

Co-movement of commodity futures and stock markets

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Abstract. Navigating through the complex interface of commodities and stock markets, this paper elucidates the pivotal role of commodities in sustaining China's expansive economic and infrastructural panorama. Amidst significant urbanization, industrial advancement, and burgeoning population, China's vast commodities sector plays a vital role in satisfying domestic consumption, facilitating export operations, and underpinning sustained growth. Exploring the intricate linkage between commodities and stock markets, the study reveals a positive correlation between commodity futures and stock market dynamics, enriching the discourse on their co-movements within an emerging economy framework like China. The research, while offering invaluable insights into the complexities of these relationships, also lays the groundwork for future studies, inviting exploration into the causal dynamics and global perspectives. The findings, though illuminative, underscore the necessity for holistic, judicious investment and policy decision-making, reminding stakeholders to meticulously consider broader financial landscapes and market peculiarities alongside analytical insights, thus balancing data-driven decisions with strategic foresight in the vast, interconnected world of financial markets.

Keywords: Commodity Futures, co-movements dynamics, China's economic expansion, Financialization, VAR model.

1. Introduction

Commodities are tangible goods traded in significant volumes for both industrial and agricultural production and consumption. The industry encompasses a range of items, including energy commodities, primary raw materials, precious metals, and agricultural products. Within financial markets, commodities often signify standardized, tradable goods utilized predominantly as primary materials in various industries. Examples include natural gas, crude oil, non-ferrous metals, soybeans, corn, iron ore, and coal. At present, China's trajectory, characterized by dynamic economic expansion, industrial progression, and a significant population, makes commodities a vital component in this phase of growth.

Regarding industrial growth and infrastructural progression, China has witnessed considerable urbanization and industrial advancements in recent times. This evolution in infrastructure, essential for urban expansion, has elicited substantial demand for commodities, such as certain metals and energy sources. On a global scale, China stands as a prominent manufacturer, a sector inherently dependent on a consistent inflow of raw materials, which commodities duly supply.

From a demographic perspective, China's population surpasses 1.4 billion, positioning it as the globe's most populous nation. Such vast population figures inherently result in amplified demands for various goods and services. To adequately address the escalating domestic consumption while simultaneously facilitating export operations, there's a pronounced need for the commodities sector to expand its supply capabilities. Additionally, given its vast demographic, ensuring a consistent and reliable food supply remains paramount for the nation. Key agricultural commodities play an integral role in fulfilling these dietary requirements.

In an investment context, commodities represent a significant market segment with intricate linkages to stock markets. They are fundamental industries with ties to the nation's core economic underpinnings, and due to the supportive stance of China's economic strategies, commodities offer insights for investor strategies, production value preservation, and risk mitigation.

In summary, the commodities sector underpins several facets of China's modernization endeavors, catering to its current socio-economic dynamics, reinforcing infrastructural and sustenance needs,

and anchoring the nation's ongoing growth. Its relevance extends to China's global positioning and influence. An analysis of Chinese commodities presents valuable insights both from a national and individual perspective.

2. Literature review

Commodity futures markets serve as pivotal economic pillars, underpinning functions crucial for sustained economic progression and stability. These markets are indispensable for price discovery, facilitating agreement between buyers and sellers on future commodity delivery prices [1] (Williams, 2001). This process enhances market transparency and aids in predicting subsequent commodity prices, thereby informing pivotal business decisions and shaping sectoral transformation and value-chain configurations [2] (Anseeuw et al., 2017). Moreover, commodity futures markets offer a mechanism for risk mitigation. Stakeholders, including producers, consumers, and investors, utilize these markets to insulate against potential price volatility. However, the allure of commodity futures as speculative avenues cannot be overlooked, primarily since trading in futures demands significantly less capital than actual goods. Although financialization amplifies liquidity within the commodity market, it is not devoid of setbacks. An escalated financialization trajectory can intensify commodity market price volatility, stemming from large-scale trading, potentially causing significant deviations from intrinsic commodity values. Under aggravated circumstances, financial shocks could destabilize commodity markets, particularly jeopardizing crucial commodities like food ([3] Irwin and Sanders, 2011; [4] Isakson, 2014).

The literature on financialization and commodity markets is vast. [2] Anseeuw et al. (2017) delve into the ramifications of financialization within the agricultural sector, attributing its prominence to globalization and capital imperatives. In parallel, works by [3] Irwin and Sanders (2011) and [4] Isakson (2014) link burgeoning food prices to financialization. [5] Ding et al. (2021) discern the impact of commodity financialization on market volatility, unearthing its influence on commodity-stock market conditional correlations. Our research seeks to discern the co-movement dynamics between China's commodity and stock markets, aspiring to enrich discourse on commodity market financialization within an emerging economy framework, like China's, thereby furnishing invaluable insights for a spectrum of stakeholders.

Existing literature, however, does reveal a conspicuous absence of comprehensive studies centering on the nexus between China's commodity and stock prices. Noteworthy contributions include [6] Cine and Gurdgiev (2013), who expound on dynamic correlations across multiple financial assets using U.S. and U.K. data. Further, [7] Zheng et al. (2018) address the financialization of commodities within China's economic milieu, albeit without profound depth and exhaustive data support. Given this context, our paper, building upon antecedent research, adopts the VAR model to intricately dissect correlations between various commodity categories and stock price trajectories within China.

3. Data and preliminary analysis

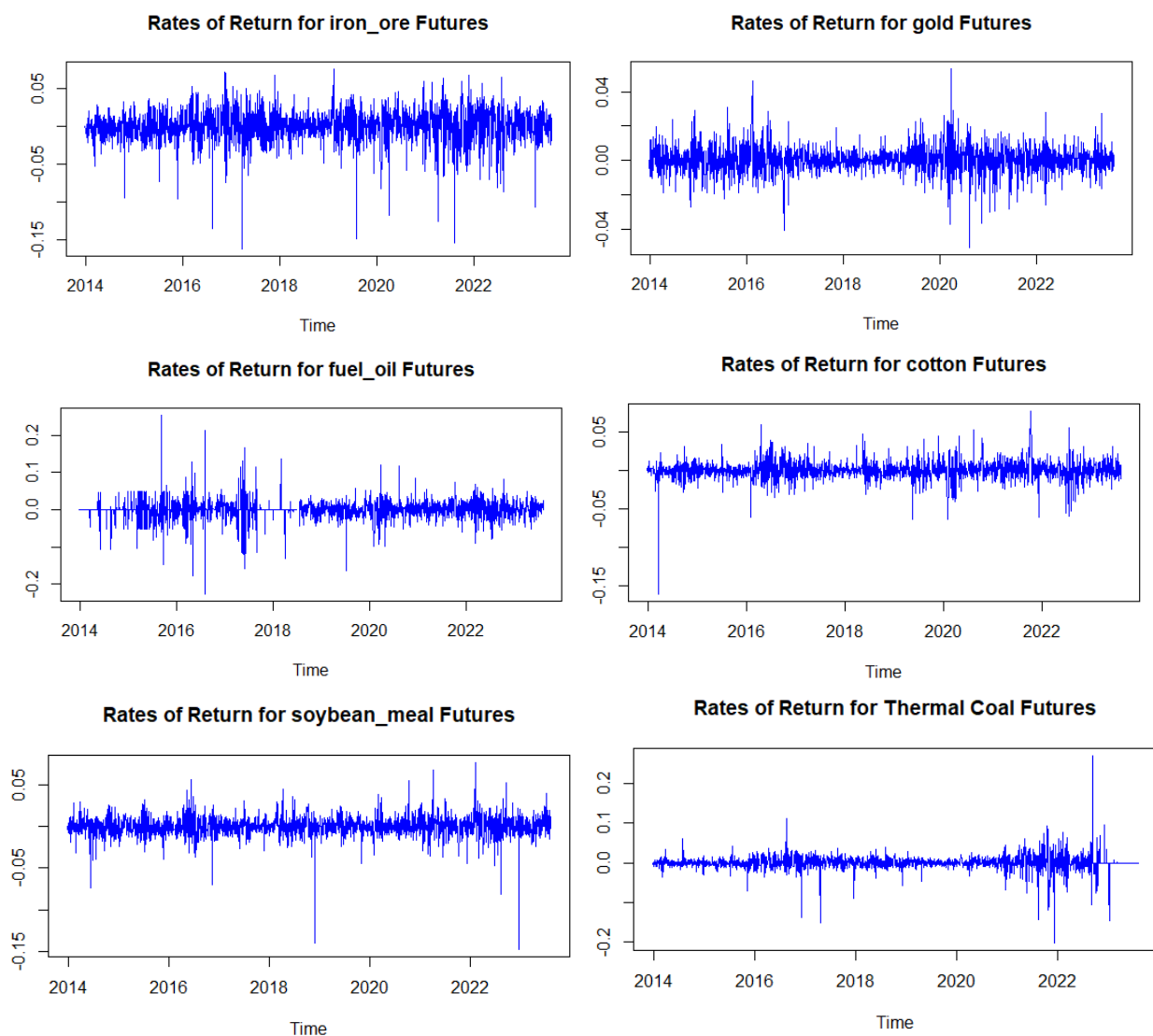
The methodology for our research will harness data meticulously sourced from reputable financial database - WIND to ensure the reliability and accuracy of our findings. Our analysis will be structured around monthly data, spanning from January 2013 through December 2022. This approach is crucial for capturing variances and trends over time. Concerning variables, we will primarily focus on stock market indices and various commodity future prices, such as Thermal Coal, Fuel Oil, Iron Ore, Gold, Cotton, Corn, and Soybean Meal. To draw a comprehensive understanding, we will consider both the Shanghai Stock Exchange Composite (SSE) Index and the Shenzhen Stock Exchange Composite (SZE) Index. Both indices are vital for investors, analysts, and policymakers to gauge the economic and financial health of the Chinese market and, to an extent, reflect economic trends in China.

We first plot a trend chart of the SSE index, see Figure 1. This graph revealed the nonstationary nature of the index, necessitating the conversion of indexes/prices to rates of return. Note that the prices series are in general nonstationary, the visualization of the Shenzhen Stock index and various futures are omitted for brevity. Not that the concept of stationarity is pivotal in time series analysis; specifically, stationary data ensure that estimators of the model parameters are consistent and ensures valid construction of confidence interval.



Figure 1. Shanghai Composite Index

Upon achieving this for all seven commodity categories, we plot them against a time axis, revealing the trend in returns across different industries, as depicted in Figure 2.



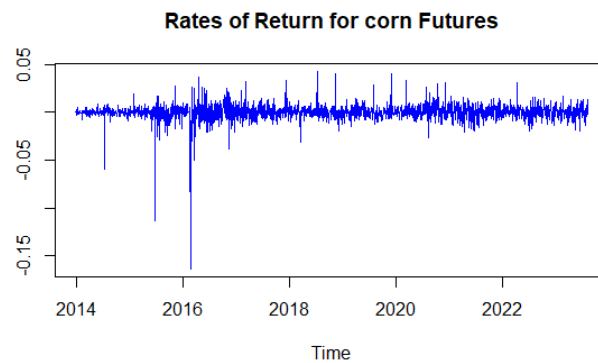


Figure 2. Continuously compounded rates of return for various commodity futures

Figure 2 illustrates how commodity returns, over time, revolve around a specific range, which suggests stationarity. Notably, fluctuations in iron ore, gold, and fuel oil futures are more pronounced, while commodities like cotton and soybean meal remain relatively stable. The observed stability in agricultural products can be attributed to their significance to daily livelihoods, which tends to stabilize demand and, consequently, prices. In contrast, metals and fuels, integral to the industrial sector, experience demand fluctuations depending on the pace of urbanization.

For comparative analysis, Figure 3 showcases the returns for both the SSE and SZE against a constant time axis, underscoring the apparent similarities, especially around the 2016 time point and during 2017-2018.

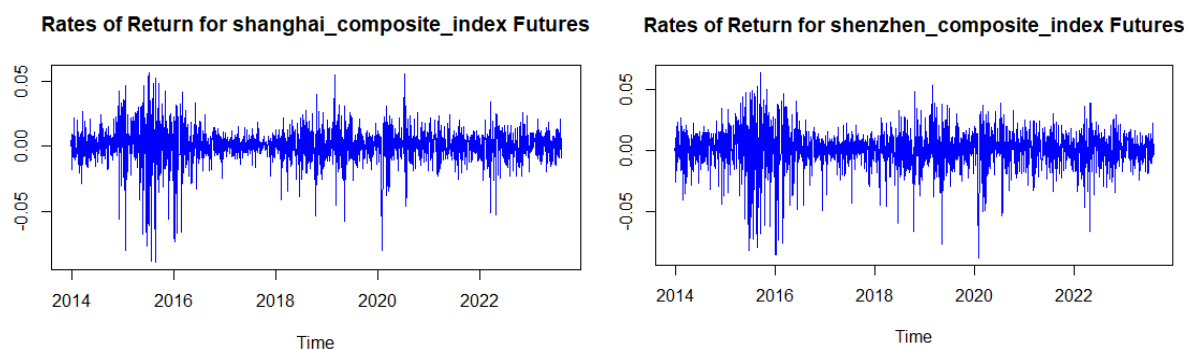


Figure 3. Continuously compounded rates of return for the Shanghai Composite Stock Index and the Shenzhen Composite Index

We also examined the descriptive statistics of various continuously compounded rates of return, and they are tabulated in Table 1. Table 1 presents descriptive statistics for continuously compounded rates of return on different commodities and stock indices. The data spans a range of maximum and minimum values, and there are varying standard deviations for each asset, indicating different levels of volatility. Importantly, the Augmented Dickey-Fuller (ADF) test results for each series are statistically significant at the 1% level. This suggests that each series is stationary, meaning it doesn't have a unit root and its properties are consistent over time. The stationarity of these series is vital for time series analysis as it ensures that the results will be valid and not spurious.

Table 1. Descriptive statistics of various continuously compound rates of return

Statistics	Coal	Oil	Iron Ore	Gold	Cotton	Soybean	Corn	SSE	SZE
Maximum	0.2677	0.2534	0.0757	0.0532	0.077	0.0763	0.0424	0.056	0.0632
Minimum	-0.2002	-0.2255	-0.1618	-0.0507	-0.1603	-0.1468	-0.1633	-0.0887	-0.0879
Standard Deviation	0.0179	0.0269	0.0209	0.0073	0.0114	0.0116	0.008	0.0132	0.0158
ADF	-12.2255	-12.0487	-12.3981	-12.59	-12.4846	-12.3776	-12.283	-13.445	-12.69

Note: All ADF tests are statistically significant at 1% significance level.

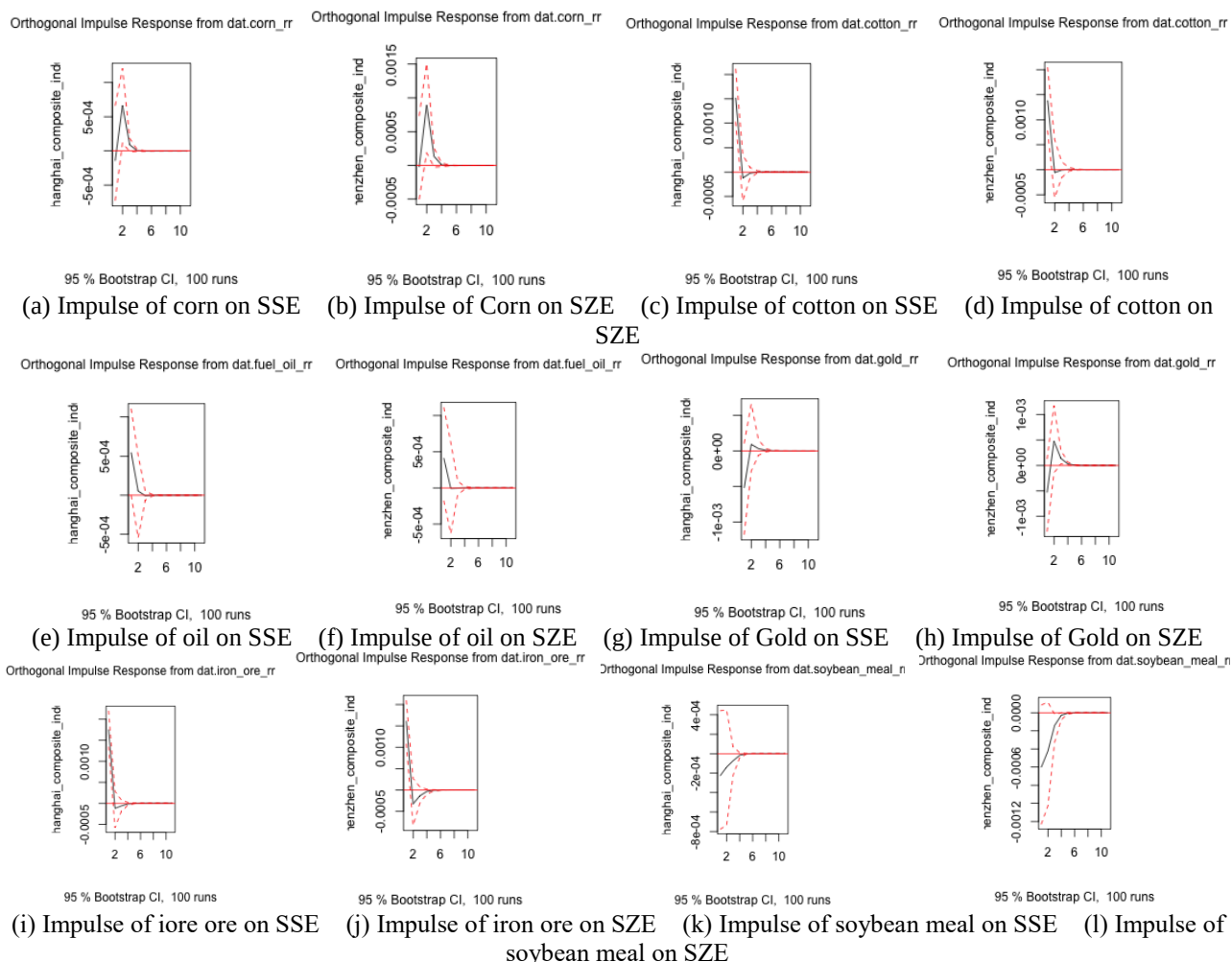
4. Empirical analysis

Here we utilize the vector autoregression (VAR) model to analyze the comovements of rates of return for various commodities and stock indices. The VAR model is as follows:

$$y_t = c + \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \dots + \Phi_p y_{t-p} + \varepsilon_t, \quad (1)$$

Where y_t is the vector of endogenous variables at time t , c is the vector of constants, $\Phi_1, \Phi_2, \dots, \Phi_p$ are matrices of coefficients, p is the order of the VAR model, and finally, ε_t is the vector of error terms at time t . Here p can be selected using information criteria, such as the Akaike Information Criterion (AIC), Hannan-Quinn Information Criterion (HQ), Schwarz Bayesian Criterion (SBC) and Final Prediction Error (FPE). In this paper, we set the small p selected by these criteria, inspired by the principle of parsimony, also known as the Occam's Razor. We then use the orthogonal impulse response function to evaluate how impulse/change to one variable in the system affects the other variables, both contemporaneously and over subsequent periods. The results are visualized in Figure 3.

From Figure 4, it is clear that the impulses of the same commodity on both SSE and SZE indices are very similar, this is due to the similarity of both the SSE and SZE. Both indices represent the A share market in China, both markets are among the largest stock exchanges in the world in terms of capitalization, both compass the same range of sectors, such as finance, technology, manufacturing, amongst other, albeit with slightly different in the prominence of certain sectors in each index. Furthermore, most of the confidence intervals contain zero, this reflects the Efficient Market Hypothesis (EMH), which posits that financial markets are "efficient" in that they immediately incorporate all available information into asset prices, thereby making it impossible to consistently achieve higher-than-average returns on investments through trading strategies based on historical price data or public information.



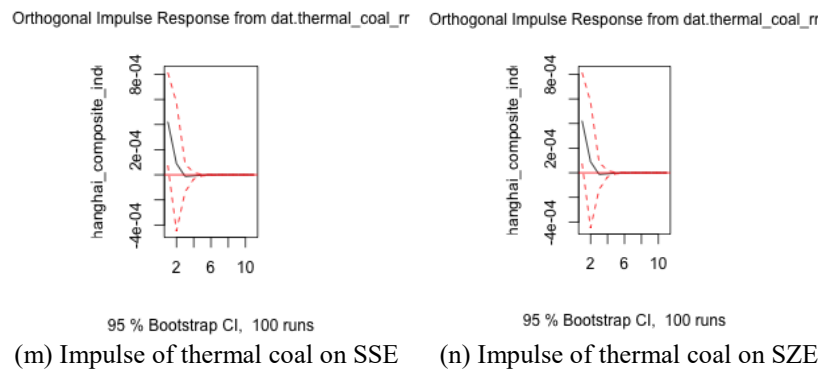


Figure 4. Orthogonal impulse response functions based on equation (1)

However, such analysis only covers comovements in the mean. We also need to investigate the comovement/spillover of volatilities, therefore we fit a VAR model to $\hat{\varepsilon}_t^2$, which is the squared estimated residuals of equation (1), viz.

$$\hat{\varepsilon}_t^2 = a + \Theta_1 \hat{\varepsilon}_{t-1}^2 + \dots + \Theta_q \hat{\varepsilon}_{t-q}^2 + e_t. \quad (2)$$

By squaring the residuals $\hat{\varepsilon}_t^2$, we focus on the variance (volatility) of the financial returns, since the squared residuals are an estimate of the time-varying conditional variance/volatility of the rates of return. Equation (2) can be used to study volatility clustering and investigate the dynamics of volatility over time. Again, we plot the orthogonal impulse response functions. This is particularly important, as the orthogonal impulse response functions allow for an analysis of policy implications by studying how a volatility increase/decrease in a particular commodity/stock index can be transmitted to another commodity/stock index.

As depicted in Figure 5, the volatility of the equity index of commodities exhibits distinct behaviors across the various sectors we have selected (which we have highlighted). Among these, Corn, Oil, and Gold have a positive impact, whereas other sectors, such as Iron Ore and Power Coal, show negligible impacts on the stock market. The reasons for this discrepancy might include the fact that oil, as a member of the energy sector, is crucial for both the industrial and energy sectors. Modernization is heavily reliant on urban infrastructure and economic development, emphasizing the importance of oil in the stock market. Consequently, the stock market is highly sensitive to its price changes.

Furthermore, gold, being a precious metal, acts as a stronghold in the global market. Fluctuations in its price significantly influence investor sentiment. With rising uncertainties, investors tend to re-evaluate risks, altering their investment decisions. This shift has a domino effect on the stock market. Moreover, gold's unique standing as a de facto currency means that its price variations can instigate inflation. This not only influences market prices but also investor profit margins and stock values. In response to inflationary pressures, investors might adjust their monetary policy expectations, which, in turn, affects stocks.

The affirmative influence of corn, a primary commodity in the agricultural sector, on the stock market might stem from the notion that a surge in corn prices often indicates inflation. Price oscillations in corn might prompt investors to fear a broader inflationary impact on the market, inciting market panic and altered market anticipations, subsequently affecting the stock market. Moreover, corn serves dual purposes: as a staple for the food processing industry and a raw material for producing ethanol — a significant component of the energy sector. This duality binds the volatility of corn prices with the energy industry market's fluctuations, rendering a pronounced impact on the stock market. Hence, it's evident that price shifts in different commodity segments can exert varying degrees of influence on the stock market, attributed to the inherent variability of commodities and their associated industries.

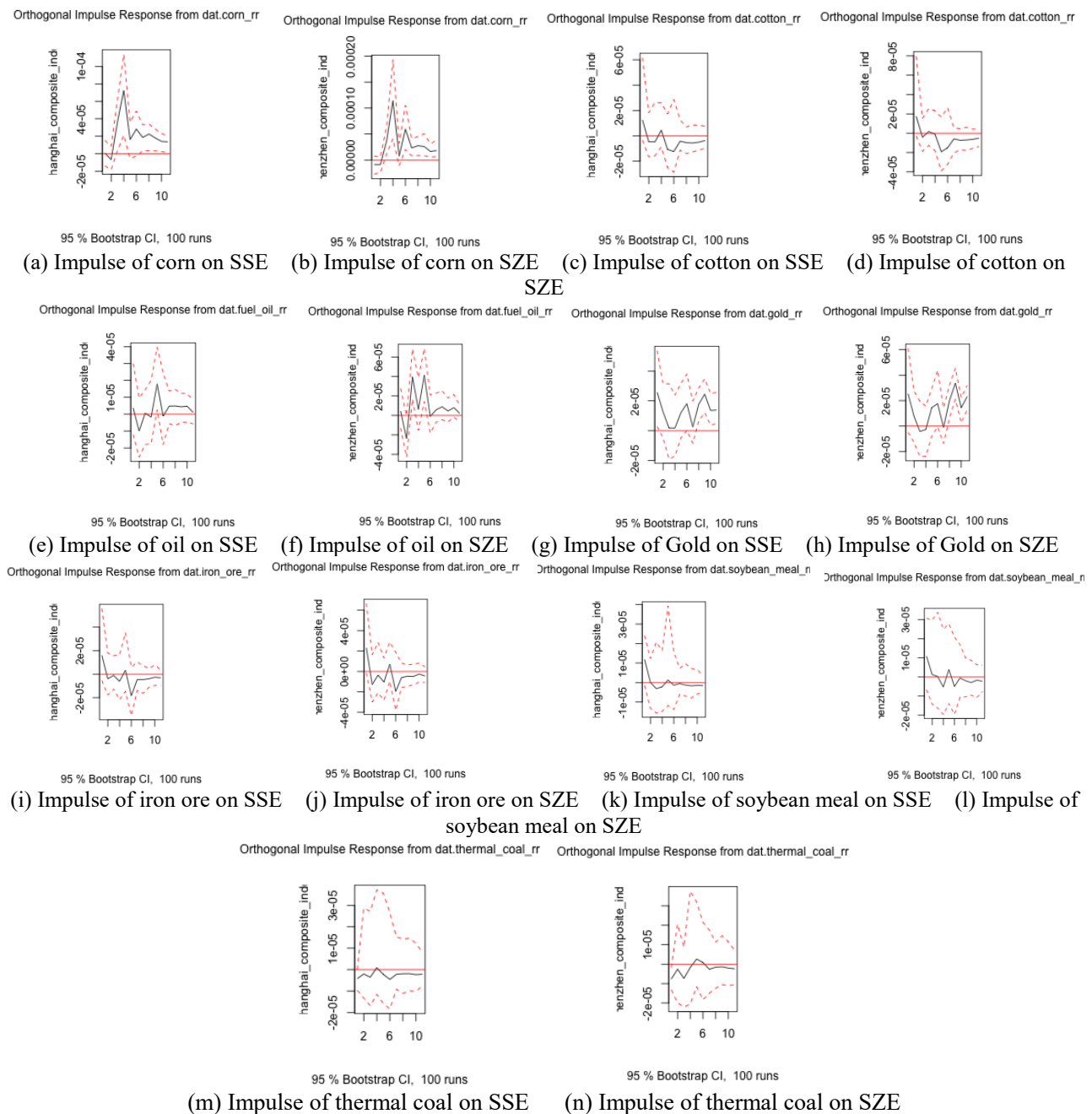


Figure 5. Orthogonal impulse response functions based on equation (2)

5. Discussion

Our investigation into the co-movement of commodity futures and stock markets reveals a notable positive correlation between the concurrent movement of commodity futures and stock markets in China during the studied period. Typically, when commodity volatilities rise, stock market volatilities tend to follow suit. Regarding timeliness, a review of the data indicates that the strength of the co-movement between commodity futures and the stock market fluctuates over time. Factors such as market sentiment, policy alterations, and significant intra-firm shifts can contribute to this variation.

For sector-specific analysis, the commodities market encompasses energy commodities, primary raw materials, precious metals, and agricultural commodities. Some commodities, like energy or precious metals, show a closer relationship with the stock market than agricultural commodities and primary raw materials. The stock market seems more responsive to fluctuations in commodities such as energy and precious metals. This discrepancy could be due to the distinct attributes of commodities;

for instance, agricultural products, being more necessity-driven, have price determinants like demand that wield minimal influence.

Volatility analysis reveals that commodities generally display higher volatility compared to equity markets. Nonetheless, the correlation between their volatilities can shift, subsequently impacting the overall portfolio risk. One exception is corn; the volatility changes in corn have a positive effect on the volatility of both SSE and SZE. The reason is threefold. First, corn is a staple crop in many countries, including China. Its significance in the Chinese diet and agricultural industry could mean that volatility in corn prices might be reflective of broader economic conditions, which subsequently affect stock market indices such as the SSE and SZE. Second, corn is not just a food crop. It's used in a variety of industrial applications, including the production of biofuels, sweeteners, and even some plastics. Volatility in corn prices could signal shifts in these industries, which could then ripple through the broader stock market. Third, corn, due to its significance in the Chinese economy and use beyond food, is subject to speculation. Significant speculative activity might lead to increased volatility in its prices. This could be linked with broader market sentiment and activities, thus influencing major stock exchanges.

Exploring the co-movement of commodity futures and equity markets offers significant advantages, ranging from benefiting financial and economic experts to influencing relevant policy creation.

Economic Implications: The detected co-movement indicates that investors and fund managers might benefit from portfolio diversification, integrating both commodities and equities. This amalgamation, especially of assets with low correlation, can enhance risk-adjusted returns and curtail portfolio volatility, serving as a risk-hedging strategy.

Recognizing the interdependence of commodity and equity markets, regulatory bodies may consider rigorous surveillance and potential regulatory measures to temper any cascading negative effects. Grasping the interactions between commodities and equities can guide the formulation of efficacious tax, trade, and financial market stabilization policies. Traders can leverage such co-movements to refine their trading strategies. Adjusting asset allocation based on discerned correlations helps them remain agile amidst evolving market conditions. Additionally, recognizing prevalent trends can aid in anticipating economic shifts, such as potential inflationary patterns or preludes to major events. Academically, examining the interrelation between commodity futures and stock markets aids scholars in deciphering the intricacies of pertinent financial and commodity markets. This understanding paves the way for innovating and conceptualizing new theories and models.

Despite the advantages gleaned from studying the co-movement of commodity futures and stock markets, some inherent constraints remain. Firstly, concerning timeliness, the selected timeframe can profoundly influence the outcomes. Distinct time intervals might yield varying results and trends. Especially in a dynamically evolving economy like China, with its array of historic events and policy shifts, drawing definitive conclusions from confined historical data becomes challenging. Moreover, reliable historical data on commodities and futures might be less abundant compared to stock data due to differing trading behaviors. Secondly, with respect to research methodology, numerous models exist for assessing correlation and co-movement. Yet, none can guarantee absolute precision. Actual market dynamics are often too intricate to be encapsulated by conventional theories. The scope and duration of the study also mean not every available model can be applied, which complicates comprehensive variable consideration. Lastly, unpredictable elements, including market sentiment, societal upheavals, and investor actions, can dramatically influence the market in the short term. Such abrupt shifts can introduce errors when assessing foundational market elements. Considering these uncontrollable elements is paramount in research. It's essential to adopt a holistic view, contemplate a broader set of variables, and diversify research methodologies while opting for the most apt research models.

Building upon the foundational principles outlined in prior literature, our research bridges a salient gap by meticulously exploring the interplay between China's commodity and stock markets. While

seminal works by authors like [6] Cine and Gurdgiev (2013) primarily focused on Western financial assets and [7] Zheng et al. (2018) touched upon commodity financialization within China, neither delved deep into the co-movement dynamics inherent to China's unique economic framework. Our study leverages advanced VAR modeling, offering a granular assessment of correlations across diverse commodity categories and their consequent impact on stock price trajectories. By doing so, we not only enrich discourse on commodity market financialization in emerging economies but also furnish critical insights for investors, policy makers, and academic scholars, aiding them in navigating the complex terrains of China's rapidly evolving financial landscape. This contribution solidifies our work as a pivotal addition to the existing body of literature, providing a comprehensive understanding of the intricate mechanisms driving China's financial markets.

6. Conclusion

Drawing from the extensive analysis presented, the nuanced relationship between commodity futures and stock markets becomes evident, especially within the vibrant backdrop of China's economy. Commodity futures markets are more than just trading platforms; they are fundamental pillars underpinning economic stability and growth. As highlighted by [1] Williams (2001), they play an indispensable role in price discovery. These markets offer a transparent environment, shedding light on future commodity prices, and driving transformative business strategies that reshape sectoral foundations and the architecture of value chains.

Furthermore, commodity markets cater to a spectrum of financial needs. They act as protective shields against risk for many stakeholders, while also beckoning speculators with the allure of lower capital commitments than physical assets. However, as our research indicates, financialization of these markets, though beneficial in terms of liquidity, brings with it the specter of heightened price volatility. This discrepancy can cause considerable departures from a commodity's inherent value, with particularly dire consequences for essential items like food, echoing the insights of [3] Irwin and Sanders (2011) and [4] Isakson (2014).

Our research uncovers a pronounced positive co-movement between China's commodity futures and stock markets. This correlation becomes especially palpable during periods of heightened commodity volatility, with stock markets often mirroring these fluctuations. Various elements, including changes in policies, market sentiment, and corporate dynamics, play pivotal roles in these shifts. Diving deeper, certain commodities, such as energy and precious metals, share a stronger bond with stock markets than do agricultural products and base materials. An examination of volatility patterns emphasizes the inherently volatile nature of commodities compared to equities. An illustrative example here is corn, whose volatility leaves an imprint on both the SSE and SZE, owing to its diverse applications in China's consumption, industrial processes, and speculative endeavors.

Recognizing the intertwined nature of commodity futures and equity markets offers profound implications. For investment professionals, the revelations stress the merits of portfolio diversification. Meanwhile, regulatory bodies are alerted to the need for rigorous oversight and potential interventions to prevent domino effects. Moreover, these insights offer traders a refined lens, facilitating more astute market navigation strategies. From an academic standpoint, this newfound comprehension challenges and refines prevailing theories, setting the stage for fresh conceptual explorations.

Still, no study is without constraints. Factors like our selected timeframe, the research methodologies employed, and volatile elements such as market sentiment can introduce deviations in the final outcomes. Hence, while our conclusions are significant, they demand careful interpretation, contextualized within the broader economic tapestry. By juxtaposing our findings with existing literature, it's clear our study plugs a crucial knowledge void. Building on works like those of [6] Cine and Gurdgiev (2013) and [7] Zheng et al. (2018), we delve into the distinctive co-movement dynamics embedded within China's economic landscape. Harnessing the VAR model, our exploration

intricately dissects correlations spanning various commodities and their ripple effects on Chinese stock indices.

In summation, our research stands as a guidepost for stakeholders ranging from investors and policy architects to academicians. It emphasizes judicious data interpretation and the necessity to adapt to the fluid nature of global financial markets. The ultimate worth of our study lies not merely in the revelations it offers but in how these insights are pragmatically applied in tangible scenarios.

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