm the diversification purpose of the financial investor such as Bhardwaj et al. (2015), Galvani and Plourde (2010) and Cheung and Miu (2010). On the contrary, some papers challenge that hypothesis such as Belousova and Dorfleitner (2012), and Daskalaki et al. (2014).

[4]ETFs are a mutual fund shares traded on a stock exchange where the prices of these shares follow a commodity index. ETNs are debt securities where the issuer commits to a pay-out based on the value of the underlying commodity index.

[5]See the review of Irwin and Sanders (2011) and Cheng and Xiong (2014).

evidence for crude oil futures. Generally, the studies concentrate on energy markets and specifically on crude oil, with less attention on agricultural and metals markets. Bosch and Pradkhan (2015) find no evidence of speculative activities on precious metals. Bruno et al. (2017) study the linkage between grains, livestock, and stock markets and finds a relation between speculative activities and the strength of the commodity-equity linkage before the 2008 financial crisis. But, in the period after the 2008 crisis, the speculative activities are weaker. Despite all the studies related to the financialization of commodities, which are mostly empirical, the research still debates the effect of financial investors. Therefore, there is a need for more theoretical studies on this phenomenon. Moreover, to the best of my knowledge, in the context of the financialization, the futures risk premium gets less attention in the literature. In this paper, I look at the interaction between the financial investors and the futures risk premium for energy commodities.

I develop a model in the spirit of Ekeland et al. (2018). My model allows financial investors to participate both in the futures market and in the stock market, which is not the case in Ekeland et al. (2018). The model examines the interaction between commodity (physical & futures) and stock markets in which investors trade a single commodity. The model has two periods in which the markets interact: t and T. There are four types of traders: inventory holder (storer), processor, financial investor, and spot trader. The inventory holder has the capacity to store the commodity; he or she buys, holds, and then sells the commodity (physical speculation). The processor uses the commodity as an input to produce final products. Both of them, the storer and processor, operate in the futures market for hedging reasons. The storer hedges his or her physical position against any decrease in the prices by taking short futures positions, while the processor takes long futures positions to hedge his or her physical positions from any increase in the commodity price. The financial investor includes futures contracts in his or her stock portfolio for diversification reasons. The spot traders are located on the demand and supply sides in commodity spot markets. In the model, the storer creates the link between the two periods, the storer and processor create the link between the physical and the futures markets, and the financial investor creates the link between the stock and futures markets. The agents are mean variance utility maximizers. The uncertainty is sourced from the demand of the spot traders and the stock prices at T. But, the distribution functions are common knowledge for all agents.

The equilibrium shows that the commodity's futures risk premium is determined by the signs and the magnitudes of the physical positions of the hedgers, which is referred to as hedging pressure, the financial investor's profit, which is the expected stock returns, and the commodity-equity correlation. Also, the premium is affected by the magnitudes of other factors comprised of the number of agents restricted to their risk aversions, and the variances of the spot and stock prices. Many papers addressed that the correlation between the stock and the futures returns witnessed changes over time. Buyukşahin et al. (2010) find that the commodity-equity correlation increased sharply in the fall of 2008, but it was still less than its previous peaks.

Later, Buyukşahin and Robe (2014a,b) explain that the linkage between commodity and stock markets increased after the 2008 financial crisis. Basak and Pavlova (2016) also conclude that the financialization raises the correlation between commodity and equity markets. These studies show that the correlation between equity and commodity markets can vary. Therefore, I compute the dynamic conditional correlation (DCC) addressed by Engle (2002).

In this paper, I study the interaction between the energy futures and stock markets. I do so by regressing the futures risk premium for energy commodities on both the hedging pressure and the adjusted stock returns, which are defined as the expected stock returns multiplied by the commodity-equity correlation. I choose datasets that cover the period from 1995 to 2015. I divide the tested period into three subperiods: 1995-2002, 2003-2008, and 2008-2015. These subperiods represent the pre-financialization and post-financialization periods. I test three energy commodities: WTI, natural gas, and heating oil, which are traded in the New York Mercantile Exchange (NYMEX). For the selected commodities, I construct weekly datasets for the futures returns of several maturities. This step is different from most of the literature which focus on the first or the first two nearest-to-maturities. The investors who are looking for diversified portfolios are passive investors. Therefore, they buy and hold benefiting from long run returns. Logically, they buy long maturity futures contracts and hold them. Then, they offset these contracts when they are close to maturity. Furthermore, Buyukşahin and Robe (2014b) show that the excess speculation increased in both short and long maturities. I also collect the hedgers' positions published by CFTC, which are used to compute the net short hedging pressure. Further, I collect weekly data from the S&P500 composite index in order to compute the expected stock returns. By finding the DCC between the commodity and equity markets, I observe that the commodity-equity correlation increases dramatically after 2008 to 0.6 for WTI and heating oil, which supports my hypothesis of considering the commodity-equity correlation as varied.

The empirical findings confirm the theoretical ones. I find that the hedging pressure is a strong explanatory variable for the futures risk premium of energy commodities in different circumstances. My results are in line with the traditional price pressure hypothesis and show that net short (long) hedging positions are related with a positive (negative) futures risk premium, which also corresponds with Ekeland et al. (2018). The hedging pressure linkage with the futures risk premium decreases when the maturity increases that means the hedging activities are intensive in short maturities more than in long ones. However, the vision would be more specific if there is data about the hedging position for each maturity and not aggregated ones as published by CFTC. Second, I find that the stock market became significantly linked with the futures risk premium for the selected energy commodities after the 2008 financial crisis. This result could be interpreted by the dramatic increase in the commodity-equity correlation for most commodities, which means the diversification from commodities is doubtful. In such circumstances, the financial investors should be remunerated for the risk from commodity futures markets. Moreover, the results show the importance of having several maturities in our tests.

The linkage between stock market and the futures risk premium overwhelms the linkage between hedging pressure and the futures risk premium for long maturities, especially for crude oil and heating oil. This finding does not contradict the findings of Boons et al. (2014) who find that for first and second nearest maturities, the hedging pressure has a major influence on the futures risk premium, while stock returns are contributing the rest. For short maturities, the result is inverted. Investors in commodity markets are passive; they buy and hold the futures contracts. They are interested in long maturities and offset their futures positions before the maturity dates.

Based on the previous results, I can deduce further main results. First, based on the data collected from CFTC, the net hedging pressures for WTI and heating oil are net short. This net short hedging pressure is fluctuated for heating oil, while it increases after the period 2007-2008 for WTI. Thus, the futures risk premium for WTI increases after 2007-2008. For natural gas, the net hedging pressure is short up to the financial crisis in 2008. After that, it becomes net long. Therefore, the futures risk premium for natural gas decreases after 2008. Second and after 2008 crisis, an increasing positive commodity-equity correlation accompanies the positive stock returns for WTI and heating oil. Thus, the futures risk premium for WTI and heating oil increases. Overall, the futures risk premiums for WTI and heating oil increased after the 2008 crisis.

I implement several robustness checks. First, I test the theoretical findings by replacing the weekly data sets with monthly ones. Second, I substitute the maturities from the S&P GSCI total return for the tested commodities. Third, I divide the tested periods into shorter subperiods. Each subperiod represents 175 weeks. Fourth, I replace the net short hedging pressure with the net long speculative pressure. I use this test based on the fact that the speculators sit in the opposite direction of the hedgers to offset their net positions. These checks support my results and show qualitatively the same results as I found in the original regressions.

The rest of the paper is organized as follows: Section 2 has the literature review. Section 3 introduces the theoretical model. Section 4 presents the data sets and their summary statistics. Section 5 presents the empirical results. Section 6 retests the regressions using different methods. Section 7 concludes.

2 Literature review

This research extends the studies that overall address the financialization of commodities and specifically the risk premium in the commodity markets. Further, the model extends those theoretical frameworks that study the interaction between the spot and futures commodity markets, such as Anderson and Danthine (1983a,b), Hirshleifer (1988b), Hirshleifer (1989b), Acharya et al. (2013), and Ekeland et al. (2018), to study the interaction between stock and commodity markets (physical and futures). Boons et al. (2014) is one of the few equilibrium models that is similar to my research. Their study follows Hirshleifer (1988a, 1989a) by including multiple assets in their model. However, there are several differences between my work and theirs. They do not model storage, while I do. In my model, I study the inventory separated from the production. I do so to investigate different phases of inventory and its impact of the equilibrium state. Hence, in the model, I clearly study the cases when there is inventory, for most of commodities, and when there is no inventory such as electricity.

While my model has two periods, there are also dynamic models that investigate the financialization such as Basak and Pavlova (2016) and Baker (2016). Basak and Pavlova (2016) develop a model with multiple goods and assets that has institutional investors and participants in the futures market. They find that the commodity futures, commodity-equity correlation, and the volatilities in the futures returns increase with the financialization. I take their results about the commodity-equity correlation as the motivation to study the effect of that correlation on the futures risk premium. Baker (2016) builds a dynamic model about the interaction between spot and futures prices that does not investigate the interaction between commodity and stock markets.

Speaking about the risk premium goes with us to Keynes (1930) and Kaldor (1940). The classic view of Keynes (1930) states that the speculators must be remunerated for their risk in the futures market from the classic hedgers (producers), which is referred to as the theory of normal backwardation. By contrast, Kaldor (1940), Working (1949), and Brennan (1958) develop the theory of storage that argues that inventory levels determine the risk premium, where backwardation depends on the size of the convenience yield.

Several researchers have theoretically investigated the futures risk premium. Hirshleifer (1988a, 1989a, 1990) argue that the risk premium is determined by the hedging pressure and the systematic risk. On the one hand, Bessembinder (1992), De Roon et al. (2000), and Basu and Miffre (2013) empirically verify the significant effect of hedging pressure on the futures risk premium. On the other hand, Daskalaki et al. (2014) find that the hedging pressure is not informative about the risk premium. But, their result is not robust when they analyse their data based on sub-samples and find that the hedging pressure factor is significant at monthly frequency[6]. However, my findings confirm the effect of hedging pressure at both the theoretical and empirical levels.

After the growing linkage between commodity and equity markets, the studies about the futures risk premium are part of the rapidly growing literature that studies the financialization of commodity markets. The reviews by Fattouh et al. (2013) and Baumeister and Kilian (2015) (for oil market) cover some of these papers. Acharya et al. (2013) find that capital constrained

[6] Daskalaki et al. (2014) calculate the hedging pressure for futures contracts. Then, they construct a portfolio in monthly or quarterly frequency. They construct a risk factor by constructing High minus Low hedging pressure.

speculators can affect the risk premium through limits to hedging. They associate the increase in the commodity futures risk premium with the increase in the default risk. They predict an increase in the futures risk premium when the risk aversion of hedgers increases. They also predict an increase in both the futures risk premium and the changes in spot prices when the risk aversion of speculators increases. Etula (2013) links between the broker-dealer risk and the commodity risk premium, and finds that the time variation in the effective risk aversion has the greatest effect on the expected risk premium. In contrast to Acharya et al. (2013) and Etula (2013), I do not focus on the comparative statics between risk aversion and the futures risk premium. Hamilton and Wu (2014), through different theoretical construction, show significant changes in the risk premium after 2005. They show that the compensation for taking long positions became lower after 2005.

The work that is closest to mine is Boons et al. (2014). They find that about 70% of the cross spread in the average returns can be attributed to traditional hedging pressure and the remaining 30% to the stock market risk. I confirm that the futures returns has a greater linkage with the hedging pressure than the stock market for short maturities. But, for long maturities, the stock market has the major influence on the futures risk premium. However, in their paper there is no storage, but in my paper, the inventory is a determinant of the futures risk premium. The study of storage separated from production is supported by the theories that consider the physical inventory of a commodity as a fundamental determinant of the commodity prices and their futures risk premiums (e.g., Ekeland et al. (2018), Kaldor (1940)). That is confirmed by Gorton et al. (2013) who show a relation between the inventory levels and the risk premium. Haase and Zimmermann (2013) studies the risk premium for crude oil for several maturities as I do. However, their study proposes a decomposition of spot and futures prices that separate a scarcity price component from a quasi-asset price component.

3 The model

I develop a model in the spirit of Ekeland et al. (2018) to examine the interaction between the commodity, both physical and futures, and the stock markets. I investigate the integration of four types of agents in the model: inventory holder (storer), processor, financial investor, and spot traders. These agents are interested in one commodity. The storer (physical speculator) has the capacity to store the commodity. He or she aims to make a profit from the changes in the commodity spot prices. He or she buys the commodity, stores it, and then sells it at a future time. The processor uses the commodity to produce final goods; he or she uses the commodity in his or her production process (raw materials). Both of these agents operate in both the physical and futures markets. They participate in the futures market for hedging reasons. The interest of having both inventory holders and processors is that it gives a complete view of all possible positions in the futures market: short and long positions. This allows us to study the equilibrium in the futures markets. The financial investor holds a stock portfolio and futures contracts, which differentiates my model from the model of Ekeland et al. (2018). The spot traders operate only in the physical market to meet the immediate demand and supply in that commodity market. The model has two time periods, t and T. The operation in the physical market is at t and T. Meanwhile, the futures contracts are traded at t and are offset at T. I assume that the risk-free rate is neglected.

At time t, the storer locates on the demand side of the physical market and buys x quantity of the commodity at spot price P_t to store it. The spot traders appear on both the demand and supply sides of the physical market. They supply ω_t of the commodity and ask for quantity $\mu_t - mP_t$, which is the demand curve. The processor decides the volume of the commodity (y) that he or she wants to buy in the future (T) at future spot price $\tilde{P}_T$. The storer and processor hedge their physical positions in the futures market at futures price $F_{t,T}$. The storer sells his or her futures positions (take short positions), while the processor buys futures positions (takes long positions). Both take futures positions f_I and f_P respectively. The financial investor takes (f_S) positions in the futures market. At time T, the storer sits on the supply side and sells his or her inventory in the physical market. The processor locates on the demand side and delivers the commodity that he or she had asked for. The spot traders appear on the demand and supply side of the spot market. They supply $\tilde{\omega}_T$ and demand $\tilde{\mu_T} - m\tilde{P}_T$. $\sim$ indicates the variables' randomness. The futures contracts are settled at financial profit $\tilde{P}_T - F_{t,T}$. The futures contracts are offset either by cash settlements (agents take the opposite direction of their futures positions) or possibly by physical settlement (by delivery of the commodity at the maturity date[7]).

3.1 Agents' profits

3.1.1 Storer

The storer holds a non-negative quantity x of inventory. He or she buys x at t for spot price P_t and sells it at T for future spot price $\tilde{P}_T$. Holding the commodity from t to T costs $\frac{1}{2}Cx^2$ where C is the cost of storage. He or she holds f_I futures positions at futures price $F_{t,T}$. His or her profit from operating in both physical and futures markets is:

$$\tilde{\pi}(x, f_I) = x(\tilde{P}_T - P_t) + f_I(\tilde{P}_T - F_{t,T}) - \frac{1}{2}Cx^2 \tag{1}$$

where x is the inventory that is held by the storers, P_t and $\tilde{P}_T$ are the commodity spot prices at time t and T respectively, f_I is the storer's futures positions, $F_{t,T}$ is the futures price, and C is the cost of storage.

3.1.2 Processor

The processor buys the commodity to use it in the production process, and then produce other final goods. He or she buys a quantity y at T. His or her revenue from selling the final output is

[7] 1-2% of the futures contracts reach their maturity date.

$\left(y-\frac{\beta}{2}y^2\right)Z$ where Z is the price of the final product. He or she holds f_P futures positions with profit $\tilde{P}_T - F_{t,T}$. The profit for the processor from operating in both the physical and futures markets is:

$$\tilde{\pi}(y, f_P) = (y - \frac{\beta}{2}y^2)Z - y\tilde{P}_T + f_P(\tilde{P}_T - F_{t,T}) \tag{2}$$

where y is the demanded quantity of the commodity, β is the cost of the production, $\tilde{P}_T$ is the future spot price of the commodity, $F_{t,T}$ is the futures price, Z is the price of the final good, and f_P is the processor's futures positions.

3.1.3 Financial investor

The financial investor operates in the stock and futures markets. He or she takes f_S futures positions in addition to his or her portfolio in the stock market. The profit comes from the profit in the futures and stock markets. First, the profit from the futures market is $(\tilde{P}_T - F_{t,T})$. Second, the profit from the stock market in the period $T-t$ is the difference in the total value of his or her portfolio between time t and T $(\tilde{V_T} - V_t)$.

$$V_t = \Sigma_i^n \theta^i S_t^i$$

where S_t^i is the price of the asset i at time t, and θ^i is the total number of asset i in the portfolio.

Thus, the total profit is given by:

$$\pi(k, f_S) = k(\tilde{V_T} - V_t) + f_S(\tilde{P}_T - F_{t,T}), k \geq 0 \tag{3}$$

where V_i is the value of the financial investor's portfolio in the stock market, i is t or T, f_S is the financial investor's positions in the futures market, and k shows the positions taken in the stock market.

3.2 Profit optimization

Agents are profit maximizers. Their problem is to find the optimal positions in the physical, the futures, and the stock markets. They apply their profits to the mean-variance utility, in the line with Anderson and Danthine (1983b), Ekeland et al. (2018), and others.

$$E(\tilde{\pi}_j) - \frac{1}{2}\alpha_j Var(\tilde{\pi}_j) \tag{4}$$

where π_j is the profit for agent j, α_j is the risk aversion of agent j, and j represents the financial investor, storer or processor. I assume different risk aversions for the different agents. The risk aversion ranges between *zero* to ∞ $(0 < \alpha_j < \infty)$.

3.2.1 Storer

The storer has positions in both the physical and futures markets. His or her optimal positions are x^* and f_I^* in the physical and futures markets respectively.

$$x^* = \frac{1}{C} max \{F_{t,T} - P_t, 0\} \tag{5}$$

$$f_I^* = \frac{E[\tilde{P}_T] - F_{t,T}}{\alpha_I Var[\tilde{P}_T]} - x^* \tag{6}$$

The storer holds the commodity in the physical market when he or she believes that the futures price is higher than the current spot price. As shown in equation (6), the optimal futures positions consist of the hedging term $(-x^*)$ and a pure speculative term $\left(\frac{E[\tilde{P}_T]-F_{t,T}}{\alpha_I Var[\tilde{P}_T]}\right)$. If $f_I > 0$, then the storer takes long futures positions, otherwise he or she takes short futures positions. His or her positions in the futures market demonstrates that he or she hedges the commodity physical positions by having positions equal to the negative physical position $(-x^*)$. The negative sign indicates that he or she takes short positions for their hedging purposes. Meanwhile, the pure speculative term shows that the storer can speculate in the futures market after hedging 100% of his or her physical position. Based on the pure speculative term, the storer takes long positions whenever he or she believes that the expected future spot price is higher than the futures price. Otherwise, he takes short positions.

3.2.2 Processor

The optimal positions of the processor are y^* and f_P^* in the physical and futures markets respectively.

$$y^* = \frac{1}{\beta Z} \max \{Z - F_{t,T}, 0\} \tag{7}$$

$$f_P^* = \frac{E[\tilde{P}_T] - F_{t,T}}{\alpha_P Var[\tilde{P}_T]} + y^* \tag{8}$$

Equation (7) shows that the processor buys the commodity physically when he or she believes that the price of the final good is higher than the futures price. The same as the storer, his or her optimal futures positions for the processor consist of the hedging term y^* and the speculative term $\left(\frac{E[\tilde{P}_T]-F_{t,T}}{\alpha_P Var[\tilde{P}_T]}\right)$. He or she hedge his or her physical positions against price increases. For his or her hedging purposes, he or she takes long positions in the futures markets. However, for the speculative purposes, he or she takes short or long futures positions. The position is determined by the difference between the expected future spot price and the futures prices. Both storer's and processor's positions correspond to the findings in Ekeland et al. (2018).

3.2.3 Financial investor

Equations (9) and (10) express the optimal positions of the financial investor in the futures and stock markets respectively. The equations are highly symmetric. The positions comprise the expected returns of the futures, the stock market's expected returns, the commodity-equity correlation, the financial investor's risk aversion, and the variance in the prices of both the stock and physical markets. The terms between the brackets appear like the sum of two Sharpe ratios weighted by the correlation between the markets.

$$f_S^* = \left(\frac{1}{1-\rho^2}\right)\frac{1}{\alpha_S\sigma_P}\left[\frac{E[\tilde{P}_T]-F_{t,T}}{\sigma_P} - \rho\frac{E[\tilde{V}_T]-V_t}{\sigma_V}\right], \rho \neq \pm 1 \tag{9}$$

$$k^* = \left(\frac{1}{1-\rho^2}\right)\frac{1}{\alpha_S\sigma_V}\left[\frac{E[\tilde{V}_T]-V_t}{\sigma_V} - \rho\frac{E[\tilde{P}_T]-F_{t,T}}{\sigma_P}\right], \rho \neq \pm 1 \tag{10}$$

When $f_S^* > 0$, the financial investor goes long. Otherwise, he or she goes short. Unlike Ekeland et al. (2018), the sign and the level of the futures positions are not determined only by the bias in the futures prices. The determinants are extended to have the combination of the stock's risk premium and the commodity-equity correlation[8]. Regarding the pure speculative term, the financial investor goes long in the futures market when he or she believes that the expected spot price is higher than the futures price, otherwise he or she goes short. The combination of the stock's risk premium (stock return) and the commodity-equity correlation affects the positions in the futures market in a way that shows diversification. A stock's positive risk premium that is accompanied by a positive commodity-equity correlation decreases (increases) the long (short) positions of the financial investors. But, a stock's positive risk premium that is accompanied by a negative commodity-equity correlation increases (decreases) the long (short) positions for financial investors. From equation (9), high risk aversions decrease the positions in the futures market. Also, the variance in the commodity price has a negative relation with the futures positions. In contrast, the financial investor's futures position has a positive relation with the variance in the stock market.

3.3 Market clearing

Up to now, the optimal positions reflect those for one storer, one processor, and one financial investor. In the model, N_I, N_P, and N_S represent the number of storers, processors, and financial investors respectively. Consequently, the total positions of the agents are in aggregate. Hence, the storers' total inventory in the physical market is given by $N_I x^*$, the total number of futures positions is $N_I f_I^*$, the total quantity demanded for production is $N_P y^*$, the total number of futures positions for the processors is $N_P f_P^*$, and the total number of futures positions for financial investors is $N_S f_S^*$.

At any time, the physical market is clear when total supply corresponds to total demand. In the futures market, the market is clear when there is a zero summation for futures contracts.

[8] Anderson and Danthine (1983b) states that the pure speculative is not generalized in determining whether the speculators trade in several assets, and this what my findings confirm.

Thus, at time t in the physical market, spot traders supply a total quantity of commodity, ω_t. On the demand side, there are spot traders and inventory holders (storers). The spot traders demand $\mu_t - mP_t$ of the commodity. The storers buy a quantity $N_I x^*$ of the commodity. As a result, the clearing of the physical market at t is:

$$\omega_t = N_I x^* + \mu_t - mP_t$$

Subsequently,

$$P_t = \frac{1}{m}\left(\mu_t - \omega_t + N_I x^*\right) \tag{11}$$

At time T, both the storers and the spot traders exist on the supply side. The spot traders supply $\tilde{\omega}_T$, while the storers supply all their inventory, $N_I x^*$. On the demand side, there are processors and spot traders. The spot traders demand a quantity represented by $\tilde{\mu}_T - m\tilde{P}_T$, and the processors ask for a quantity equal to $N_P y^*$. Consequently, the clearing in the physical market at time T is:

$$\tilde{\omega}_T + N_I x^* = N_P y^* + \tilde{\mu}_T - m\tilde{P}_T$$

Thus,

$$\tilde{P}_T = \frac{1}{m}\left(\tilde{\mu}_T - \tilde{\omega}_T - N_I x^* + N_P y^*\right) \tag{12}$$

In the commodity futures markets, the market is clear when the total short and the total long futures positions are zero.

$$N_S f_S^\star + N_P f_P^\star + N_I f_I^\star = 0$$

By substituting the values of f_j^*, I get,

$$\mathrm{E}[\tilde{P}_T] - F_{t,T} = \frac{\mathrm{Var}[\tilde{P}_T]}{\frac{N_P}{\alpha_P} + \frac{N_I}{\alpha_I} + \frac{N_S}{\alpha_S}\left(\frac{1}{1-\rho^2}\right)}\left(N_I x^* - N_P y^* + \frac{N_S}{\alpha_S}\rho\frac{E[\tilde{V}_T] - V_t}{\sigma_P \sigma_V (1-\rho^2)}\right) \tag{13}$$

Equation 13 shows the futures risk premium, which is defined here as the difference between the expected future spot and the futures prices. The futures risk premium is determined first by the fundamental economic structures represented by the difference between the physical positions of the storers and the processors, which is referred by the hedging pressure[9]; second, by the expected stock returns; third, by the commodity-equity correlation; fourth, by the number of agents (I, P, S) restricted to their risk aversion; and fifth, by the volatility for each of the underlying asset (futures contract) and the stock portfolio. The sign of the futures risk premium depends on the aggregated sign of the hedging pressure, the expected stock returns, and the commodity-equity correlation.

[9] I refer to the difference between storers physical positions and the processors physical positions as hedging pressure. The estimation raised from the point that the storers take short positions for their hedging purpose, while the processors take long positions. The difference between both of them corresponds with the definition of the net short hedging pressure.

My finding of the determinants of futures risk premium extends the finding of Ekeland et al. (2018) who find that the futures risk premium is determined only by the hedging pressure. Equation 13 shows that the storage has a positive relation with the futures risk premium, while the demand for production has a negative relation with the futures risk premium. The finding shows the significance of the stock market on the futures risk premium. The direction of this relation is determined by the combination of the expected stock market returns and the commodity-equity correlation. Consequently, an increase in the positive stock risk premium that is accompanied by a positive (negative) commodity-equity correlation is linked with an increase (decrease) in the futures risk premium. But, an increase in the negative stock risk premium that is accompanied by a positive (negative) correlation is linked with a decrease (increase) in the futures risk premium.

Prediction *The futures risk premium of any commodity is determined by the hedging pressure of commercial agents and the stock returns adjusted by the commodity-equity correlation. Therefore:*

1. *An increase in the net short hedging pressure is correlated with an increase in the futures risk premium.*
2. *An increase in the stock returns, while the commodity-equity correlation is positive, is correlated with an increase in the futures risk premium.*

$$\mathrm{E}[\tilde{P}_T] - F_{t,T} = \beta_1 HP + \beta_2 \rho \left(E[\tilde{V}_T] - V_t \right) \tag{14}$$

Where HP is the hedging pressure, and $\beta_1 \& \beta_2$ are coefficients.

Equation (14) comes from (13) as explained in the appendix A. Hence, my objective is to test the theoretical prediction.

4 Data

In this section, I first introduce the datasets that are required to estimate the determinants of the futures risk premium for some of energy commodities. Second, I give the summary statistics for these datasets.

4.1 Data description

I use weekly datasets for the period from 1995 to 2015 for three commodities in the energy market: crude oil (WTI), heating oil, and natural gas. These datasets contain futures prices for different maturities, open interest positions for each commodity (long and short open interest positions), and S&P 500 composite index. The selected commodities are traded on the New York Mercantile Exchange (NYMEX). The data comes from the Thomson Reuters Datastream and from the Commodity Futures Trading Commission (CFTC). Table 1 shows some information about the selected commodities.

Table 1: Commodity futures contracts description

Commodity	Sample period	Exchange	Contract size	Prices quotation	Delivery
Crude oil (WTI)	10/3/1995 - 12/29/2015	NYMEX	1,000 barrels	U.S. $ per barrel	Monthly
Natural gas	1/3/1995 - 12/29/2015	NYMEX	10,000 mmBtu	U.S. $ per mmBtu	Monthly
Heating oil	1/10/1995 - 12/29/2015	NYMEX	42,000 gallons	U.S. $ gallon	Monthly

This table shows the description of the commodity futures contracts. It shows the sample period, the exchange, the contract size, the price quotation, and the delivery time. NYMEX is the New York Mercantile Exchange. mmBtu means million British thermal units.

4.1.1 Hedging pressure (HP)

To determine the hedging pressure, I use the public data from The Commodity Futures Trading Commission (CFTC). The CFTC publishes regular reports entitled Commitments of Traders (COT) that provide each Tuesday's open interests positions[10]. These positions are aggregated for all maturities. The CFTC reports show both short and long open interest positions. The aggregate of long open interest is equal to the aggregate of short open interest. The open interest positions are comprised of reportable and non-reportable positions[11]. The reportable traders are classified as either commercial or non-commercial traders. The commercial trader uses futures contracts for hedging reasons. Otherwise, the trader is a non-commercial. In this context, I use the data on commercial traders to indicate the hedgers and the data on non-commercial traders to indicate the financial investors (speculators). However, the number of commercial and non-commercial traders are unknown in the non-reportable category[12]. Therefore, I depend on the reportable positions of the commercial traders to indicate the hedgers' positions. In the model, the storers take short positions, and the processors take long positions in the futures market for their hedging purposes. Therefore, I measure the hedging pressure by computing the difference between the reportable short and long positions for the commercial traders divided by the total reportable hedging positions for the commercial traders. This method is consistent with De Roon et al. (2000), Boons et al. (2014), Szymanowska et al. (2014), Daskalaki et al. (2014), Haase and Zimmermann (2013), Etula (2013), and Acharya et al. (2013).

$$\textbf{The net short hedging pressure}_t = \frac{\textbf{Reportable commercial Short}_t - \textbf{Reportable commercial long}_t}{\textbf{Reportable commercial Short}_t + \textbf{Reportable commercial long}_t}$$

[10] Open interest is the total of all futures contracts entered into and not yet offset by a transaction, by delivery, by exercise, etc.

[11] The reportable positions are the positions of traders that hold positions above specific reporting levels set by CFTC regulations. The non-reportable short (long) positions are derived by subtracting the total reportable short (long) positions from the total open interest. In this category, the number of commercials and non-commercials are unknown.

[12] The reportable positions represent 70 to 90% of the total open interest.

4.1.2 Commodity expected futures returns

I construct weekly futures prices for the selected commodities from Datastream. I use the available dead and live futures contracts to form the time series of futures prices for different maturities. For each commodity, there are several deliveries for the futures contracts during the year (e.g., there is monthly delivery for energy futures as shown in table 1). At the termination of trading, the first nearest-to-maturity disappears. On the next day, the second nearest-to-maturity is switched to the first nearest-to-maturity. As a result, I construct 18, 18, and 16 maturities for WTI, natural gas, and heating oil respectively. For a selected date, the first futures price represents the futures price for the contract that is the closest to delivery at that date. The second futures price represents the price of the contract that is the second closest to delivery at that given date, and so on. Buyukşahin and Robe (2014b) are the motivation behind the choice of several maturities. They show that excess speculation increases in both short and long maturities. Furthermore, the investors who are looking for diversified portfolios are passive investors. Therefore, they buy and hold benefiting from long run returns.

For each maturity, I follow Gorton and Rouwenhorst (2006) and compute the futures returns as:

$$RFUT_t = \frac{F_{t,T} - F_{t-1,T}}{F_{t-1,T}}$$

where $RFUT$ is the futures risk premium, and $F_{t,T}$ is the futures price in week t on the contract whose expiration is at time T[13].

4.1.3 Expected stock returns

To estimate the stock returns, I compute the growth return of the S&P 500 composite index:

$$RSP500_t = \frac{SP500_t - SP500_{t-1}}{SP500_{t-1}}$$

where $SP500_t$ is the $S\&P500$ composite index at time t.

[13] Fama and French (1987) mention that predictable variation in realized premiums is evidence of time-varying expected premiums $\left(\tilde{P}_T - F_{t,T} \text{ implies } \mathrm{E}_t[\tilde{P}_T] - F_{t,T}\right)$. Accordingly, I replace the expected future spot price by the future spot price. The futures price is considered the best estimator of the future spot price. This could be confirmed by the convergence of the futures prices to the spot prices at the expiration time ($P_t = F_{t,t}$), otherwise an arbitrage opportunity exists. As a result, the final estimation of the futures return is $F_{T,T} - F_{t,T}$, that is, the growth return is $\frac{F_{T,T}-F_{t,T}}{F_{t,T}}$. This method fits the mechanism of the theoretical framework. However, the financial investors do not wait until the expiration of the futures contract in order to avoid the physical settlements. They roll over their contracts before the expiration. Therefore, I follow Gorton and Rouwenhorst (2006) and compute the futures returns as:

$$RFUT_t = \frac{F_{t,T} - F_{t-1,T}}{F_{t-1,T}}$$

where $RFUT$ is the futures risk premium, and $F_{t,T}$ is the futures price at week t on the contract whose expiration is at time T.

The theoretical results show that the stock returns combine with the commodity-equity correlation in determining the effect of the stock market on the futures risk premium. Furthermore, it has been found that the financialization increases the linkage between commodity and equity markets (Basak and Pavlova (2016)), which also has been confirmed empirically in different articles such as Buyukşahin and Robe (2014a,b). Therefore, I construct a new index that is named adjusted stock returns. The adjusted stock returns are a result of the multiplication of the stock returns by the commodity-equity correlation at week t.

$$RPSP500adj_t := \rho_t \times RPSP500_t$$

I collect further datasets for implementing the robustness checks in section 6. I collect the S&P GSCI from Datastream. I also use the non-commercial positions for the tested commodities from CFTC, which will be used to compute the speculative pressure.

For the rest of the paper, I denote the variables as follows: hedging pressure by HP, the futures returns by $RFUTXM$ where X indicates the maturity, the stock returns by $RPSP500$, the commodity-equity correlation by ρ, and the adjusted stock returns by $RPSP500adj$.

4.2 Summary statistics

In this section, I present the statistics of the selected datasets. Table 2 presents a statistical summary for WTI in panel A, heating oil in panel B, and natural gas in panel C for the period from 1995 to 2015 (1,057 week for WTI and 1,096 week for heating oil and natural gas). The statistics show that the mean of the commodity futures returns is positive for the selected commodities over the sample period. They also show that the mean of the futures returns and the standard deviation decrease when the maturity increases. In appendix B, figure 4b presents the futures returns of WTI. The figure displays the futures returns of the 1^{st} and the 18^{th} maturities for WTI. The WTI returns for the 1^{st} maturity are higher than the 18^{th} maturity until 2003–2004. After then, the 18^{th} maturity increases to almost in the same level as the 1^{st} maturity return. Heating oil has the same movements. By contrast, the futures returns of the long maturities (e.g. 18^{th} maturity) for natural gas stay less than the returns of short maturities (e.g. 1^{st} maturity). Following the theoretical results, I expect that the agents activities, or one of them, in the short maturities are greater than the long-term ones. I also expect that the interaction between the financial investors and the futures risk premium for WTI and heating oil increases, specifically after 2003–2004. The hedging pressure for WTI and heating oil is net short, while it is net long for the natural gas. Further, the stock market return is positive. Based on theoretical results, I expect to have a positive relationship between hedging pressure and the futures risk premium for WTI and heating oil. The statistics also show that the futures returns for WTI have a negative skew, while the futures returns for heating oil have a positive skew. The futures returns for natural gas has a positive skew until the 8^{th} maturity, after then it converts to a negative skew. The net short hedging pressure of the WTI and heating oil have a positive skew. But, the net short hedging pressure of natural gas has a negative skew. The stock returns have a negative skew. All variables have a positive kurtosis.

The fifth column of each panel in table 2 shows the results of the unit root test for all the time series for each commodity. From a statistical point of view, I do so to verify that each time series has the same distribution function. I conclude that all the time series of the futures returns and stock returns are stationary at 1% level of significance except the hedging pressure for natural gas. However, I will be implementing my tests on three sub-periods. The hedging pressure in these sub-periods is not stationary. To solve the non-stationary problem of the hedging pressure, I compute the first difference of the net short hedging pressure (CHP), where CHP refers to change in hedging pressure.

Table 2: Summary statistics

Variable	Panel A Crude oil (WTI) No. of observations = 1057					Panel B Heating oil No. of observations = 1095					Panel C Natural gas No. of observations = 1096				
	Mean	Std. Dev.	Skewness	Kurtosis	Unit root test	Mean	Std. Dev.	Skewness	Kurtosis	Unit root test	Mean	Std. Dev.	Skewness	Kurtosis	Unit root test
RFUT1M	0.0021	0.0512	-0.008	4.5746	-35.969***	0.0019	0.0485	0.1617	4.36888	-34.809***	0.0031	0.07578	0.80531	8.1082	-34.795***
RFUT2M	0.0019	0.0473	-0.042	4.4784	-35.166***	0.0018	0.0449	0.1506	4.30792	-34.112***	0.0026	0.06773	0.30019	4.5064	-34.365***
RFUT3M	0.0018	0.0447	-0.076	4.6365	-34.968***	0.0017	0.0427	0.1151	4.33751	-33.744***	0.0023	0.06241	0.2969	5.617	-34.328***
RFUT4M	0.0017	0.0426	-0.084	4.7464	-34.859***	0.0017	0.0409	0.0613	4.56326	-33.552***	0.0019	0.05504	0.27684	4.692	-35.395***
RFUT5M	0.0017	0.0409	-0.089	4.7872	-34.796***	0.0016	0.0393	0.0613	4.64568	-33.723***	0.0016	0.0502	0.10307	5.2802	-34.971***
RFUT6M	0.0016	0.0396	-0.098	4.8001	-34.842***	0.0016	0.0379	0.1054	4.6581	-34.121***	0.0014	0.04613	0.32398	4.9688	-34.032***
RFUT7M	0.0016	0.0382	-0.097	4.9172	-34.756***	0.0015	0.0365	0.1413	4.69917	-34.260***	0.0013	0.04346	0.15266	5.3037	-33.153***
RFUT8M	0.0016	0.0372	-0.097	5.0034	-34.761***	0.0015	0.0353	0.1568	4.79809	-34.358***	0.0012	0.04051	0.10133	4.1774	-33.137***
RFUT9M	0.0015	0.0363	-0.098	5.0558	-34.811***	0.0015	0.0342	0.1598	4.75357	-34.454***	0.0011	0.03977	-0.1473	4.7424	-33.652***
RFUT10M	0.0015	0.0355	-0.097	5.1006	-34.863***	0.0014	0.0333	0.1704	4.81363	-34.420***	0.001	0.03797	-0.2216	5.1986	-34.881***
RFUT11M	0.0015	0.0348	-0.095	5.1657	-34.900***	0.0014	0.0326	0.1591	4.78332	-34.448***	0.001	0.03663	-0.3582	5.8306	-35.775***
RFUT12M	0.0015	0.0341	-0.094	5.2426	-34.900***	0.0014	0.0318	0.1856	4.83278	-34.521***	0.0009	0.03509	-0.1584	5.5152	-35.418***
RFUT13M	0.0015	0.0335	-0.088	5.3136	-34.876***	0.0014	0.0315	0.1912	4.81289	-34.582***	0.001	0.03423	-0.1618	6.2424	-35.168***
RFUT14M	0.0015	0.033	-0.08	5.3796	-34.925***	0.0014	0.0312	0.1509	4.71347	-34.511***	0.001	0.03316	-0.0257	5.0507	-34.217***
RFUT15M	0.0015	0.0325	-0.076	5.4326	-34.990***	0.0013	0.031	0.1084	4.6703	-34.243***	0.001	0.03299	-0.0992	5.286	-34.17****
RFUT16M	0.0015	0.032	-0.075	5.4937	-34.982***	0.0013	0.0311	0.0849	4.65007	-34.014***	0.0009	0.03231	-0.3419	6.5052	-34.787***
RFUT17M	0.0014	0.0315	-0.072	5.5593	-35.002***						0.0009	0.03173	-0.5062	8.2397	-33.856***
RFUT18M	0.0014	0.0311	-0.066	5.6146	-35.013***						0.0009	0.03076	-0.2321	6.3381	-33.250***
TOI	969134	486821	0.207	1.4677	-1.067	213675	80041	0.5569	2.17173	-1.479	617839	355881	0.40205	2.0663	-1.124
TL	492960	166250	0.1502	1.9595	-2.283	120985	45889	0.3364	2.13723	-2.343	286434	116033	-0.2065	1.9144	-1.774
TS	574897	242021	0.1835	1.6258	-1.749	138332	48333	0.4448	2.11869	-2.424	253500	92753.5	0.36505	2.2497	-2.407
HP	0.0581	0.0888	0.5961	3.1352	-3.426**	0.074	0.0773	0.2368	2.90191	-6.192***	-0.042	0.14191	-0.5866	2.3817	-2.236
SP500	1254.2	343.91	0.5958	3.3016	-1.032	1228.2	364.02	0.4079	3.21392	-1.115	1228.2	364.017	0.40787	3.2139	-1.115
RPSP500	0.0015	0.0243	-0.438	6.8263	-36.208***	0.0017	0.0239	-0.459	7.00575	-36.849***	0.0017	0.02395	-0.4595	7.0057	36.849***
RPSP500adj	0.0004	0.0071	-0.085	8.9199	-35.618***	0.0004	0.0074	0.0775	8.59973	-36.824***	0.0001	0.00145	-0.4599	7.009	-36.849***
DCC	0.162	0.2674	0.1527	2.2413	-1.926	0.1877	0.2395	-0.019	2.09222	-2.382	0.0605	3.9E-05	-0.1582	5.0724	-9.425***

The table shows a summary statistics of the datasets. The data covers the period 1995-2015. Panels A, B, and C show the statistics for WTI, heating oil, and natural gas respectively. In each panel, there are five columns: mean, standard deviation, skewness, kurtosis, and unit root test (Dicky-Fuller). The variables are the futures returns of the first 18 maturities for WTI and natural gas, and 16 maturities for heating oil (RFUT1M ... RFUT18M), the open interests positions (TOI), the commercials long positions (TL), the commercials short positions (TS), the hedging pressure (HP), the change in hedging pressure (CHP), the *S&P*500 composite index (SP500), the stock returns (RPSP500), the adjusted stock returns (RPSP500adj), and the commodity equity correlation (DCC).

5 Empirical implementation

5.1 Commodity-equity correlation

In this subsection, I construct an index of adjusted stock returns that identifies the effect of the stock market. For the index, I multiply the expected stock returns in each week by the commodity-equity correlation.

$$RPSP500adj_t := \rho_t \times RPSP500_t$$

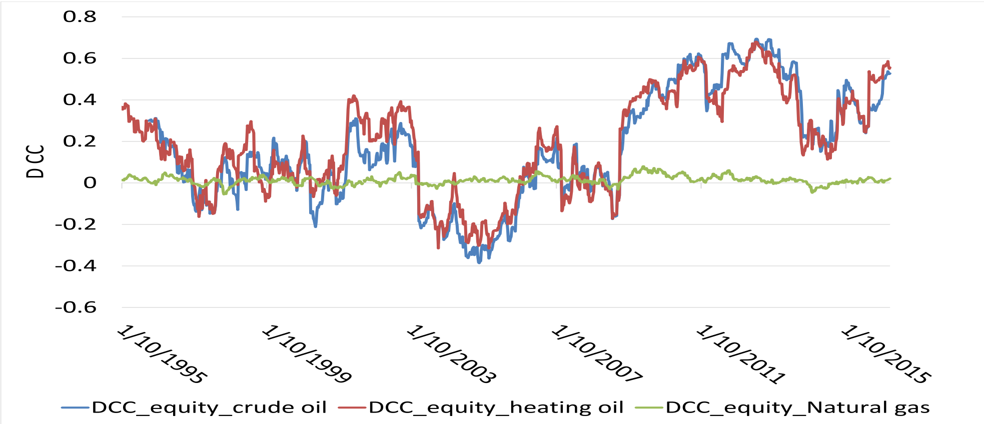
Where ρ_t is the commodity-equity correlation, and $RPSP500_t$ is the stock returns.

Theoretically, the commodity-equity correlation is actually the correlation between the future spot price and the stock market. Since the futures prices are considered estimators of the future spot prices, I use the first nearest-to-maturity, which is the one-month maturity for the tested commodities to approximate the future spot prices. Hence, I compute the correlation between the futures contract returns of the first nearest-to-maturity and the S&P 500 returns. I resort to compute the dynamic conditional correlation (DCC) introduced by Engle (2002) in order to have variable correlation. Engel's model is implemented into two steps: by estimating a time-varying variances GARCH(1,1) model and then by estimating a time-varying correlation by using the residual from the first step[14].

Figure 1 shows the DCC of the commodity-equity returns for WTI, heating oil, and natural gas. The commodity-equity correlations for WTI and heating oil are not stable. The correlation has changed widely over the last two decades. For the WTI, the correlation moved from 0.3 to −0.2 up to 2002. From 2002 to 2006, the correlation was completely negative and reached −0.38 by the end of 2004. After 2008, the correlation increased sharply to over 0.6. Up to 2008, the DCC for WTI corresponds to Buyukşahin et al. (2010) whose sample ended in 2008. The commodity-equity correlation for heating oil has the same track as WTI. In the period 1995–2002, the correlation moved from 0.37 to −0.164 (on average, the correlation was positive). From March 2003 to February 2006, the correlation was negative, and the lowest value of −0.32 was reached in March 2005. After October 2008, the correlation became positive and jumped significantly to reach a peak of 0.68 in July 2012. Then, the correlation decreased in 2013 and went to around 0.2 in the beginning of 2014. After 2014, the correlation started increasing again. But, the correlation for natural gas was stable and did not change much; the commodity-equity correlation was 0.06 on average. Therefore, the commodity-equity correlation for natural gas should have a stable and negligible effect on the futures risk premium over time.

[14]For the methodology to compute the DCC, you can see the paper of Buyukşahin et al. (2010). They well explain the increased linkage between commodity futures and stock returns.

Figure 1: Dynamic conditional correlation (DCC) between commodity and equity markets for WTI, heating oil, and natural gas, 1995-2015



This figure shows the correlation between S&P 500 returns and the spot returns for WTI (blue), heating oil (red), and natural gas (green) for the period from 1995 to 2015. The original datasets (S&P 500 and the nearest-to-maturity futures prices) are obtained from Datastream.

5.2 Regression results

In this section, I regress the futures risk premium on its determinants as explained in the theoretical predicition. I aim to test the hypothesis of whether financial investors is linked with the futures risk premium for energy market or not[15]. I examine the financial investors' participation over three periods: 1995-2002, 2003-2008, and 2008-2015. Why do I choose these periods? I aim to study the futures risk premium in the pre-financialization and post-financialization periods. The financialization phenomenon appeared at the beginning of the twenty-first century. The aggregated positions of the non-commercial traders, which are published by CFTC, show that non-commercial traders' long and short positions started increasing sharply after 2002, as shown in figure 2. Masters (2008) also makes this observation that investments in the commodity index had risen from $ 13 billion in 2003 to $ 260 billion in March 2008. The first period, 1995-2002, refers to the pre-financialization period. The second period, 2003-2008, ends with the 2008 crisis. The third period, 2008-2015 represents the period after the crisis. Both the second and third periods refer to the post-financialization period. Furthermore, I choose these divisions to equalize the periods' length.

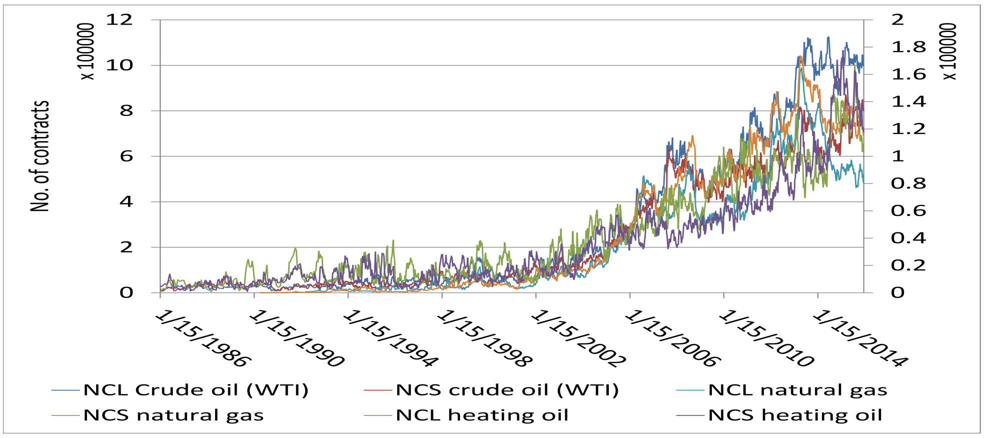
The regression equation is:

$$RFUTXM_t = \beta_1 CHP_t + \beta_2 RPSP500adj_t + \epsilon_t$$

[15]My model does not look for inferences regarding the causality between variables such as positions and prices.

where $RFUTXM$ is the futures risk premium of X month maturity, CHP is the change in net short hedging pressure, and $RPSP500adj$ is the adjusted stock returns. Finally, β_1 and β_2 are the coefficients of the net hedging pressure and the adjusted stock returns respectively.

Figure 2: Long and short futures positions for WTI, heating oil, and natural gas



This figure shows the non-commercial traders' positions for each WTI, heating oil, and natural gas. NCL indicates the non-commercial traders' long positions. NCS indicates the non-commercial traders' short positions. The right y-axis is only for heating oil, while WTI and natural gas are displayed on left y-axis. The data are obtained from the Commodity Futures Trading Commission (CFTC).

Table 3 explains the regression estimation of the WTI for the first 18 maturities. The table contains three panels: Panel A shows the estimated coefficients for the period from October 1995 to December 2002. Panel B shows the estimated coefficients for the period from December 2002 to October 2008. Panel C shows the estimated coefficients for the period from October 2008 to December 2015. The coefficient for the net short hedging pressure (CHP) in the three periods is positive and strongly significant for each maturity. It also decreases when the maturity increases. In the October 1995-December 2002 period, the coefficient decreases from 0.946 to 0.298 when the maturity increases from the 1^{st} to the 18^{th}. In the December 2002- October 2008 period, the coefficient decreases from 1.343 for the 1^{st} maturity to 0.586 for the 18^{th} maturity. In the October 2008- December 2015 period, the coefficient decreases from 0.829 for the 1^{st} maturity to 0.369 for the 18^{th} maturity. The coefficient of the net hedging pressure for the period between 2002 and 2008 is slightly higher than the other two periods. However, the coefficient for the adjusted stock returns is not significant in all periods. In the first two periods (1995-2002 and 2003-2008), the coefficient is not significant except for the 1^{st} maturity in the 2003-2008 period. But, the coefficient is positive and strongly significant in the 2008-2015 period. It decreases very slightly when the maturity increases (after the second maturity), where the average of the adjusted stock returns coefficient is 2.010. The R-squared has an inverse relation with the increase in the maturity in the 1995-2002 (after the 3^{rd} maturity) and 2003-2008 periods. Oppositely, the R-squared has a positive relation with the increase in the maturity. In the 1995-2002 period, the R-squared decreases from 0.267 for the 3^{rd} maturity to 0.114 for the 18^{th} maturity. In the 2003-2008 period, the R-squared decreases from 0.2 for the 1^{st} maturity to 0.078 for the 18^{th} maturity. In post-crisis period (2008-2015), the R-squared increases from 0.269 for the 1^{st} maturity to around 0.34 for the 18^{th} maturity.

Table 4 expresses the regression estimation of natural gas for the first 18 maturities. The table contains three panels: Panel A explains the regression estimation on the period from January 1995 to December 2002, Panel B shows the regression estimation on the period from December 2002 to October 2008, and Panel C shows the regression estimation on the period from October 2008 to December 2015. The three panels show that the coefficient for the net hedging pressure is positive, significant, and decreasing when the maturity increases. In Panel A, the coefficient for the net hedging pressure decreases from 1.329 for the 1^{st} maturity to 0.207 for the 18^{th} maturity. In Panel B, the coefficient decreases from 1.864 for the 1^{st} maturity to 0.330 for the 18^{th} maturity. In Panel C, it decreases from 0.791 for the 1^{st} maturity to 0.143 for the 18^{th} maturity. The coefficient for the adjusted stock returns varies in the three periods. In the January 1995- December 2002 period, the coefficient for the stock returns is significant only for 1^{st} , 5^{th}, 6^{th}, and 7^{th} maturities at the 10% level of significance. In the December 2002-October 2008 period, the coefficient is also significant for several maturities (2^{nd}, 5^{th}, 6^{th}, 8^{th}, 14^{th} and 15^{th} at the 10% level of significance, and 13^{th} at the 5% level of significance). However, in the October 2008- December 2015 period, the coefficient for the adjusted stock returns is positive and significant. The R-squared dropped significantly in the 2008-2015 period; it is between 0.049 and 0.082 for the available maturities.

Table 5 demonstrates the regression estimation of heating oil for the first 16 maturities. Panels A, B, and C show the regression estimation for the periods of January 1995- December 2002, December 2002- October 2008, and October 2008- December 2015. As for WTI and natural gas, the coefficient for the net short hedging pressure is positive and significant at the 1% level of significance for all periods. Also, it decreases when the maturity increases. In the January 1995- December 2002 period, the coefficient for the net hedging pressure decreases from 0.818 for the 1^{st} maturity to 0.276 for the 16^{th} maturity. In the December 2002- October 2008 period, the coefficient decreases from 0.898 for the 1^{st} maturity to 0.532 for the 16^{th} maturity. In the October 2008- December 2015 period, the coefficient decreases from 0.729 for the 1^{st} maturity to 0.510 for the 16^{th} maturity. The coefficient for the adjusted stock returns is not significant most of the time. In the January 1995- December 2002 period, 11 out of 16 maturities have coefficients that are significant at the 5% or 10% levels of significance. In the December 2002-October 2008 period, the coefficient is not significant for any maturity. Inversely, in the October 2008- December 2015 period, the coefficient for the adjusted stock returns is positive and strongly significant for all the maturities. It does not decrease widely when the maturity increases; the average coefficient for the stock returns is 1.629. The R-squared generally decreases when the maturity increases in the 1995-2002 and 2003-2008 periods. By contrast, in 2008-2015, the R-squared is almost stable when the maturity increases, which is around 0.4.

5.3 Economic interpretation

The coefficient for the net short hedging pressure (CHP) for the tested commodities (WTI, heating oil, and natural gas) is positive and significant. It also decreases when the maturity increases. First, I conclude that the hedging pressure is significantly correlated with the futures risk premium for energy market during different periods and different circumstances. This finding corresponds with Bessembinder (1992), Hirshleifer (1990), De Roon et al. (2000), Basu and Miffre (2013), Boons et al. (2014), and others. Second, my finding goes in the line with the traditional price pressure hypothesis, which explains the positive coefficient for the net short hedging pressure. This hypothesis states that a net short (long) futures position is related to a positive (negative) bias in the futures prices. This hypothesis corresponds to the theoretical findings of Ekeland et al. (2018) who find that the sign and the magnitude of the hedging pressure determine the sign of the bias in the futures price (when the hedging pressure is short (long), the futures market is in backwardation (contango)). Third, my results show that the coefficient for the net short hedging pressure decreases when the maturity increases. Therefore, I deduce that the hedging activities are greater in the short maturities[16]. This finding corresponds with Haase and Zimmermann (2013) who study the risk premium of crude oil for different maturities.

My results show that the significant relation between the stock market and the futures risk premium appeared after the 2008 financial crisis[17]. This result might be interpreted by the dramatic increase in the commodity-equity correlation, especially for WTI and heating oil. The increase in the commodity-equity correlation makes the diversification in energy markets doubtful. The latter argument is supported by Daskalaki and Skiadopoulos (2011) and Belousova and Dorfleitner (2012). Therefore, the financial investors must be remunerated for their risk borne in the futures market. This remuneration could be interpreted as the financial investors asking for liquidity instead of providing liquidity to the hedgers, which Cheng et al. (2015) also find. Cheng et al. (2015) find that after the 2008 crisis, because of distress in financial markets, the financial traders reduced their long positions due to their lower capacity for risk absorption, while the hedgers take the other side. The hedgers start to hold more risk than they did previously; that is, a portion of the risk that was previously held by financial traders was taken back by hedgers. This flow reallocates risk from the groups less able to bear it to the groups more able to bear risk. Therefore, the investors demand liquidity from the commercial hedgers rather

[16]The data collected by CFTC is aggregated, so I cannot have specific futures positions for each maturity.

[17]This finding is in the line with the literature track that says that the financialization is not a driving force to the increase in the prices prior the financial crisis 2008. Therefore, the role of financial investors in commodity markets in the early period of financialization is not as important to study as what happened after the crisis in 2008.

than provide liquidity. Also, the positive sign of the coefficient corresponds with the theoretical finding in section 3, which states that the positive stocks returns, accompanied by a positive commodity-equity correlation, is positively correlated with the futures risk premium.

The results also show that the futures risk premium is attributed to the stock returns more than the hedging pressure for long maturities of WTI and heating oil. For short maturities, the result corresponds to Boons et al. (2014) who find that the majority of futures returns are attributed to the traditional hedging pressure. However, they study only the first two nearest-to-maturities. This result is noticed by the values of R-squared and the coefficients when the maturity increases for WTI and heating oil on the period 2008-2015[18]. As explained before, the hedgers are more active in short maturities, and their effect decreases when the maturity increases. By contrast, the financial investors are passive investors who are interested in holding the futures contracts to secure their portfolios. When the contracts get close to maturity, they roll over the futures contract and buy other futures contracts with longer maturities. Therefore, they are active in trading long maturities.

[18]My results reveal that R-squared decreases when the maturity increases for natural gas (see table 4), and the first two sub-periods of WTI and heating oil (see Panel A and Panel B in tables 3 and 5). That means, if we see the linkage between the hedging pressure and the futures risk premium, it decreases when the maturity increases. For the case of heating oil and WTI in the period post 2008 crisis, R-squared increases or stays stable when the maturity increases, which is against the role of hedging pressure when the maturity increases.

Table 3: Regression estimation for crude oil (WTI) on the periods 1995-2002, 2003-2008, and 2008-2015

	Panel A 1995-2002				Panel B 2003-2008				Panel C 2008-2015			
VARIABLES	CHP	RPSP500adj	Obs	R-squared	CHP	RPSP500adj	Obs	R-squared	CHP	RPSP500adj	Obs	R-squared
RFUT1M	0.946***	-0.0827	376	0.200	1.343***	1.483*	307	0.200	0.829***	2.097***	375	0.269
	(0.0981)	(0.574)			(0.156)	(0.860)			(0.185)	(0.213)		
RFUT2M	0.927***	-0.0915	376	0.258	1.276***	0.998	307	0.195	0.758***	2.172***	375	0.295
	(0.0817)	(0.477)			(0.149)	(0.823)			(0.175)	(0.201)		
RFUT3M	0.863***	-0.0320	376	0.267	1.212***	0.838	307	0.192	0.719***	2.163***	375	0.311
	(0.0743)	(0.434)			(0.143)	(0.790)			(0.166)	(0.192)		
RFUT4M	0.784***	0.0246	376	0.261	1.144***	0.714	307	0.184	0.686***	2.145***	375	0.319
	(0.0686)	(0.401)			(0.138)	(0.763)			(0.161)	(0.185)		
RFUT5M	0.714***	0.0718	376	0.251	1.079***	0.628	307	0.174	0.651***	2.120***	375	0.324
	(0.0642)	(0.375)			(0.135)	(0.744)			(0.156)	(0.180)		
RFUT6M	0.650***	0.0936	376	0.229	1.018***	0.547	307	0.164	0.620***	2.093***	375	0.327
	(0.0621)	(0.363)			(0.132)	(0.728)			(0.152)	(0.176)		
RFUT7M	0.603***	0.136	376	0.229	0.961***	0.496	307	0.154	0.592***	2.074***	375	0.330
	(0.0577)	(0.337)			(0.129)	(0.715)			(0.149)	(0.172)		
RFUT8M	0.558***	0.146	376	0.218	0.910***	0.44	307	0.144	0.566***	2.053***	375	0.333
	(0.0552)	(0.323)			(0.127)	(0.704)			(0.146)	(0.168)		
RFUT9M	0.518***	0.180	376	0.206	0.867***	0.384	307	0.135	0.543***	2.031***	375	0.336
	(0.0533)	(0.311)			(0.126)	(0.695)			(0.143)	(0.165)		
RFUT10M	0.485***	0.201	376	0.194	0.826***	0.353	307	0.127	0.517***	2.009***	375	0.337
	(0.0519)	(0.303)			(0.124)	(0.687			(0.140)	(0.162)		
RFUT11M	0.453***	0.229	376	0.182	0.790***	0.343	307	0.120	0.491***	1.985***	375	0.338
	(0.0505)	(0.295)			(0.123)	(0.678)			(0.138)	(0.159)		
RFUT12M	0.425***	0.246	376	0.171	0.754***	0.342	307	0.113	0.467***	1.960***	375	0.338
	(0.0493)	(0.288)			(0.121)	(0.671)			(0.136)	(0.156)		
RFUT13M	0.398***	0.254	376	0.160	0.720***	0.332	307	0.105	0.445***	1.938***	375	0.338
	(0.0482)	(0.282)			(0.120)	(0.665)			(0.133)	(0.154)		
RFUT14M	0.372***	0.251	376	0.148	0.688***	0.323	307	0.099	0.427***	1.914***	375	0.338
	(0.0472)	(0.276)			(0.119)	(0.659)			(0.131)	(0.151)		
RFUT15M	0.351***	0.247	376	0.138	0.659***	0.321	307	0.092	0.412***	1.892***	375	0.339
	(0.0464)	(0.271)			(0.118)	(0.654)			(0.130)	(0.149)		
RFUT16M	0.331***	0.261	376	0.129	0.634***	0.272	307	0.088	0.396***	1.868***	375	0.338
	(0.0458)	(0.268)			(0.117)	(0.648)			(0.128)	(0.147)		
RFUT17M	0.314***	0.263	376	0.121	0.608***	0.250	307	0.082	0.382***	1.842***	375	0.337
	(0.0451)	(0.263)			(0.116)	(0.644)			(0.126)	(0.145)		
RFUT18M	0.298***	0.275	376	0.114	0.586***	0.250	307	0.078	0.369***	1.818***	375	0.336
	(0.0443)	(0.259)			(0.116)	(0.640)			(0.124)	(0.143)		

This table shows the regression results for crude oil (WTI) with 18 maturities considering the participation of the financial investors in the futures market. Panels *A*, *B*, and *C* cover the periods 1995-2002, 2003-2008, and 2008-2015 respectively. The values between brackets shows the standard deviation. */**/*** mark whether the coefficient is significant at the 10%, 5%, or 1% level of significance respectively. CHP is the coefficient for the first difference of hedging pressure; $RPSP500adj$ is the coefficient for the adjusted stock returns which is defined by the multiplication of the stock returns by the commodity-equity correlation; Obs indicates the number of observations. The last column of each panel shows the R-squared for each maturity regression.

Table 4: Regression estimation for natural gas in the periods 1995-2002, 2003-2008, and 2008-2015

	Panel A 1995-2002				Panel B 2003-2008				Panel C 2008-2015			
VARIABLES	CHP	RPSP500adj	Obs	R-squared	CHP	RPSP500adj	Obs	R-squared	CHP	RPSP500adj	Obs	R-squared
RFUT1M	1.329***	4.262*	417	0.190	1.864***	4.339	302	0.160	0.791***	4.503**	378	0.064
	(0.139)	(2.243)			(0.248)	(3.646)			(0.175)	(2.069)		
RFUT2M	1.292***	2.594	417	0.211	1.810***	5.344*	302	0.213	0.827***	4.308**	378	0.078
	(0.125)	(2.012)			(0.203)	(2.990)			(0.161)	(1.906)		
RFUT3M	1.164***	2.208	417	0.209	1.664***	4.161	302	0.199	0.716***	4.627***	378	0.075
	(0.113)	(1.821)			(0.194)	(2.860)			(0.149)	(1.759)		
RFUT4M	0.976***	1.919	417	0.200	1.359***	4.121	302	0.175	0.617***	4.955***	378	0.074
	(0.0973)	(1.572)			(0.172)	(2.535)			(0.138)	(1.626)		
RFUT5M	0.769***	2.438*	417	0.170	1.259***	3.961*	302	0.170	0.499***	4.940***	378	0.064
	(0.0859)	(1.387)			(0.163)	(2.395)			(0.130)	(1.540)		
RFUT6M	0.644***	2.239*	417	0.143	0.946***	3.697*	302	0.125	0.471***	5.285***	378	0.069
	(0.0800)	(1.292)			(0.148)	(2.174)			(0.124)	(1.467)		
RFUT7M	0.568***	2.220*	417	0.124	1.013***	3.320	302	0.157	0.495***	4.685***	378	0.078
	(0.0773)	(1.248)			(0.138)	(2.025)			(0.114)	(1.345)		
RFUT8M	0.517***	1.520	417	0.107	1.036***	3.182*	302	0.196	0.498***	3.744***	378	0.080
	(0.0751)	(1.213)			(0.123)	(1.804)			(0.104)	(1.229)		
RFUT9M	0.483***	1.199	417	0.097	1.098***	2.082	302	0.206	0.452***	3.507***	378	0.075
	(0.0736)	(1.189)			(0.125)	(1.836)			(0.0990)	(1.171)		
RFUT10M	0.417***	0.955	417	0.082	0.828***	1.730	302	0.121	0.409***	3.513***	378	0.073
	(0.0696)	(1.124)			(0.129)	(1.900)			(0.0938)	(1.109)		
RFUT11M	0.348***	0.922	417	0.062	0.753***	2.280	302	0.106	0.365***	3.752***	378	0.074
	(0.0677)	(1.094)			(0.128)	(1.879)			(0.0889)	(1.052)		
RFUT12M	0.270***	1.348	417	0.044	0.487***	2.161	302	0.054	0.342***	3.983***	378	0.074
	(0.0655)	(1.057)			(0.122)	(1.794)			(0.0884)	(1.045)		
RFUT13M	0.264***	1.184	417	0.044	0.286**	4.339**	302	0.036	0.377***	3.745***	378	0.082
	(0.0637)	(1.029)			(0.120)	(1.770)			(0.0859)	(1.016)		
RFUT14M	0.276***	0.253	417	0.045	0.407***	3.174*	302	0.050	0.369***	3.399***	378	0.080
	(0.0627)	(1.013)			(0.114)	(1.682)			(0.0828)	(0.979)		
RFUT15M	0.321***	-0.0936	417	0.061	0.549***	2.996*	302	0.078	0.278***	3.143***	378	0.058
	(0.0622)	(1.004)			(0.115)	(1.688)			(0.0809)	(0.956)		
RFUT16M	0.300***	-0.126	417	0.056	0.481***	2.111	302	0.057	0.219***	3.347***	378	0.055
	(0.0604)	(0.975)			(0.117)	(1.716)			(0.0775)	(0.916)		
RFUT17M	0.252***	0.536	417	0.042	0.491***	1.704	302	0.059	0.177**	3.231***	378	0.049
	(0.0605)	(0.977)			(0.115)	(1.689)			(0.0746)	(0.882)		
RFUT18M	0.207***	0.720	417	0.030	0.330***	1.774	302	0.032	0.143**	3.823***	378	0.060
	(0.0600)	(0.968)			(0.110)	(1.618)			(0.0726)	(0.859)		

This table shows the regression results for natural gas with 18 maturities considering the participation of the financial investors in the futures market. Panels A, B, and C cover the periods 1995-2002, 2003-2008, and 2008-2015 respectively. The values between brackets show the standard deviations. */**/*** mark whether the coefficient is significant at the 10%, 5%, or 1% level of significance respectively. CHP is the coefficient for the first difference of hedging pressure; $RPSP500adj$ is the coefficient for the adjusted stock returns which is defined by the multiplication of the stock returns by the commodity-equity correlation; Obs indicates the number of observations. The last column of each panel shows the R-squared for each maturity regression.

Table 5: Regression estimation for Heating oil on the periods 1995-2002, 2003-2008, and 2008-2015

	Panel A 1995-2002				Panel B 2003-2008				Panel C 2008-2015			
VARIABLES	CHP	RPSP500adj	Obs	R-squared	CHP	RPSP500adj	Obs	R-squared	CHP	RPSP500adj	Obs	R-squared
RFUT1M	0.818***	0.625*	418	0.292	0.898***	-0.175	302	0.259	0.729***	1.745***	377	0.392
	(0.0641)	(0.348)			(0.0877)	(0.877)			(0.0804)	(0.175)		
RFUT2M	0.748***	0.524*	418	0.329	0.867***	-0.488	302	0.262	0.701***	1.773***	377	0.399
	(0.0537)	(0.291)			(0.0844)	(0.843)			(0.0785)	(0.171)		
RFUT3M	0.677***	0.429	418	0.317	0.839***	-0.533	302	0.269	0.697***	1.715***	377	0.397
	(0.0498)	(0.270)			(0.0803)	(0.802)			(0.0771)	(0.167)		
RFUT4M	0.615***	0.336	418	0.299	0.824***	-0.398	302	0.279	0.677***	1.676***	377	0.396
	(0.0470)	(0.255)			(0.0767)	(0.766)			(0.0754)	(0.164)		
RFUT5M	0.553***	0.349	418	0.280	0.799***	-0.0177	302	0.279	0.653***	1.657***	377	0.396
	(0.0445)	(0.241)			(0.0743)	(0.742)			(0.0737)	(0.160)		
RFUT6M	0.487***	0.408*	418	0.255	0.764***	0.209	302	0.269	0.632***	1.645***	377	0.396
	(0.0421)	(0.229)			(0.0728)	(0.727)			(0.0723)	(0.157)		
RFUT7M	0.433***	0.457**	418	0.238	0.704***	0.173	302	0.245	0.622***	1.630***	377	0.399
	(0.0396)	(0.215)			(0.0714)	(0.713)			(0.0710)	(0.154)		
RFUT8M	0.389***	0.516**	418	0.221	0.643***	-0.00343	302	0.221	0.607***	1.615***	377	0.399
	(0.0379)	(0.206)			(0.0698)	(0.697)			(0.0700)	(0.152)		
RFUT9M	0.359***	0.478**	418	0.205	0.586***	-0.216	302	0.200	0.599***	1.596***	377	0.403
	(0.0367)	(0.199)			(0.0679)	(0.679)			(0.0685)	(0.149)		
RFUT10M	0.342***	0.455**	418	0.201	0.553***	-0.281	302	0.190	0.584***	1.589***	377	0.407
	(0.0353)	(0.192)			(0.0662)	(0.661)			(0.0671)	(0.146)		
RFUT11M	0.329***	0.377**	418	0.187	0.541***	-0.169	302	0.189	0.572***	1.561***	377	0.409
	(0.0353)	(0.191)			(0.0648)	(0.648)			(0.0655)	(0.142)		
RFUT12M	0.312***	0.347*	418	0.188	0.522***	-0.0167	302	0.180	0.557***	1.570***	377	0.417
	(0.0332)	(0.180)			(0.0643)	(0.642)			(0.0640)	(0.139)		
RFUT13M	0.299***	0.326*	418	0.181	0.516***	0.0149	302	0.177	0.546***	1.577***	372	0.417
	(0.0325)	(0.176)			(0.0642)	(0.642)			(0.0637)	(0.139)		
RFUT14M	0.288***	0.302*	418	0.169	0.511***	-0.157	302	0.176	0.533***	1.561***	368	0.413
	(0.0326)	(0.177)			(0.0639)	(0.638)			(0.0633)	(0.139)		
RFUT15M	0.278***	0.266	418	0.157	0.521***	-0.170	302	0.184	0.524***	1.538***	364	0.410
	(0.0327)	(0.177)			(0.0635)	(0.634)			(0.0631)	(0.139)		
RFUT16M	0.276***	0.203	414	0.146	0.532***	-0.102	302	0.192	0.510***	1.519***	359	0.404
	(0.0338)	(0.183)			(0.0632)	(0.632)			(0.0632)	(0.138)		

This table shows the regression results for heating oil with 16 maturities considering the participation of the financial investors in the futures market. Panels A, B, and C cover the periods 1995-2002, 2003-2008, and 2008-2015 respectively. The values between brackets shows the standard deviations. */**/*** mark whether the coefficient is significant at the 10%, 5%, or 1% level of significance respectively. CHP is the coefficient for the first difference of hedging pressure; $RPSP500adj$ is the coefficient for the adjusted stock returns which is defined by the multiplication of the stock returns by the commodity-equity correlation; Obs indicates the number of observations. The last column of each panel shows the R-squared for each maturity regression.

6 Robustness check

I perform several robustness tests. First, I re-estimate the regression coefficients by using monthly data sets instead of weekly for the sample period in order to check the effect of the data's frequency. Second, I replace the futures returns for the available maturities with the S&P GSCI total return index for each commodity for the same period. Financial investors prefer to invest in a basket of commodities. They build portfolios that mimic an existing index, such as the S&P GSCI, which is considered a well-diversified index. Third, I implement the regression estimation for shorter subperiods. I divide the tested period (1995 to 2015) into six subperiods of 175 weeks each. This test examines whether the earlier three periods were divided correctly. Another reason is to determine whether the effect of the stock market truly appeared after the 2008 crisis. Fourth, I replace the net short hedging pressure with the net long speculative pressure. This test is supported by the fact that the speculators offset the hedgers' positions. This test should verify that there is no effect for the non-reportable (speculative) futures positions. I use the non-commercial traders' positions that are published by CFTC[19].

First, the monthly datasets qualitatively show the same results as obtained from the weekly datasets for WTI and heating oil. For natural gas, the monthly results boost the weekly ones for the period between 1995 and 2008. However, after 2008 crisis, the monthly data expresses a non-significant coefficient for the adjusted stock returns. This result is not a surprise, because I find a significant result by using weekly data, but the R-squared dropped suddenly compared to the previous periods, which ensures that there is a problem in the natural gas market after the financial crisis in 2008. Second, the results from using the index S&P GSCI instead of the maturity returns show that the adjusted stock returns are significant after 2008, which is the same finding as for the tested commodities.

Third, by dividing the whole sample into shorter subperiods, I find that hedging pressure is significantly related with the futures risk premium for all periods and for all selected commodities. However, the results of the adjusted stock returns are different from one commodity to another. For heating oil, the coefficient for the adjusted stock returns is significant in the last two subperiods, which are May-2008-September 2011 and September 2011- March 2015. The results of these two periods correspond with the results in the post-crisis period (2008-2015). For WTI, the coefficient for the adjusted stock returns shows some changes during the different periods.

- From October 1995 to January 1999, the coefficient for the adjusted stock returns is

[19] The net long speculative pressure is defined as:

$$NLCP = \frac{\textbf{Non commercials Long} - \textbf{non commercials short}}{\textbf{Non commercials long} + \textbf{non commercials short} + 2 * \textbf{positions spread}}$$

negative, and significant at the 5% or 10% level of significance for most maturities.

- From January 1999 to June 2002, the coefficient of the adjusted stock returns is not significant.

- From June 2002 to October 2005, the coefficient of the adjusted stock returns is positive and significant at the 5% level of significance for all maturities.

- From October 2005 to February 2009, the coefficient is positive and strongly significant at the 1% level of significance.

- For the remaining periods, the adjusted stock returns are positive and significant at high levels of significance.

The previous check confirms the results, except for the period between 2002 and 2008. For the significance of the coefficient for the adjusted stock returns, I deduce that the aggregation of the first two subperiods (October 1995 to January 1999 and January 1999 to June 2002) becomes insignificant. But, for the next two subperiods (June 2002 to October 2005 and October 2005 to February 2009), I find the coefficient for the adjusted stock returns is significant in both periods. At first, this appears to be inconsistent with my results that the coefficient for the adjusted stock returns is not significant for the 2003-2008 period. The reason is that the new division is inconsistent with the primary one. In the paper, the post-2008 crisis period starts in October 2008, but the new division extends that to 2009, which causes the coefficient's significance. I rechecked this issue again by dividing 2002-2008 into two subperiods: January 2002- November 2005 and November 2005-September 2008. I find that the coefficient for the adjusted stock returns is positive and significant at the 5% or 10% level of significance for the 2002-2005 period. However, the coefficient is not significant for the 2005-2008 period.

For natural gas, the coefficient for the adjusted stock returns is significant for some maturities for January 1995- June 1998 (from 3^{rd} to 10^{th} maturity). On June 1999- May 2008, the coefficient for the adjusted stock returns is not significant. But, the coefficient for the adjusted stock returns is strongly significant for May 2008 - September 2011. However, on September 2011- March 2015, the coefficient is not significant and the R-squared drops sharply for all the maturities. These results support what I have obtained from the regressions in table 4.

Fourth, by replacing the hedging pressure with the speculative pressure, the results mimic the original tests. For the tested commodities, the coefficient for net long speculative pressure is positive and strongly significant. It also decreases when the maturity increases. For WTI, the coefficient for the speculative pressure in 2008-2015 is higher than 2003-2008, which is higher than the coefficient for 1995-2002. Heating oil has the same results as WTI but with lower jumps in the coefficients' value. For natural gas, the coefficients for the speculative pressure in 2003-2008 and 2008-2015 are higher than for the 1995-2002 period, but the R-squared decreases through time. The coefficient for the adjusted stock returns corresponds to the results obtained from the original regressions for all commodities.

I implement further econometric tests to study the consistency of my estimations. By using White test and Breusch-Peagan test, I find that the heteroskedasticity is not a problem in my regressions. I test the autocorrelation by using the autoregressive model AR(1) and Durban Watson test, and find no autocorrelation problem. Furthermore, I test the two least squares regressions, and no endogeneity problem was detected.

7 Conclusion

In this article, I develop and test a theoretical model to study the interaction between commodity and stock markets. This work is motivated by the ongoing and unresolved debate about the effect of financialization of commodities, and especially the energy market case. This article adds a theoretical interpretation to the research on this debate. Also, this article seeks to clarify the debate between the two conflicting empirical opinions about the impact of financialization on commodity markets: one that claims there is an effect, and one that denies that effect.

The theoretical model determines the futures risk premium through two components: first, the hedging pressure that is in the line with the literature that addresses the relation between hedging pressure and the futures risk premium such as De Roon et al. (2000) and Boons et al. (2014); second, the stock market returns and the commodity equity correlation. Theoretically, I find that the net short hedging pressure is positively correlated with the futures risk premium. Regarding the second component, the combination of the stock returns and the commodity-equity correlation creates four scenarios. Those four scenarios can be reduced to one by noticing the increase in the commodity-equity correlation and the phase of $S\&P500$ equity index. This scenario is the combination of positive commodity-equity correlation and positive stock returns. I find that the financial investors' flow in the commodity market is positively correlated with the futures risk premium.

I test the futures risk premium in the era of financialization based on my theoretical prediction for three commodities in the energy market: crude oil (WTI), natural gas, and heating oil. The sample covers the period from 1995 to the end of 2015. I regress the futures risk premium on the change in net short hedging pressure and the adjusted stock returns. I estimate the regression for three subperiods: 1995-2002, 2003-October 2008 and October 2008-2015. These regressions are tested for several maturities.

First, I empirically confirm that the hedging pressure is a strong explanatory variable for the futures risk premium for energy commodities. I find that the net short hedging pressure is positively correlated with the futures risk premium for all tested commodities. Also, there is a negative relation between the effect of the hedging pressure and the futures maturity. Second, the effect of the stock market became significantly related to the futures risk premium for energy commoditites in the period after the 2008 financial crisis. By that time, the futures risk premium and the adjusted stock returns are positively correlated. This finding confirms the theoretical prediction mentioned above, which stated that positive stock returns that are accompanied by a positive commodity-equity correlation is positivly correlated with the futures risk premium[20]. For crude oil (WTI) and heating oil, the significant linkage is accompanied by increases in the commodity-equity correlation. This finding is in line with Daskalaki and Skiadopoulos (2011) and Belousova and Dorfleitner (2012) and leads to the conclusion that diversification is doubtful. Consequently, financial investors demand liquidity instead of providing liquidity to hedgers (e.g., Cheng et al. (2015)). Third, when the maturity increases, the adjusted stock market returns have stronger explanatory power than the hedging pressure. This finding confirms Boons et al. (2014) who study the first two maturities, but it is the opposite for longer maturities. Fourth, in natural gas case, although the explanatory variables are significant in the 2008-2015 period, the futures risk premium should be determined by extra explanatory variables, which is a motivation for further studies to find an explanation for this issue.

As a result, the role of financial investors in the period of financialization and 2008 crisis is not as important to study as what happened after the 2008 crisis. Finally, this paper contributes to the literature that emphasizes the effect of financialization on commodity markets such as Henderson et al. (2015), Hamilton and Wu (2015), Singleton (2014), and others.

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[20] I was also able to test the opposite case, when the correlation is negative. For instance, the period from 1995 to 1999 for crude oil, the effect of the adjusted stock risk premium on the futures risk premium is significantly negative.

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A From the model to the empirical test

The futures risk premium as defined in (13) is determined by the hedging pressure and the stock market factor, which is defined as the combination of the stocks returns and the commodity-equity correlation.

$$\mathrm{E}[\tilde{P}_T] - F_{t,T} = \frac{\mathrm{Var}[\tilde{P}_T]}{\frac{N_P}{\alpha_P} + \frac{N_I}{\alpha_I} + \frac{N_S}{\alpha_S}\left(\frac{1}{1-\rho^2}\right)} \left(N_I x^* - N_P y^* + \frac{N_S}{\alpha_S}\rho \frac{E[\tilde{V}_T] - V_t}{\sigma_P \sigma_V (1-\rho^2)} \right) \tag{13}$$

Where P_T is the commodity spot price at T; $F_{t,T}$ is the futures price at t when the maturity is at T; $\mathrm{E}[\tilde{P}_T] - F_{t,T}$ is the futures risk premium; ρ is the commodity-equity correlation; σ_P and σ_V are the standard deviations in commodity spot price and stock prices respectively; $\frac{N_i}{\alpha_i}$ is the number of agents i restricted to their risk aversion, and $i := P, I, S$; P is the processor; I is the storer; S is the financial investor; V_j is the value of the financial investor's portfolio in the stock market at time j, $j := t, T$; $\mathrm{E}[\tilde{\mathrm{V}}_T] - V_t$ is the stock market profit; $\mathrm{Var}[\tilde{P}_T]$ is the variance in the commodity prices; and HP' is the hedging pressure.

$$HP' := N_I x^\star - N_P y^\star$$

where $N_I x^\star$ is the total inventory of the commodity which is held by the storers in the physical market, and $N_P y^\star$ is the total quantity demanded by the processor in the physical market.

In equation (13), the hedging pressure is defined as the difference between the physical positions of the storers and the processors $(N_I x^\star - N_P y^\star)$. It shows only the futures positions that are taken for hedging the physical positions. However, the optimal positions of the hedgers have speculative positions after hedging 100% of their physical positions. The CFTC does not distinguish between whether the hedgers' positions are for hedging or for speculation; they publish aggregated positions for commercial traders. Therefore, it is necessary to match the theoretical base with the reality that is represented by the available data. To do so, I rearrange the risk premium to adapt with the practical definition.

First, I introduce the agents' optimal positions as obtained in section 3.2 where C is the cost of storage; β is the cost of production; $F_{t,T}$ is the futures price; P_t is the spot price at time t; $E[\tilde{P}_T]$ is the expected spot price at time T; α_I, α_P, and α_S are the risk aversions for the storer, the processor, and the financial investors respectively. The $Var[\tilde{P}_T]$ is the variance in the commodity spot price, and ρ is the commodity-equity correlation.

The optimal positions of the storer are x^* and f_I^* in the physical and the futures market respectively.

$$N_I x^* = \frac{N_I}{C} max\left\{F_{t,T} - P_t, 0\right\} \tag{5}$$

$$N_I f_I^* = N_I \left[\frac{E[\tilde{P}_T] - F_{t,T}}{\alpha_I Var[\tilde{P}_T]} - x^*\right] \tag{6}$$

The optimal positions of the processor are y^* and f_P^* in the physical and the futures market respectively.

$$N_P y^* = \frac{N_P}{\beta Z} \max\left\{Z - F_{t,T}, 0\right\} \tag{7}$$

$$N_P f_P^* = N_P \left[\frac{E[\tilde{P}_T] - F_{t,T}}{\alpha_P Var[\tilde{P}_T]} + y^*\right] \tag{8}$$

The optimal positions of the financial investor are f_S^*:

$$N_S f_S^* = \left(\frac{1}{1-\rho^2}\right) \frac{N_S}{\alpha_S \sigma_P} \left[\frac{E[\tilde{P}_T] - F_{t,T}}{\sigma_P} - \rho \frac{E[\tilde{V}_T] - V_t}{\sigma_V}\right], \rho \neq \pm 1 \tag{9}$$

Clearing the futures market requires a zero summation of the futures positions:

$$N_S f_S^\star + N_P f_P^\star + N_I f_I^\star = 0$$

By substituting the optimal positions f_P^*, f_S^* and f_I^*, I get:

$$\mathrm{E}[\tilde{P}_T] - F_{t,T} = \frac{\sigma_P^2\left(1-\rho^2\right)}{\frac{N_S}{\alpha_S}} \left[-N_I\left(\frac{E[\tilde{P}_T] - F_{t,T}}{\alpha_I Var[\tilde{P}_T]} - x^*\right) - N_P\left(\frac{E[\tilde{P}_T] - F_{t,T}}{\alpha_P Var[\tilde{P}_T]} + y^*\right) + N_S\left(\rho\frac{E[\tilde{V}_T] - V_t}{\sigma_P \sigma_V \alpha_S (1-\rho^2)}\right)\right]$$

The hedging pressure is as follows:

$$HP =: -N_I\left(\frac{E[\tilde{P}_T]-F_{t,T}}{\alpha_I Var[\tilde{P}_T]}-x^*\right)-N_P\left(\frac{E[\tilde{P}_T]-F_{t,T}}{\alpha_P Var[\tilde{P}_T]}+y^*\right)$$

It means that,

$$E[\tilde{P}_T]-F_{t,T}=\frac{\sigma_P^2\,(1-\rho^2)}{\frac{N_S}{\alpha_S}}\left[HP+N_S\left(\rho\frac{E[\tilde{V}_T]-V_t}{\sigma_P\sigma_V\alpha_S(1-\rho^2)}\right)\right]$$

I consider the commodity-equity correlation as variable. But, the correlation exists in the coefficient terms. Therefore, I apply the Taylor theorem to $\rho = 0$ in order to eliminate the correlation between the coefficients.

$$E[\tilde{P}_T]-F_{t,T}=\left(E[\tilde{P}_T]-F_{t,T}\right)|_{\rho=0}+\rho\frac{d\left(E[\tilde{P}_T]-F_{t,T}\right)}{d\rho}|_{\rho=0}$$

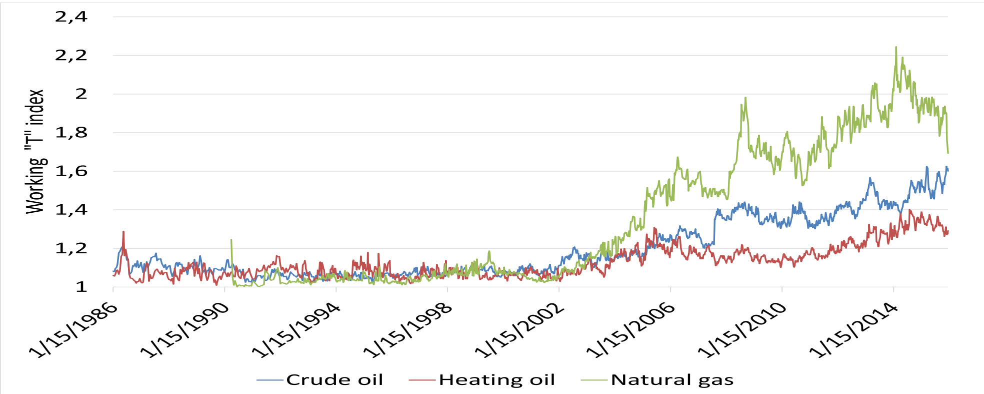
It means that,

$$\mathrm{E}[\tilde{P}_T]-F_{t,T}=\beta_1 HP+\beta_2\rho\left(E[\tilde{V}_T]-V_t\right)$$

$$\beta_1=\frac{\mathrm{Var}[\tilde{P}_T]}{\frac{N_S}{\alpha_S}},\qquad \beta_2=\frac{\mathrm{Var}[\tilde{P}_T]}{\sigma_P\sigma_V}$$

B Charts and tables

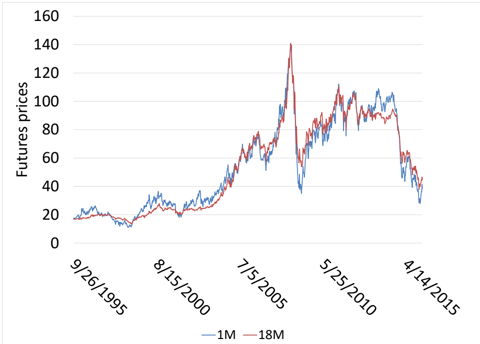
Figure 3: Working "T" index for crude oil (WTI), heating oil, and natural gas



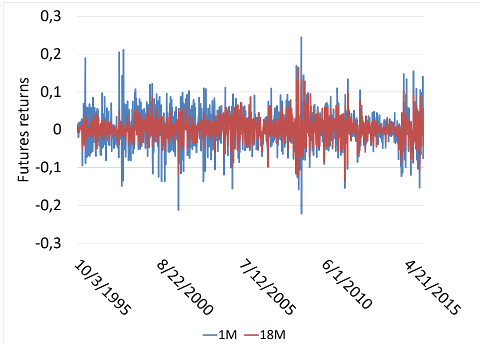
This figure shows Working "T" index for WTI (blue) and heating oil (red) from 1986 to 2015, and natural gas (green) from 1990 to 2015. Working "T" index estimates the speculation activities that surpass what are necessary to offset the hedging activities. The data are obtained from the Commodity Futures Trading Commission (CFTC). The index computations are made by the author.

Figure 4: Crude oil futures prices and futures returns for the 1^{st} and 18^{th} maturities, 1995-2015

(a) Futures prices



(b) Futures returns



This figure shows WTI futures price (a) and futures returns (b) for the 1^{st} (blue) and 18^{th} (red) maturities from 1995 to 2015. Futures prices are obtained from Datastream. The maturities datasets are constructed by the author.

Table 6: Dynamic conditional correlation (DCC) for crude oil, heating oil, and natural gas

	Crude oil		Heating oil		Natural gas	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
ρ	0.275245	0.5371	0.273804	0.1555	0.063734	0.0276
α	0.034513	0.0085	0.039093	0.0018	1.28E-05	0.8831
β	0.963604	0.0000	0.956083	0.0000	0.856538	0.0298
$\alpha + \beta$	0.998117		0.995176		0.856551	

This table shows the dynamic conditional correlation between commodity futures returns and $S\&P500$ returns for WTI, heating oil, and natural gas from 1995 to 2015. Engle (2002) introduces his model to estimate the dynamic conditional correlation into two steps: by estimating a time-varying variances GARCH(1,1) model, and then by estimating a time-varying correlation by using the residual from the first step.

C Robustness checks tables

Concerning the robustness check tables, they are available upon request.