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The Influence of Speculation in Food and Commodities and the Impact of Futures Prices on Spot Prices- Evidence from two Behavioral Experiments

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Abstract

This paper examines the impact of speculation on commodity and food futures on spot prices. Econometric studies contradict each other, coming not to a clear empirical outcome. Therefore, we take an alternative methodological approach with two behavioral experiments. The outcome shows, that tendencies in futures prices influence the price-setting behavior of market players in the spot market in the same direction. Since futures prices had no direct influence on profits and there were no other influences, futures prices must have influenced the expectations of market participants psychologically. Speculation with futures prices thus has an influence on spot prices via expectations. When speculation involves commodities and food in the future market serving crucial real economic functions it can lead to substantial misallocations and damages, why speculation should be regulated.

Keywords: financial markets, speculation, behavioral economics, futures and spot prices, commodities, food, econometric research

1. Introduction

Until the deregulation of the commodity markets, an investor in the USA could only trade 600 commodity contracts. However, this limit was lifted in 2000, enabling investment banks to construct commodity funds with unlimited cash inflows. Derivatives on commodities were added later. Commodities were negatively correlated with traditional investment options and therefore enabled diversification based on Markovitz's (1952) portfolio approach, thereby reducing risk for investors (Tang & Xiong, 2012). As a result, financial investors (so-called non-commercials) increasingly shaped the commodity markets as new players. This gave rise to the term financialization of the commodity markets. From 2003 to mid-2008, speculative financial flows into indexed commodities rose from $15 billion to $200 billion (Masters, 2009). Exchange-traded options and futures on commodities more than tripled between 2002 and mid-2008 and the volume of Over-the-Counter derivatives (OTC) increased fourteenfold to around US$ 13 trillion (Mayer, 2009). There was a big discussion about the influence of financial speculation on the markets, yet the debate on the effects of futures speculation on food and commodity prices remains controversial. This paper examines the relationship between future and spot prices through a behavioral approach. It investigates the behavior of commodity market participants through two behavioral experiments, where the test subjects are assigned the roles of commodity producers and consumer companies to simulate spot and futures trading activities. Are futures prices influenced by speculation, potentially misleading price signals?

Section 2 reviews previous literature about the influences of future prices on spot prices. Section 3 discusses the weaknesses of the econometric commodity research. Section 4 explains the experimental design, while sections 5 and 6 outline the results and conclusions, respectively. And Section 7 discusses aspects of further research in economics.

2. Related Literature

The effects of speculation with futures are the subject of heated debate among researchers. The decisive question is the extent to which speculation in futures markets impacts current prices, namely spot rates, directly affecting food consumers, processing industries, and their end consumers.

According to Krugman, every long futures contract corresponds to a short contract, which in his opinion nullifies any price influence. He claims that buying a futures contract for oil does not reduce the amount of oil available for consumption, thus ruling out the notion of "virtual hoarding" (Krugman, 2008). Nevertheless, it is important to know that supply and demand are not influenced on the spot market, but they are on the futures market. A futures contract can only be executed if the long position is matched by a corresponding short position, but excessive demand can drive

prices up until a participant finds it profitable to take the opposite position. It could therefore be assumed that additional demand for commodities will tend to push up prices on the futures markets. Numerous empirical studies establish a correlation between speculation in futures markets and the price trends of relevant goods in cash markets, along with the volatility of those prices. For instance, Gilbert (2010) shows the connection between index-based investments and food prices, particularly explaining the substantial surges observed from 2007 to 2008. Lagi et al. (2011) substantiate this connection, highlighting the peak in food prices from 2010 to 2011 through a comprehensive model, inclusive interviews with retailers and producers. Their findings, corroborated by researchers at Harvard University and the Federal Reserve Bank of Boston, illustrate that speculation inflated prices to approximately 50% beyond levels based on actual supply and demand dynamics during those periods. Numerous other studies explore the impact of speculation by index funds, particularly in agricultural commodities, consistently arriving at similar conclusions (Deutsche Bundesbank, 2006, p. 59f; Gilbert, 2010; Singleton, 2011; Chilto, 2012; Conrad, 2014, 2015a, 2015b, 2023). Additionally, Mayer's research (2009) provides evidence of the influence of various types of speculators on commodity prices.

Pies contends that prices of commodities not subject to index fund speculation or even traded on futures markets also surged during these periods (Pies, 2012). However, this observation does not necessarily negate the influence of index speculation, particularly in the absence of long-term correlation studies examining these commodities to rule out price transfers, such as substitutes from indexed to non-indexed commodities (cross-price elasticity). Moreover, there are investors who engage in speculation on rising commodity prices outside of index funds, either by purchasing non-indexed commodities forward or by investing long in futures.

Futures prices serve as a dependable benchmark for calculating returns on commodity storage. Consequently, elevated futures prices indicate the profitability of stocking warehouses and expanding storage capacities (Peck, 1985, pp. 44). The higher the futures prices, the greater the secure return on inventory. Krugman (2011) suggests that futures prices influence spot prices primarily through arbitrage, wherein a scarcity of spot supply prompts storage to sell at higher futures prices. However, he observes this phenomenon only in the cases of copper and cotton, not in agricultural products, where storage levels remained stable. Regarding agricultural markets, Pies et al. (2013) found a reduction in storage capacity up to 2008 based on wheat data. However, this conclusion was drawn from incomplete data, as noted by the authors themselves, due to many private storage facilities remaining unreported. Despite the lack of growth in warehousing and storage capacities, it is not necessarily indicative of any specific trend. If the investment costs for new storage capacity are significant, futures prices would need to consistently surpass spot prices over an extended period for such investments to be economically viable. Furthermore, expanding storage capacities inherently require time.

The empirical landscape regarding speculation's impact on commodity prices remains inconclusive. While some studies suggest speculation influences commodity prices, others refute this assertion. According to researchers at the Raiffeisen Association, the majority of empirical studies indicate no discernible correlation between investment volume and price increases (Petersen, Herlinghaus, & Menrad, 2012, p. 14). Conversely, the non-governmental organization WEED (World Economy, Ecology & Development) presents a contrasting view, citing over 100 empirical studies critical of speculation (Weed, 2013; Conrad, 2015a). Will, Prehn, Pies and Glauben (2012) analyzed 35 studies and concluded that no adverse effects of commodity speculation could be substantiated. However, WEED accused Pies of overlooking crucial speculation-critical studies and of biasedly criticizing the methodology of such studies (Henn, 2013). Haase, Zimmermann, and Zimmermann (2016) reviewed 100 studies on speculation's effects on commodity futures markets, revealing a balance between those identifying negative impacts and those refuting them, regardless of research quality. Recent studies have not significantly clarified the overall picture. Chari and Christiano (2019) found no empirical link between financialization and spot price behavior, while Bredin, Pot ̀ and Salvador (2021) detected speculator influence during periods most associated with financialization on prices. Henderson, Pearson, and Wang (2015) highlighted the significant impacts of non-information-based financial investments on commodity prices.

Singleton (2014) demonstrated substantial effects of investor flows on futures prices within the oil market. Juvenal and Petrella (2015) conducted an analysis of the oil market, revealing that global demand shocks predominantly drive oil price fluctuations, with speculative shocks ranking as the second most influential factor. They noted speculation's significant role in the oil price surge between 2004 and 2008, followed by its subsequent downturn. Knittel and Pindyck (2016) constructed a model to assess price trends in the oil market absent speculation and concluded that speculation exerts a lesser influence.

Andreasson et al. (2016) identified a unidirectional linear causality from commodity returns to excess speculation for the majority of the commodities examined, particularly evident in agricultural commodities. Consequently, they cast doubt on speculation as a driver of food prices. Conversely, Huchet and Fam (2016) analyzed data from 1998 to 2013 and provided evidence supporting the hypothesis of a positive impact of speculation in futures markets on returns for underlying commodities. Lawson, Rafayet and Xiaoli (2021) discovered that increased speculation correlated with price

hikes in wheat, corn, rice, and soybeans. They also noted that the impact of speculation varied depending on the commodity and the measure of speculation employed, with rice and wheat generally exhibiting less sensitivity compared to corn and soybeans. Samak, Hosni, and Kamal (2020) employed linear and nonlinear Granger causality tests, revealing evidence that food futures prices lead to fluctuations in food spot prices. Additionally, they utilized cointegration and error correction models, identifying evidence that food spot prices also influence food futures prices.

However, alternative methodologies fail to provide greater clarity. Garbade and Silber (1982) noted that approximately 75 percent of new information in the commodity spot market is initially reflected in future prices. Conversely, Dipf, Flad, and Jung (2017) found that future prices exert only a 10 percent influence on spot prices. Miljkovic, Vatsa, and Olson (2024) detected that futures markets play a crucial role in determining prices, often exerting a significant influence over spot markets. Through dynamic time warping analysis, they investigated the connections between daily corn futures and spot prices in the United States, highlighting the essential role of futures markets in price discovery, yet also reveal instances where spot markets intermittently dominate over futures markets.

In line with demand theory, Jacobson and Obermiller (1990) asked students, for an eight week period, to predict the price of a brand of tuna in the following week. Supporting the concept of intertemporal substitution, they observed a significant positive relationship between the quantity sold and future prices. Their findings suggest that expectations of higher future prices encourage current purchases of tuna, while expectations of lower future prices tend to discourage them. Numerous studies show that consumers evaluate a newly encountered price by comparing it to an internal reference price formed through past experiences (Mazumdar et al., 2005, Elshiewy & Peschel, 2022.).

3. Weaknesses of the Econometric Research On Commodity and Food Speculation

Empirically, econometric studies on the effects of speculation on food and commodities fail to yield a clear picture. In this context, econometrics appears to be of limited value, representing a substantial effort that muddles the issue rather than contributing to the discourse with definitive research outcomes. Both proponents and opponents of speculation criticize mutually the methodological weaknesses of their econometric studies, particularly those relying on Granger causality. These studies often overlook crucial conditions necessary for time series regression in the context of commodities and food. Critics of speculation accuse Irwin and Sanders of applying only one-week lags in their analysis, arguing that price influences cannot be confined to such a short timeframe. Furthermore, it's argued that the Granger test is unsuitable for highly volatile variables, potentially skewing the results (Frenk, 2011).

The issue of covariance stationarity, a necessary condition for time series regression, is frequently encountered in highly volatile variables like stock prices or commodities. Scholars such as Pagan and Schwert (1990), Phillips and Loretan (1990), Frenk (2011), Schlecker (2014), and Conrad (2014) have noted this limitation. Williams and Cook emphasize the notorious volatility of these variables, highlighting their non-stationarity and clear evidence of trending over time (Williams & Cook, 2016, p. 710). A different strategy, utilizing Granger's co-integration method to analyze the changes between variables (differentials), offers only a partial remedy for achieving stationarity (Granger, 2003, p. 361; Williams & Cook, 2016, p. 710).

Irwin and Sanders have been accused of using unrepresentative data, a criticism that can also be leveled against the study by Stoll and Whaley. One issue with the data is that it is not entirely transparent, as the DCOT swap dealer data include positions held by multiple market participants, not just index funds. For instance, the Commodities Futures Trading Commission estimates that only 41% of crude oil futures positions belong to index funds (Frenk, 2011; Masters & White, 2008). This lack of transparency raises a broader concern. Moreover, the quality of the data is also questionable, as it often relies on surveys or is incomplete (Williams & Cook, 2016; Irwin & Sanders, 2012; Frenk, 2011; Conrad, 2013). Furthermore, OTC derivatives were not required to be reported during the periods examined, only becoming subject to registration or clearing house trading after the financial crisis (Conrad, 2013).

Supporters of speculation contend that factors such as a significant surge in demand for commodities from China, India, and other emerging economies, production disruptions in oil, reduced consumer demand elasticity, and US monetary policy were responsible for the price hikes. Additionally, increased biofuel production and weather conditions are cited as contributing factors in the case of grain (Irwin & Sanders, 2010, pp. 4; Pies, Prehn, Glauben & Will, 2013). If indeed numerous factors influence prices, neither the Granger test nor cross-sectional tests would be applicable due to the presence of multi-causality. This is because not all influencing factors were tested separately as variables. Similarly, the Granger test for weather influences faces challenges due to the lack of necessary stationarity of the variables (Schulze, 2004, pp. 17; Hassler, 2003, p. 813). This problem extends to a more fundamental level, as the failure to isolate causal variables can result in Granger tests revealing correlations that do not truly exist (spurious regression). Moreover, purely random correlations can arise, particularly with short observation periods.

Econometrics is characterized by highly sophisticated and intricate mathematical methods, presenting results with apparent clarity. Its scientific appearance has undoubtedly contributed to its widespread adoption. Each econometric

calculation purportedly offers a definitive truth, yet when this method yields accurate yet conflicting outcomes on the same topic, it presents a paradoxical and potentially hazardous scenario. The illusion of precision emerges when results are accepted without undergoing rigorous logical scrutiny or comparison with other evidence and arguments. This issue of inconsistency is particularly pronounced in the domain of agricultural and commodity speculation, but similar unchallenged econometric analyses may exist in numerous other fields. However, if the use of econometrics can yield contradictory findings it demonstrates an inherent dilemma of this research approach. Establishing causality remains elusive, as correlations can stem from various underlying factors (Conrad, 2014; Conrad, 2015a).

According to Karl Popper, the proponent of Critical Rationalism, scientific hypotheses must be capable of refutation, thus falsifiability is essential. Popper's original intention with falsification was to provide a demarcation criterion to distinguish genuine empirical sciences from other forms of inquiry (Popper, 1958). Thus, econometric analyses pose challenges for external verification due to their complexity and opaque data foundation, thereby falling short of Popper's falsification criterion in its strictest sense. Similarly, the inconsistency of results raises concerns. While Granger causality was not originally intended to establish causality, it has unfortunately been increasingly employed in this manner, often with little scrutiny regarding its economic implications. From this perspective, it becomes crucial to subject each study to Popper's falsification criterion. Each study should be regarded as a hypothesis, subjected to rigorous testing against reality until it is falsified. Furthermore, adherence to the Popper criterion gets lost when assumptions fail to align with reality. If the choice of data or the use of assumption-based models in econometric studies influence the results, their connection to reality becomes questionable. Notably, the outcomes of such studies can be affected not only by the selection of assumptions but also by the construction of the models themselves.

The advantage of mathematics lies in its ability to yield precise and definitive results, often perceived as proof, based on model assumptions and design. However, this does not mirror economic reality, as economies are shaped by human behavior, which is often irrational and emotional. Economic science cannot be approached as an exact, deterministic natural science but rather as a social science, where including irrational behavior in models does not eliminate uncertainties (Conrad 2022, 2023). As different conclusions continue to be drawn despite numerous empirical studies, it is important to find additional alternative ways to analyze economic interactions in futures and sports markets, even if econometrics remains important. If these interactions are between human actors, the behavior plays also an important role for the outcome.

Behavioral modeling seeks to outline the economic framework guiding behavior across different contexts, acknowledging its departure from an exact depiction of reality. Unlike traditional economic modeling, which relies on mathematics and assumes rational behavior, behavioral modeling employs experiments to investigate behavior, aiming for a closer approximation of real-world dynamics. These models focus solely on the relevant factors influencing decision-making and delve into the sociological interactions among multiple actors. Behavioral hypotheses are developed within these models and tested using human subjects, with the experimental design meticulously detailed for replication by other researchers. Following Popper's philosophy (1958), these hypotheses hold validity until contradicted by experiments yielding divergent results. The identified behavioral tendencies can then serve as cornerstones for the development of new economic theories and policy strategies (De Grauwe, P/Ji, Y., 2019; Conrad 2019).

4. Experimental Design

Financialization has brought new players with different motives to the commodity markets. Massive long positions, driven by portfolio diversification before the financial crisis, have provided liquidity to the futures markets without affecting the spot markets, according to the argument of those in favor of speculation. Opponents assume a detrimental increase in spot prices due to speculation with futures. We wanted to use behavioral science to test the hypothesis that future prices influence market participants' pricing. Therefore, we conducted two experiments, one in which the subjects were asked to buy and sell on the spot market with rising future prices (Experiment A) from round 6 and one with falling future prices (Experiment B). The demanders were also allowed to buy on the future market. The order of the experiments A and B was changed between the groups. Experiments A and B were carried out during the winter semesters of 2021/22 and 2023/24, as well as in the summer semesters of 2022 and 2023, utilizing MS Teams and Excel as tools. The study involved a total of 120 different participants, organized into seven groups, consisting of students from various Business Bachelor programs such as macroeconomics and political economy at the University of Applied Sciences HTW in Saarbrücken, Germany. The students were tasked with managing as a buyer of commodities (producing company) or seller of commodities (mining company). Their primary objective was to maximize profits, an objective of a manager acting on behalf of a company owner or shareholder. Whoever realized the highest sales revenue among the vendors won and received 10 euros real money. Whoever had the most left over from their budget had the most left over won and received 10 euros.

The 120 players were divided into two groups: Suppliers and Demanders. The suppliers had to sell 10 goods per round and the demanders had to buy 10. The suppliers tried to sell their products as expensively as possible and submitted

their offers in each round (maximum price change of 10% compared to the previous period). The average offer price was calculated. The suppliers whose price offer was higher than the average offer price were only able to sell 20% at their own high price, those whose price was lower were able to sell 100%. The missing 80% were sold to the suppliers at the lower average price of the buyers. The demanders had a total budget of 10,000 euros and had to buy 10 goods per round. They submitted their price bids each round (maximum bid change of period 10%). However, they were allowed to buy maximal 8 goods according to the future prices in advance. The future purchases were not included in any market spot prices. The demanders whose price bid was above the average demand price received 100%, those whose price was lower received 20% of the goods in demand and the remaining 80% at the expensive average price of the suppliers. The goods missing in each round were automatically bought for the players, but at the expensive average price of the suppliers. In this way, the relationship between supply and demand played no role in price formation, only the bids of buyers and offers of suppliers. As this was not an auction, there were no price increases in the event of shortages on the demand or supply side. All goods demanded or offered were allocated and the price was formed in relation to the other price bids and offers. In this respect, quantities played no role. Then the supply and demand prices were averaged without the future prices to the total average price. The supplier or buyer started with a market price of 70 euros.

5. Results

Fig. 1 shows the increasing future prices with which the test subjects were able to buy in advance. The demanders were allowed to buy a maximum of 8 goods on the future market, thus had to buy at least 2 goods on the sport market. The increasing future prices were not included in the price calculation, but nevertheless had a consistent effect on the offer prices as Fig. 2 shows. The trend of rising prices supported the profit maximization of the suppliers. We wanted to analyze the dynamic reaction of the test subjects. If there were no significant reaction of the test subjects to the changes in the model, the deviations in a large sample would have to balance each other out and the average of the reactions would be zero. The extent to which the reactions deviate from one another can be analyzed using the standard deviation, which are shown in the tables.

Figure 1. Increasing Future Prices

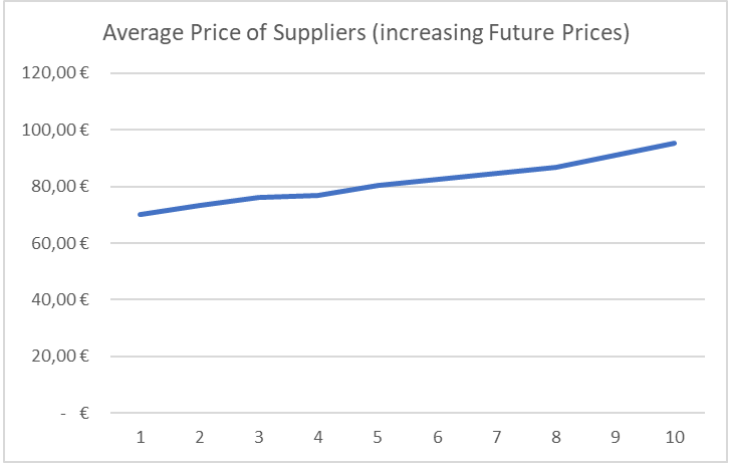

Figure 2. Average Price of Suppliers (increasing Future Prices)

Table 1. Standard Deviation Average Price of Suppliers (groups, increasing Future Prices)

Round	1	2	3	4	5	6	7	8	9	10
Standard Deviation in €	0	2,16	3,48	5,92	7,40	9,11	10,37	11,90	13,41	15,68

The rising futures prices also influenced the price offers of buyers. Unlike suppliers, they tried to push down prices in the initial period without futures prices in order to maximize their profits (Fig. 3).

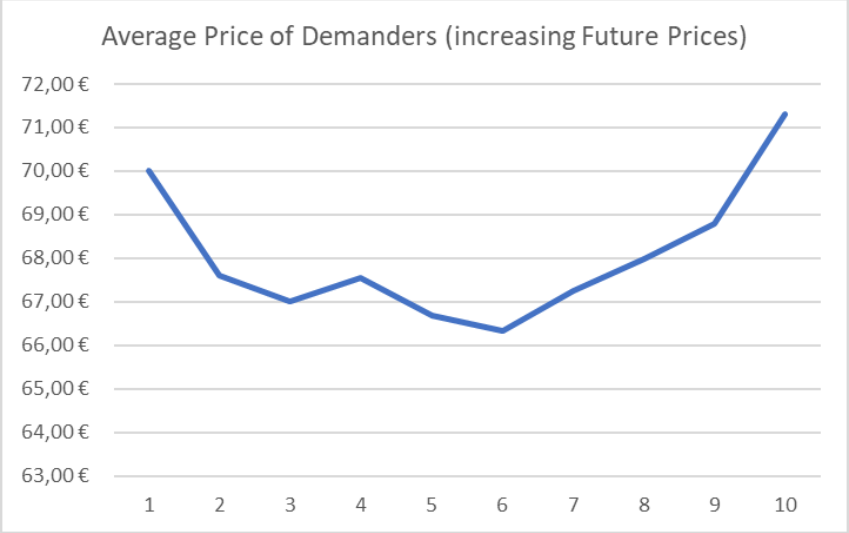

Figure 3. Average Price of Suppliers (increasing Future Prices)

Table 2. Standard Deviation Average Prices of Demanders (groups, increasing Future Prices)

Round	1	2	3	4	5	6	7	8	9	10
Standard Deviation in €	0	2,83	4,81	5,93	7,53	8,69	11,32	13,40	15,70	17,15

Taking into account the price offers of suppliers and price offers of buyers, prices rose on average over the 10 rounds from €70.00 to €83.11, i.e. by 18.73% (Fig. 4).

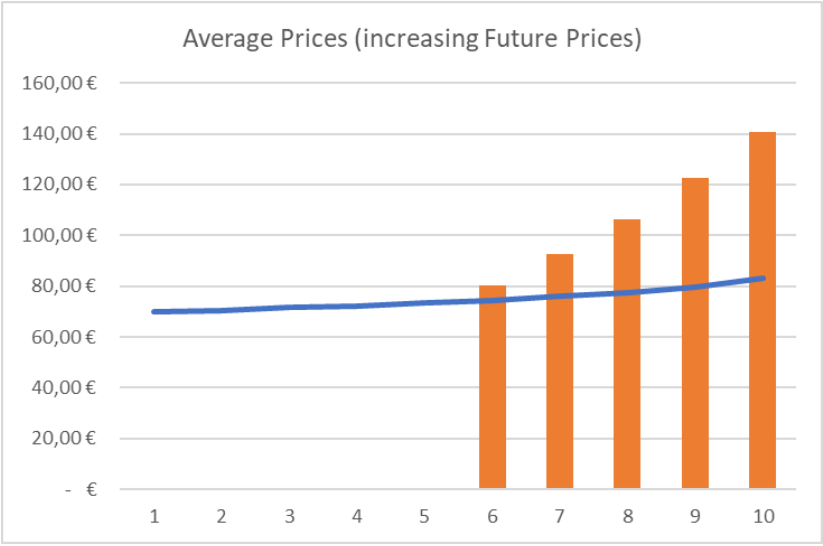

Figure 4. Average Prices (increasing Future Prices)

Table 3. Standard Deviation Average Prices (groups, increasing Future Prices)

Round	1	2	3	4	5	6	7	8	9	10
Standard Deviation in €	0	1,84	2,91	2,79	4,82	5,21	6,64	7,69	9,17	10,88

Figure 5. Decreasing Future Prices

Fig. 5 shows the decreasing future prices with which the subjects were able to buy in advance. However, the falling future prices did not consistently determine the offer prices because they worked against the profit maximization of the suppliers. The suppliers therefore tried to push through higher prices in the initial range (Fig. 6).

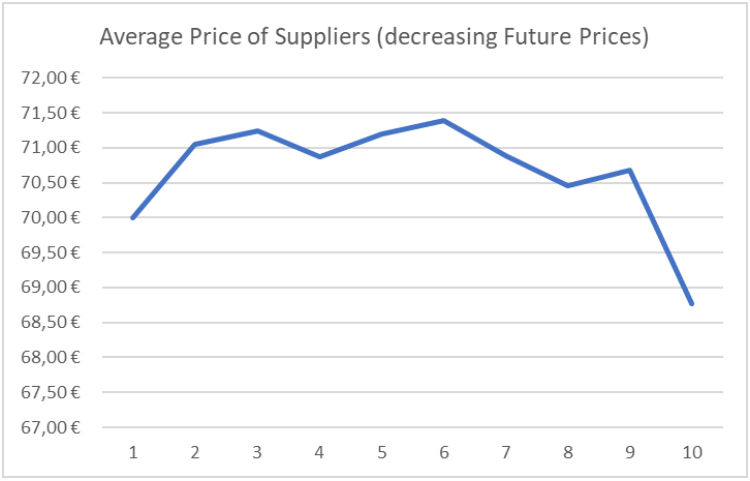

Figure 6. Average Price of Suppliers (decreasing Future Prices)

Table 4. Standard Deviation Average Price of Suppliers (groups, decreasing Future Prices)

Round	1	2	3	4	5	6	7	8	9	10
Standard Deviation in €	0	2,93	5,04	7,02	9,02	11,11	14,30	18,12	22,41	23,48

In the same way, falling futures prices had a continuous effect on the price offers of buyers (Fig. 7). Unlike the suppliers, they supported the downward process in order to maximize their profits, even in the initial area without futures prices to push prices down.

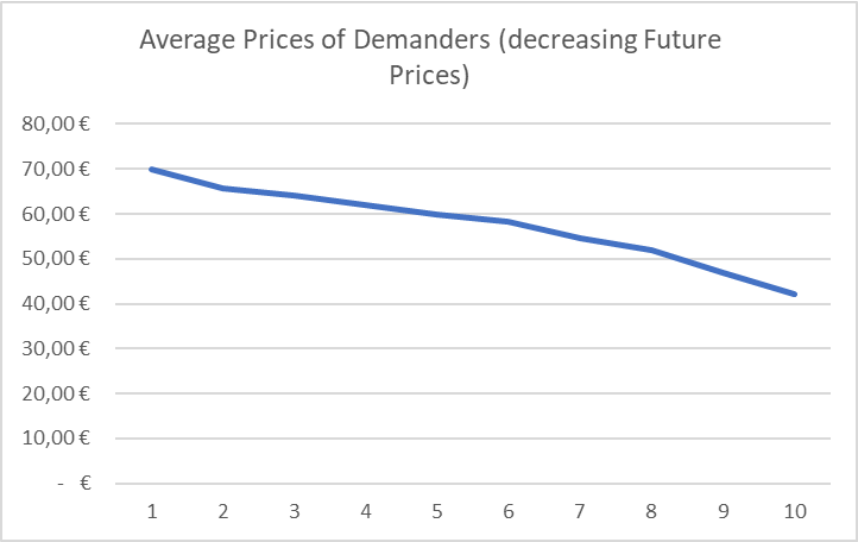

Figure 7. Average Prices of Demanders (decreasing Future Prices)

Table 5. Standard Deviation Average Prices of Demanders (groups, decreasing Future Prices)

Round	1	2	3	4	5	6	7	8	9	10
Standard Deviation in €	0	1,70	2,39	2,43	3,13	5,45	7,56	9,17	10,63	15,25

Taking into account the price offers of suppliers and bids of buyers, prices fell on average over the 10 rounds from €70.00 to €55.70, i.e. by 20.42% (Fig. 8).

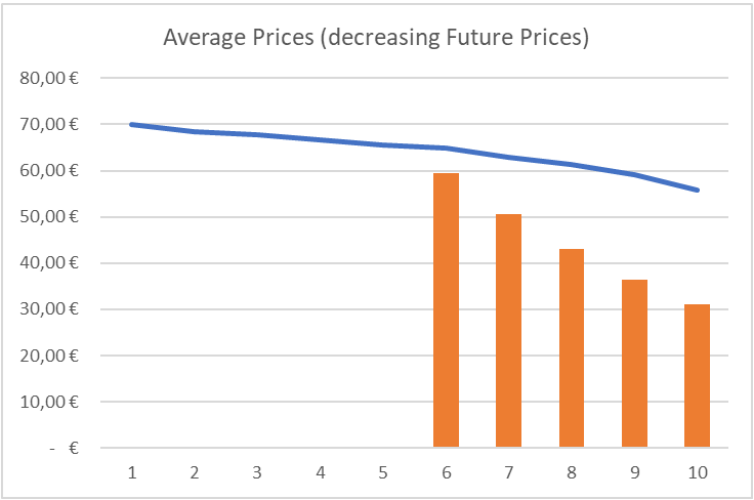

Figure 8. Average Prices (decreasing Future Prices)

Table 6. Standard Deviation Average Prices (groups, decreasing Future Prices)

Round	1	2	3	4	5	6	7	8	9	10
Standard Deviation in €	0	1,75	3,17	4,22	4,84	5,14	5,63	7,98	9,71	11,14

6. Conclusion

This study employed an experimental economics methodology to examine the behavior of commodity markets. Two experiments were conducted, each with a distinct market scenario. In experiment A, participants were tasked with buying and selling on the spot and future market with rising future prices. In experiment B, participants faced falling future prices. Additionally, demanders were permitted to purchase futures contracts.

The hypothesis that future prices influence market participants' pricing was confirmed. In experiment A, futures prices influenced the price-setting behavior of sellers and buyers in the same direction and in experiment B in the opposite direction when futures prices fell. We can therefore formulate a new hypothesis that tendencies in futures prices influence the price-setting behavior of market players in the spot market in the same direction. Since futures prices had no direct influence on profits and there were no other influences, futures prices must have influenced the expectations of market participants psychologically. This is in line with the results of the survey of Lagi et al..: ".. we interviewed participants in the spot market who state unequivocally that they base current prices on the futures market. The use of

futures prices as a reference enables speculative bubbles on the futures market to influence actual food prices." (Lagi, Bar-Yam, Bertrand, Bar-Yam, 2011, p. 5). Speculation with futures prices thus has an influence on spot prices.

In a market economy, speculation plays a vital role, as it attracts new participants to the market and increases liquidity, thereby stabilizing prices. In commodity markets, speculators can play a decisive role by buying commodities from producers and thus alleviating the risk of price fluctuations. This is akin to taking on an insurance role and this is the main argument of proponents of unregulated speculation, such as Pies and Will (2013). For instance, Gary Cohn, the co-president, managing director, and CEO of Goldman Sachs in New York, advocates for allowing non-commercial entities in the market. He explains that in the past, only producers participated in futures markets to hedge against price fluctuations. With the involvement of non-commercials, there is now increased liquidity on the buying side as well (U.S. Government Printing Office, 2008). However, Cohn overlooks the role of commodity processors and consumer companies, who have traditionally been the primary buyers in the futures market for many commodities and agricultural products (Masters, 2009, p. 4). There are also index investors, who, in contrast to speculators, never sell their assets because they seek to diversify their portfolio by buying or because they aim to maintain a fixed ratio of commodities to their other investments to mitigate risk. Their investment strategy is driven by a desire for returns, which is at odds with the goals of commodity processors seeking to buy at low prices. As prices rise, even more investors are attracted to the market. Furthermore, during the 2008 peak of raw material speculation, producers faced up to four speculators, and speculation has since expanded beyond mere hedging. Although speculators also engage in buy-and-sell transactions among themselves (Domanski & Heath, 2007), this can still lead to increased futures prices if demand exceeds supply. Index funds, which dominated the market until the 2008 peak, primarily invested in long positions, generating strong additional demand in the future market (Stoll & Whaley, 2009). Cheng et al. (2012) also highlight the negative consequences of speculation-driven liquidity inflows. Just as the influx of liquidity from non-commercials made commodities more fungible on the market, the withdrawal of liquidity in 2008 put pressure on the market. This phenomenon was similarly observed in emerging markets during the 1997 Asian crisis.

Speculation can be useful addressing future supply and demand imbalances by exploiting temporal price differences, where speculative demand drives up prices, prompting producers to increase supply. However, this isn't guaranteed due to the uncertainty of future shortages and the known present prices for arbitrage. Speculators are expected to possess superior market information, yet this assumption isn't always valid. Consequently, speculation can devolve into irrational behavior akin to betting and gambling. Conversely, speculation might also distort production signals, leading to bubbles and crashes. Derivatives, with their theoretically boundless leverage, hold a distinct position in this scenario. For instance, when futures contracts with margins are utilized for speculation, they artificially amplify the impact of money on futures prices, subsequently influencing spot prices through arbitrage movements and expectation shaping.

Even if the futures prices do not directly impact spot prices due to storage constraints, expectations can still play a role. Our behavioral experiments have demonstrated the influence of expectations on prices. Therefore, speculation affects both spot and futures prices in commodity markets, sending price signals to market participants and influencing supply and demand. A distortion of price signals by speculation on the future market can result in misallocation of resources. Take, for example, speculation in derivatives driving up prices of essential goods like staple foods or commodities such as oil. This leads to increased costs for both manufacturers and consumers. The commodities sector responds by investing in and expanding capacities as prices soar. In the absence of corresponding demand, the speculative bubble inevitably bursts, causing prices to plummet. Consequently, the commodities sector grapples with excess capacities it has built up. The costs, or rather losses, incurred from such trend speculation are ultimately borne by consumers and the real economy. Speculation, as a market phenomenon, is not inherently problematic. However, when speculation involves commodities serving crucial real economic functions—especially food—it can lead to substantial misallocations and damages. Similarly, while insuring risks through derivatives makes economic sense and is justifiable, uncontrolled speculation that distorts markets and threatens the system is not. To ensure that market forces operate for the greater good, as envisioned by Adam Smith, it is imperative to curb these influences that deviate from market principles.

To summarize, the dynamics of supply and demand are artificially distorted when goods are sold that either do not exist or are only borrowed or bought without having any real economic benefit. This results in price developments diverging from what would naturally influence supply and demand to the desired extent (Masters, 2009, p. 17). Our behavioral experiments provided evidence, that futures prices influence the price-setting behavior of market players on the spot market in the same direction. If speculators' capital drives up futures prices by buying commodities, as was the case before the financial crisis, this increases production costs in the processing industry and, in the case of food, can increase the cost of living for consumers. However, futures are economically important for hedging the price risk of commodity producers and the processing industry. Whether speculation is harmful depends on the extent of its influence on the real economy. Speculation must not be allowed to dominate the real economy, as this can lead to massive misallocations and crashes: „Speculators may do no harm as bubbles on a steady stream of enterprise. But the

position is serious when enterprise becomes the bubble on a whirlpool of speculation." (Keynes 1936, p. 159) From this point of view, trading in futures should be restricted for speculators.

7. Discussion and Further Research

Examining agricultural and commodity speculation, we've identified several shortcomings in the existing econometric research. Many studies have relied on poor or incomplete data, and an economic analysis based on statistical evidence and logical reasoning is often lacking. While econometrics will remain important, it must be applied with a critical and transparent approach to ensure that it serves a meaningful purpose in understanding economic phenomena. What is often overlooked in these studies is not only a thorough discussion of methods and data but also an economic analysis grounded in statistical data and logical reasoning as part of scientific inquiry. Instead, it appears that econometric studies are increasingly becoming more mathematically intricate without yielding substantial economic insights. This trend cannot represent the future direction of economics. Instead, economics seems to be moving toward application-oriented field studies focused on specific economic phenomena and behavioral experiments. While econometrics will retain its relevance, it must be applied with critical scrutiny and transparency. Furthermore, economics requires not only a microeconomic foundation but also a behavioral aspect. Psychology plays a crucial role in how individuals form their expectations. Additionally, it is often overlooked that economic agents primarily interact in groups, resulting in dynamic responses from other participants, which can lead to different outcomes than if an individual acts in a given incentive framework.

Here are six suggestions to improve econometric models and their findings:

1. Do the assumptions underlying the models reflect real-world economic conditions, or are they idealized and unrealistic?

2. Is there a logical economic basis for the relationships and connections revealed by the models, or are they simply statistical correlations?

3. Do the findings align with broader statistical trends and patterns, or do they contradict them?

4. To ensure transparency and accountability, researchers should provide a clear explanation of their methods and data, as well as access to the underlying calculations and data, potentially through a cloud-based repository.

5. It is crucial to avoid overinterpreting the results and drawing conclusions that are not supported by the data. For example, simply because no regression is found does not necessarily mean that speculation has no impact on price increases.

6. Finally, do the assumptions and correlations made by the model align with real-world human behavior and decision-making, as observed in behavioral science? Do people actually behave as predicted by the model, or are there significant deviations?

Since economic reality is shaped by human behavior, mathematical models should be validated through interactions with the individuals they aim to model. However, behavioral experiments also have limitations. One of the main challenges is ensuring reproducibility, as human behavior can change over time and be influenced by external factors. To address this, experiments must be designed with transparency in mind, allowing other researchers to replicate the results. The more subjects are tested under different conditions, the more robust the findings will be and the stronger the hypotheses.

Behavioral experiments have the advantage that they can test human behavior in reality without assuming rationality, while econometric methods have the advantage of mathematical accuracy and the law of large numbers in economic reality. Therefore, both scientific approaches complement each other, and it is essential to combine their strengths to gain a deeper understanding of economic phenomena.

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