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Commodities and monetary policy—the role of interest rates revisited

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HIGHLIGHTS

- Structural vector autoregressive (SVAR) model and a sub-period analysis.
- Significant influence of interest rates on commodity prices.
- Contractionary monetary policy shocks leading to rising prices before the crisis.
- Unconventional monetary policy shocks resulted in declining commodity prices after crises.
- Variations across commodity classes, particularly industrial and precious metals.

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ABSTRACT

In this study, we examine whether and how the impact of monetary policy on commodity markets changed due to the unconventional monetary policy actions, such as large-scale asset purchase programs and forward guidance, implemented by the Federal Reserve when the interest rate reached its zero lower bound (ZLB) posterior to the financial crisis. Utilizing a structural vector autoregressive (SVAR) model and a sub-period analysis, we identify a significant influence of interest rates on commodity prices before the crisis, with a contractionary monetary policy shock leading to rising prices. However, during the ZLB period, unconventional monetary policy shocks resulted in declining commodity prices, highlighting a directional shift. Our findings underscore the role of monetary policy mechanisms in shaping commodity markets and reveal variations across commodity classes, particularly industrial metals and precious metals. These insights hold practical implications for investors and policymakers.

1. Introduction

The Federal Reserve (FED) continuously lowered interest rates to near zero in order to strengthen the U.S. economy throughout the financial crisis, starting as early as 2007. Once the interest rate reached its zero lower bound (ZLB), the FED implemented unconventional monetary policy actions like large-scale asset purchase programs (LSAP) and forward guidance (FG) to maintain its support for the economy. In particular, the FED extensively used LSAP and FG in the period from January 2009 to October 2015 until the end of the ZLB period, see Swanson (2021). This period coincides with high commodity prices, whereby the question arises whether and how the zero interest rate policy changed the impact of monetary policy on the economy, and especially on commodity prices.

In general, monetary policy transmits to economic variables mainly via financial markets, as asset prices and returns are directly affected, according to Bernanke and Kuttner (2005). Frankel (2008) state that an expansionary monetary policy, conventionally

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represented by lower interest rates, theoretically leads to rising commodity prices through several supply- and demand-sided channels. Hereby, investors shift their portfolios out of bonds, and potentially (at least partly) into commodity markets, in times of an expansionary monetary policy, see Calvo (2008). In contrast, Baffes and Dennis (2013) and Svensson (2008) state the impact of interest rates on prices is ambiguous. Hereby, Svensson (2008) states the impact depends on the shock hitting the system, as economic activity is positively correlated with interest rates and commodity prices. Moreover, Baffes and Dennis (2013) argue higher interest rates cause a decline in the supply due to a higher required rate of return on storage. In contrast, higher interest rates cause a decline in the demand, due to lower purchasing power and a change in the expectations about future economic activity. Therefore, Baffes and Dennis (2013) conclude contractionary monetary policy leads either to an increase or a decrease in prices. Moreover, prices influence monetary policy when they signal potential inflationary pressures or deflationary forces, according to Bernanke and Gertler (2000). In particular, central banks rise interest rates in response to a "heating" economy probably leading to synchronous patterns between prices and interest rates, see Hammoudeh et al. (2015).

Empirically, the evidence is mixed. While Akram (2009), Anzuini et al. (2013), Apergis et al. (2014), and Byrne et al. (2013) validate the inverse impact of monetary policy on commodity prices, Lombardi et al. (2012) and Nicola et al. (2016) are unable to confirm any relationship, whereas Baffes and Dennis (2013) and Hammoudeh et al. (2015) even detect a concurrent behavior. These heterogeneous results can be explained by the contrasting supply and demand responses, see Baffes and Dennis (2013). In addition, monetary policy is only represented by interest rates in these studies, neglecting further monetary policy actions. However, the Federal Reserve continuously lowered interest rates to near zero at the end of 2008 and subsequently implemented unconventional monetary policy actions. While Eksi and Tas (2017), Haitsma et al. (2016) and Swanson (2021) reveal that the zero interest rate environment changes the effect of monetary policy on stock markets, the impact on commodity markets is still underrepresented in the literature. For commodity markets, Aliyev and Kocenda (2023) analyze how commodity prices denominated in US dollars are affected by European conventional as well as unconventional monetary policy actions. Moreover, Apergis et al. (2020) and Gomis-Porqueras et al. (2023) focus on the monetary policy of the FED, however, they do not account for interrelations within the economy. In particular, the reverse impact of commodity prices on monetary policy is not considered.

In this context, the objective of this study is to examine the impact of monetary policy on commodity prices, with a particular focus on understanding whether and how the zero-interest-rate policy influenced the relationship between monetary policy and commodity prices in the U.S. economy. Specifically, the research aims to uncover period-specific variations in the effects of monetary policy on commodity prices attributed to the zero lower bound (ZLB) era. Furthermore, it seeks to explore potential differences in the impact of monetary policy across various commodity classes.

For this reason, we follow the literature, e.g. Akram (2009), Anzuini et al. (2013), Bernanke and Kuttner (2005), and Hammoudeh et al. (2015), and initially model the U.S. economy, via a structural vector autoregressive (SVAR) model. Our analysis utilizes monthly data encompassing key economic indicators: U.S. industrial production as a proxy for economic activity, the U.S. consumer price index to represent the inflation rate, the shadow rate from Wu and Xia (2016) to capture both conventional and unconventional monetary policy, the U.S. dollar index as a measure of exchange rate fluctuations, and the Bloomberg Commodity (BCOM) index to reflect overall commodity price movements.

The results can be summarized as follows. First, a structural break test confirms the relations in the system changed significantly during the financial crisis, corresponding to the beginning of the zero interest rate policy. Second, we analyze the effects of monetary policy on commodity prices by splitting the data into two sub-periods based on the identified structural break: the pre-crisis period (up to the end of 2008), reflecting conventional monetary policy where the shadow rate aligns with the federal funds rate, and the post-crisis period, marked by zero interest rate policy and increased unconventional monetary actions. This division enables a comparative assessment of monetary policy shocks on commodity markets across these distinct economic contexts. Overall, the distinct investigation of the two sub-periods reveals the impact of monetary policy on commodity prices significantly changed, indicating the zero interest rate environment affected their relation. While a contractionary monetary policy, which is equal to a positive shock to the shadow rate, leads to increasing commodity prices in the first sub-period, underlining the findings of Baffes and Dennis (2013) and Hammoudeh et al. (2015), the prices decrease in the posterior crisis period, in line with the hypotheses of Frankel (2008). Hereby, the response in prices is more pronounced to a shock in the shadow rate in the second sub-period, representing unconventional monetary policy actions. In particular, our results reveal the constitution of the U.S. economy, especially the impact of monetary policy on commodity prices, changed significantly during the financial crisis.

Third, we examine whether the impact of monetary policy differs across several commodity classes. In this context, the results reveal that agricultural and energy commodities are affected by monetary policy actions, whereby the effects of unconventional monetary policy are even more pronounced. Moreover, they do not affect the interest rates, as their prices are not considered within the core inflation rate. In contrast, industrial metal prices and interest rates exhibit strong positive correlations in the pre-crisis period, while the relation between monetary policy and metals changed significantly due to the ZLB period.

Overall, we contribute to the literature with an in-depth analysis of the relation between monetary policy and commodity markets. Hereby, we examine how the effects of monetary policy change due to the zero interest rate environment. While previous studies mostly focus on the effects of interest rates on commodity markets, we provide evidence that a change in monetary policy affects the relationbetween monetary policy and commodity markets.

The relevance of this study lies in its comprehensive analysis of the dynamic relationship between monetary policy and commodity markets, providing critical insights into an area with profound economic implications. By examining how the effects of monetary policy have changed in response to the zero-interest-rate environment, this study addresses a key gap in the existing literature. While previous research has primarily focused on the direct impact of interest rates on commodity prices, our work extends this discussion by analyzing how shifts in monetary policy mechanisms—particularly during periods of unconventional monetary policy—reshape these dynamics. This study also contributes to the debate on the theoretical underpinnings of monetary policy's influence on commodity prices. Specifically, we assess whether the price-increasing effect of expansionary monetary policy, as suggested by Frankel (2008), holds in different monetary regimes, or whether the relationship is more ambiguous, as argued by Svensson (2008). By empirically testing these contrasting perspectives, our findings help refine the theoretical and empirical understanding of how monetary policy interacts with commodity markets across varying economic conditions. These findings are significant for understanding market dynamics, guiding investor strategies, and shaping effective regulatory and policy responses.

Hereby, similar to Eksi and Tas (2017) for the stock market, we reveal that the impact of monetary policy on commodity prices differs in the periods prior to and posterior to the financial crisis, whereby monetary policy is still an important determinant of commodity markets in the ZLB period. While prices and conventional monetary policy are positively interdependent in the pre-crisis period, aligning with the findings of Kim (2022), unconventional monetary policy actions stimulated the economy during the recession period caused by the financial crisis, leading to higher prices in response to an expansionary monetary policy, consistent with the conclusions of Aliyev and Kocenda (2023) for Europe. These results contribute to enriching the theory. They demonstrate the validity of both postulated mechanisms in the literature. Therefore, it is necessary to complement Frankel's approach with the considerations of Hammoudeh et al. (2015), which argue for a reverse causality as central banks rise interest rates in response to a "heating" economy. Furthermore, the empirical evidence for the United States highlights that the prevailing relationship depends on the time period. In low-interest-rate periods, such as during a zero-interest-rate policy, there is an inverse relationship, while in high-interest-rate periods, a positive correlation exists.

The remainder of this paper is structured as follows: Section 2 reviews the literature, whereas Section 3 presents the applied data and methodology, followed by the empirical analysis and findings described in Section 4, while Section 5 concludes.

2. Literature

The impact of monetary policy on commodity prices is focus of several studies, albeit the evidence in the literature is ambiguous. On the one hand, Akram (2009) and Frankel (2008) list several possible supply- and demand-sided related reasons for an inverse relationship between monetary policy and commodity prices and even state that prices will overshoot a permanent shock in money supply due to the law of one price as well as the storability of commodities. First, investors will invest less in bonds and more in commodities in response to an expansionary monetary policy, oftentimes reflected by decreasing interest rates, which leads to a rise in demand and, ultimately, to price increases. In this context, commodities may serve as a hedge against inflation, since lower interest rates increase future inflation expectations, see Gomis-Porqueras et al. (2023). Second, lower interest rates reduce carrying costs, while simultaneously increasing inventory demand, which leads, due to the no-arbitrage condition, to a rise in overall demand and, ultimately, to price increases. Third, the extraction of exhaustible commodities, such as oil and minerals, is less profitable in low interest rate environments, which leads to a decrease in supply and, ultimately, to price increases.

On the other hand, Baffes and Dennis (2013) state that the impact of interest rates on prices is indefinite. While higher interest rates cause a decline in the demand due to lower purchasing power, the supply also decreases due to a higher required rate of return on storage, leading to either an increase or a decrease in prices. In this line, Svensson (2008) also doubts whether the theoretical negative correlation, argued by Frankel (2008), can be observed empirically, since the relationship between commodity prices and interest rates depends on the shock hitting the economy and its short- and long-term effects on all variables, as the interest rate and the economic activity are interdependent themselves. In particular, an output shock is expected to increase commodity prices as well as real interest rates. As long as central banks aim for a stable gap between nominal and real interest rates, both rates will increase in response to the output shock, causing a positive correlation between rates and prices. In addition, Hammoudeh et al. (2015) reverse the causality and argue that central banks rise interest rates in response to a "heating" economy, leading to synchronous patterns in prices and interest rates, see for example Gubler and Hertweck (2013) for the empirical evidence of increasing rates in response to a shock in commodity markets.[1]

Empirically, the evidence in the literature is mixed. Even Frankel (2008) only confirms his theory of an inverse relation in the analysis of commodity prices in the period from 1950 to 1979 and from 1950 to 2005, whereas the observed relation between interest rates and commodity prices is positive in the period from 1976 to 2005 and from 1980 to 2005, indicating the relation might change over time. Moreover, the study by Kim (2022) finds that expansionary U.S. monetary policy leads to higher commodity prices, consistent with the findings of Frankel (2008). However, several studies fully support the inverse relationship. In particular, Akram (2009) as well as Anzuini et al. (2013) observe shocks to the interest rate significantly affect commodity prices, reflected by commodity indices, in the period from 1989 to 2007 and 1970 to 2008, respectively. Hereby, oil as well as industrial raw materials tend to overshoot in response to a real interest rate shock, but Akram (2009) also confirms the shock dependence of Svensson (2008), as a positive shock in economic activity leads to synchronous responses in the real interest rate, the oil price as well as the commodity price. Moreover, Klotz et al. (2014) and Smiech et al. (2015) empirically underline the inverse reaction of (non-)energy commodity prices to interest rates in the Chinese and euro area economy in the period from 1998 to 2012 and 1997 to 2013, respectively.

In contrast, several studies only detect ambiguous, weak or no effects from monetary policy on commodity prices, see Baffes and Savescu (2014), Frankel and Rose (2010) and Siami-Namini (2021) or Ahumada and Cornejo (2014), Kagraoka (2016), Lombardi et al. (2012), and Nicola et al. (2016) among others. In particular, the results of Baffes and Savescu (2014) are heterogeneous, whereby

[1] Gubler and Hertweck (2013) investigate the impact of commodity prices on the economy. Hereby, they reveal that a shock to the commodity prices causes a higher inflation rate, whereupon the Federal Reserve reacts with higher interest rates.

their bi-variate regressions show a strong negative link between commodity prices and interest rates, while long-term interest rates positively affect metal prices in their multivariate model. Further, Schischke et al. (2023) detect a positive effect of interest rates on metal markets. However, Frankel and Rose (2010) and Siami-Namini (2021) only detect weak evidence of an impact of monetary policy on commodity prices. Hereby, Siami-Namini (2021) only confirm long-term effects, whereas the studies of Ahumada and Cornejo (2014), Arias et al. (2019), Kagraoka (2016), Lombardi et al. (2012) and Nicola et al. (2016) even reveal that interest rates do not affect commodity prices. In addition, Frankel and Rose (2010) find little support for an impact of low real interest rates on commodity prices, besides any effect monetary policy actions might have via real economic activity and inflation. Hereby, Pfäuti (2024) demonstrate that reduced public attention to inflation complicates monetary policy during periods when nominal interest rates are constrained by the effective lower bound.

Besides the ambiguous impact of monetary policy on commodity prices, see Baffes and Dennis (2013), the zero-interest rate environment might cause the mixed evidence in the literature. Hereby, Anzuini et al. (2013) as well as the more recent study by Kim (2022) even restrict their sample period until 2008 such that their results about the impact of interest rates on commodity markets are not biased by the change in the policy. To strengthen the U.S. economy, the Federal Reserve continuously lowered interest rates to near zero at the end of 2008 and subsequently implemented unconventional monetary policy actions, whereby the question arises whether unconventional monetary policy affects prices in the same manner as conventional policy. In this context, Glick and Leduc (2012) focus on the short-term reaction of long-term interest rates, exchange rates and commodity prices on the days of LSAP announcements. In contrast, Aliyev and Kocenda (2023) use monthly data to investigate the impact of European conventional as well as unconventional monetary policy actions on commodity prices in the period from 2001 to 2019. While food and metal prices significantly increase in response to contractionary monetary policy shocks in the pre-crisis period from 2001 to 2008 as well as in the post-crisis period from 2009 to 2019, the aggregated commodity index as well as fuel prices only increase significantly in the post-crisis period, contrary to the theoretical inverse relation stated by Frankel (2008). However, they only focus on European markets, whereby a contractionary monetary policy shock might be associated with an appreciation of the euro, leading to an increased domestic demand for commodities traded in other currencies, which finally causes rising prices. Hence, they are not able to disentangle the exchange rate effects from the monetary policy effects.

With focus on the U.S. economy, Hammoudeh et al. (2015) examine the differences in the impact of monetary policy on several commodity classes. Hereby, they generally restrict their sample to 2008, similar to Anzuini et al. (2013), however, they also investigate the effect of unconventional monetary policy, measured by central bank reserves, on prices for a robustness analysis, accounting for the zero interest rate environment. They conclude that conventional and unconventional monetary shocks cause similar reactions in the commodity markets. Further, the study by Umar et al. (2023) investigates the effects of U.S. unconventional monetary policy, measured using the Shadow Short Rate, on the returns and volatility of agricultural commodity futures. Umar et al. (2023) find that U.S. monetary policy acts as a net transmitter of volatility and return spillovers to agricultural commodities. The effects are time-varying and become more pronounced during periods of market turmoil, such as the Global Financial Crisis and the COVID-19 pandemic, though the overall impact remains small. While Amatov and Dorfman (2017) and Umar et al. (2023) examine the impact of monetary policy on agricultural commodities, Papadamou and Sogiakas (2018) analyze the effects of unconventional monetary policy announcements by the Bank of England (BoE), Bank of Japan (BoJ), and European Central Bank (ECB) on gold and silver markets, emphasizing the significant heterogeneity in the transmission channels across these policies. In addition, Amatov and Dorfman (2017) investigate the effects of the Federal Reserve balance sheet on an aggregated and agricultural commodity index in the period from 1992 to 2013 via a vector error correction model. Their results reveal a long-term relationship, where expansionary monetary policy increases commodity prices, however, they do not account for possible changes in the relationship in the ZLB period. Moreover, Gomis-Porqueras et al. (2023) examine impulse responses using local projections to disentangle the impact of forward guidance and LSAP of the FED on commodity markets, whereby they detect that the responses differ across the commodities. In particular, conventional and unconventional monetary policy shocks affect production-like and agricultural commodities to a similar extent, whereas asset-like commodities increase in response to easing FG shocks, while they decrease in response to easing LSAP shocks. Another closely related study with focus on the impact of (un-)conventional monetary policy on individual commodity prices via an EGARCH-X methodology is the article by Apergis et al. (2020). Hereby, Apergis et al. (2020) detect that the effects of unconventional monetary policy are more pronounced than those of the conventional one. However, the methodologies applied by Apergis et al. (2020) and Gomis-Porqueras et al. (2023) only enable the analysis of the effects of (un-)conventional monetary policy on commodity prices, but the interrelations within the economy are not reflected at all. In this context, we use the widely common structural VAR model to reflect the interdependencies in the U.S. Since we incorporate these interdependencies and various periods, such as those characterized by a zero-interest-rate policy, we can specifically focus on different mechanisms of action between monetary policy and commodity markets and analyze them.

3. Methodology and data

The objective of this study is the analysis of the impact of monetary policy on commodity markets and the potential change in the relation due to the zero interest rate environment. Therefore, we estimate a structural vector autoregressive (SVAR) model[2] for the United States, similar to e.g. Anzuini et al. (2013), and Hammoudeh et al. (2015), using macroeconomic variables, monetary policy

[2] The SVAR model is preferred over the Bayesian vector autoregressive model, because it relies on theoretically motivated identification schemes rather than requiring additional prior information that might not align with the data or theoretical framework.

proxies as well as a commodity index, capturing the period from January 1990 to December 2019 representing one super cycle of commodity prices.[3]

Most of the previous studies on the impact of monetary policy on commodity markets reflect the monetary policy actions by the Federal Funds Rate, see e.g. Anzuini et al. (2013), Hammoudeh et al. (2015), Lombardi et al. (2012) and Nicola et al. (2016). However, the Federal Reserve continuously lowered interest rates to near zero at the end of 2008 and implemented unconventional monetary policy actions to further support the U.S. economy. Therefore, interest rates do not fully cover the monetary policy after the financial crisis. In this context, Wu and Xia (2016) propose a shadow federal funds rate based on a shadow rate term structure model, whereby the shadow rate reflects the effective Federal Funds rate before the interest rates reached their zero lower bound, but also "exhibits similar dynamic correlations with macro variables of interest in the period since July 2009 as the federal funds rate did in data prior to the Great Recession." In particular, the shadow rate represents conventional monetary policy until 2008, while it reflects unconventional monetary policy in the post-crisis period. Therefore, we use this shadow rate (SR) of Wu and Xia (2016) instead of the Federal Funds Rate, following the studies of Eksi and Tas (2017) and Aliyev and Kocenda (2023), to investigate the impact of monetary policy on commodity prices, both before and after the financial crisis.

In this context, we reflect the nominal commodity prices by the Bloomberg Commodity (BCOM) index in U.S. dollar, representing energy commodities, grains, agriculturals, livestock, as well as precious and industrial metals, drawn from Bloomberg Index Services Limited (2022).[4] Moreover, we disentangle whether the impact of monetary policy differs for different commodity classes. Therefore, we substitute in a further analysis the overall BCOM index with the corresponding subindices in U.S. dollar for the energy, agricultural, precious metal as well as industrial metal commodities.[5]

To account for the economy, we consider further macroeconomic variables. Hereby, we include the U.S. industrial production (IP), measuring the U.S. real output for all facilities including manufacturing, mining, electric, and gas utilities, drawn from Board of Governors of the Federal Reserve System (U.S.) (2021), as proxy for the economic activity in the United States. Moreover, we add the inflation rate, measured by the U.S. consumer price index (CPI), representing all items for the United States, drawn from Organization for Economic Co-operation and Development (OECD) (2021). As most of the commodities are traded in U.S. dollar, but only a small portion is actually mined in the United States, we also account for the exchange rate by considering the U.S. dollar index (FX), drawn from New York Stock Exchange (2022), measuring the value of the U.S. dollar relative to a basket of six foreign currencies.[6]

Using these factors as endogenous variables $\mathbf{y}_t = (IP_t, CPI_t, SR_t, FX_t, BCOM_t)'$, we model the economy by the following structural VAR(P) model with P lags[7]:

$$\mathbf{A}\mathbf{y}_t = \mathbf{H}_1\mathbf{y}_{t-1} + \cdots + \mathbf{H}_P\mathbf{y}_{t-P} + \boldsymbol{\upsilon}_t, \tag{1}$$

where $\mathbf{H}_p$ are the matrices of lagged coefficients for $p = 1, \dots, P$.[8] Further, we assume the residuals $\boldsymbol{\upsilon}_t$ follow a white noise process with $\mathbb{E}[\boldsymbol{\upsilon}_t] = 0$ and covariance matrix $\mathbb{E}[\boldsymbol{\upsilon}_t\boldsymbol{\upsilon}_t{\prime}] = \mathbf{V}$.

In accordance with Hammoudeh et al. (2015), we use a recursive identification scheme. Hereby, we separate the variables into three groups $\mathbf{y}_t = \left(\mathbf{y}'_{1,t}, \mathbf{y}'_{2,t}, \mathbf{y}'_{3,t}\right)'$. The n_3 variables of the last subset $\mathbf{y}_{3,t} = (FX_t, BCOM_t)'$ are contemporaneously affected by shocks in the monetary policy variable $\mathbf{y}_{2,t} = (SR_t)$, while the n_1 variables of the first subset $\mathbf{y}_{1,t} = (IP_t, CPI_t)'$ only react with a lag. In particular, we assume the policy variable responds immediately to the set of macroeconomic variables, the industrial production as well as the inflation rate, whereas the monetary policy has only a lagged and no contemporaneous effect on these macroeconomic variables. In contrast, the exchange rate is immediately affected by changes in the monetary policy. Moreover, the commodity price index responds contemporaneously to macroeconomic as well as monetary policy shocks, but only affects these variables with a lag. Overall, the restrictions of the system can be summarized as follows: $\mathbf{A} = \begin{pmatrix} \boldsymbol{\alpha}_{11} & \mathbf{0}_{n_1\times n_2} & \mathbf{0}_{n_1\times n_3} \\ \boldsymbol{\alpha}_{21} & \boldsymbol{\alpha}_{22} & \mathbf{0}_{n2\times n_3} \\ \boldsymbol{\alpha}_{31} & \boldsymbol{\alpha}_{32} & \boldsymbol{\alpha}_{33} \end{pmatrix}$. With this identification scheme, we analyze the effects of shocks to the variables by one standard deviation via impulse response functions, based on the 68 % significance level obtained by bootstrapping, following Anzuini et al. (2013) and Hammoudeh et al. (2015).

As a reaction to the financial crisis, the FED lowered the federal funds rate to near zero in the year 2009, while simultaneously expanding unconventional monetary policy actions, such as forward guidance and asset purchases. Hereby, the question arises whether the zero interest rate policy led to significant changes in the dependencies between monetary policy and commodity prices.

Therefore, we apply a structural change test from the empirical fluctuation process framework, using moving sums of residuals, see Zeileis et al. (2002), on the individual linear regressions of the VAR model and identify structural breaks in the system, see Table 1. In

[3] We exclude the recent years to ensure the results are not biased by the COVID-19 pandemic.

[4] To verify the results and to ensure that the results did not depend on the commodity index used, we also performed the analyses on the Thomson Reuters/Corecommodity CRB Total Return (CRB) index, including energy commodities, agriculturals, livestock, as well as precious and industrial metals, and S&P GSCI index, including energy commodities, agriculturals, livestock, as well as precious and industrial metals. Hereby, the results are comparable. While in some cases the magnitude of the effects differs, all statements remain the same.

[5] The analysis of the industrial metal index is restricted to the period January 1991 to December 2019, due to data limitations.

[6] Descriptive statistics of the seasonally adjusted return data are presented in Table 2 of Appendix A.

[7] To ensure the VAR models do not suffer from autocorrelation, we set the lag length for each VAR model in this study individually. Hereby, we increase the lag length recursively until the Durbin Watson test suggests the model does not exhibit any autocorrelation at the 5 % significance level. In particular, the final models include up to three lags.

[8] Since all variables in the model, except the CPI, were non-stationary at first, based on an Augmented Dickey Fuller test at the 5 % level, we calculate log-returns for all variables. Further, we seasonally adjust the resulting variables and proceed with the original, unadjusted variable names.

Table 1
Structural break test results.

	IP	CPI	SR	FX	BCOM
Statistic	1.33	1.51	1.69	1.46	1.54
p-value	0.17	0.06	0.01	0.09	0.05
Breakpoint	2008/09	1998/12	1996/08	2008/12	2009/02

This table shows the test statistic and the corresponding p-values of the structural break test of Zeileis et al. (2002), as well as the date of the breakpoint, applied to the individual linear regression models within the VAR of the entire sample.

case of the inflation rate, the shadow rate of Wu and Xia (2016), the exchange rate and the commodity index, the structural break test identifies a significant change in the system at the 10 % level, indicating the variables' dependency structure changed significantly. Hereby, the additional test based on the F-test framework of Zeileis et al. (2002) assigns the relations in the commodity markets observe a breakpoint in February 2009, within the financial crisis. This suggests the financial crisis and the following zero interest rate environment, changed the impact of the economy on commodity prices.

In this context, the question arises as to how the zero interest environment changed the relation between monetary policy and commodity markets. Therefore, we disentangle the monetary policy effects on commodity prices before and during the ZLB period. Hereby, we split our sample, in line with several studies in the economic literature, see for example Aliyev and Kocenda (2023), Amatov and Dorfman (2017), Eksi and Tas (2017), Gomis-Porqueras et al. (2023), and Raza et al. (2022). The first sub-sample covers the period until the structural break at the end of 2008, representing the period of conventional monetary policy, where the shadow rate actually represents the effective federal funds rate, while the second sub-sample covers the period of zero interest rate policy combined with increased unconventional monetary policy actions. Subsequently, we compare the effect of a monetary policy shock on commodity markets in the first and second sub-period. Hereby, a shock to the shadow rate in the first sub-period represents a shock to the interest rates, whereas in the second sub-period the shock represents a change in the unconventional monetary policy.

4. Empirical results

In the following, we examine whether and how the impact of the economy on commodity prices changed after the financial crisis. Hereby, we investigate impulse response functions with 68 % confidence intervals obtained by bootstrapping to analyze the impact of a one standard error shock in one variable on the other variables, following Anzuini et al. (2013) and Hammoudeh et al. (2015). First, we briefly discuss the effects of macroeconomic variables in Section 4.1. Second, we investigate the impact of monetary policy on commodity prices before and after the financial crisis in Section 4.2 and disentangle the reactions of several commodity classes in Section 4.3.

4.1. Impact of economic conditions on commodity prices

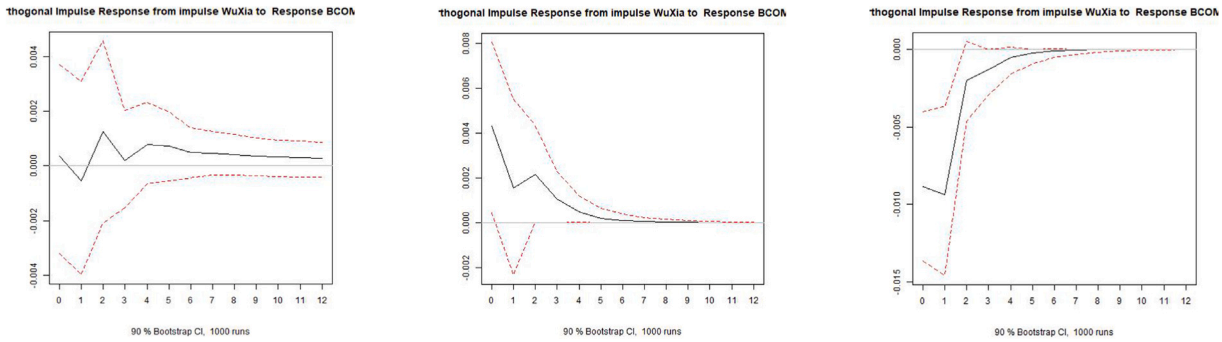
First of all, we briefly discuss the reaction of commodity prices in response to shocks to the economy. Overall, the results reveal commodity prices generally react to macroeconomic innovations in the United States, confirming the sensitivity of commodity prices to macroeconomic shocks, as found by Aliyev and Kocenda (2023) for the euro area economies. While the impact of the economic activity on commodity prices changed, the inflation rate as well as the exchange rate affect commodity prices to a similar extent in the pre- and post-crisis period, see Appendix B for the graphical illustration.

In particular, the results indicate that a positive shock to the economic activity, reflected by the U.S. industrial production, causes rising commodity prices in the first sub-period, whereas the commodity markets do not react significantly in the post-crisis period, see Fig. 4. Our results align with previous findings in the literature, such as those of Akram (2009) and Lombardi et al. (2012), demonstrating that economic activity significantly influenced commodity prices during the period preceding the financial crisis.

Since Svensson (2008) highlights that the impact of monetary policy on commodity prices is shock-dependent, we extend our analysis following Akram (2009) by examining the effect of economic activity on monetary policy, as represented by the shadow rate of Wu and Xia (2016), illustrated in Fig. 7. Specifically, an increase in U.S. industrial production leads to significantly higher shadow rates in the first sub-period, indicating a positive correlation between interest rates and commodity prices. This finding suggests that economic activity drives similar patterns in both monetary policy and commodity markets, supporting the argument of Svensson (2008) and the empirical results of Akram (2009). In contrast, the response of the shadow rate during the second sub-period, reflecting unconventional monetary policy actions, is insignificant, highlighting the system's transformation due to the ZLB.

Furthermore, the inflation rate affects the commodity prices in both samples to a similar extent. Hereby, a positive shock to the U.S. consumer price index leads to significantly rising commodity prices, see Fig. 5, underlining previous findings in the literature, see Apergis et al. (2014) and Kagraoka (2016).[9] Moreover, a shock to the exchange rate causes decreasing prices in both sub-periods, indicating an appreciation of the U.S. dollar causes decreasing prices, in line with Akram (2009) among others.

[9] For further information, we also investigate how the inflation rate affects the shadow rate. The shadow rate significantly increases in response to an inflation shock in the first sub-period. Hereby, we observe a long-lasting change, whereas the shadow rate is rather unaffected in the ZLB period. As the inflation rate still affects commodity prices, but not the shadow rate, we conclude the relation between prices and monetary policy caused by the inflation has changed.



(a) From 1996 until 2019 (b) From 1996 until 2008 (c) From 2009 until 2019

Fig. 1. Response of BCOM index to a one-sd shock in the shadow rate of Wu and Xia (2016).

To summarize, the significant structural break during the financial crisis in the economic system slightly changed the impact of the economic activity on commodity markets, whereas the influence of the inflation rate as well as the exchange rate on commodity markets remains unaffected. Hereby, the question arises whether and how the effects of the monetary policy on commodity prices changed.

4.2. Impact of monetary policy on commodity prices

Focusing on the relation between monetary policy and commodity prices, we observe that the impact significantly differs between the period prior to and posterior to the financial crisis, indicating that the zero interest rate environment affected their relation. While a contractionary monetary policy,[10] represented by a positive shock to the shadow rate of Wu and Xia (2016), leads to increasing commodity prices in the first sub-period, the prices decrease in the posterior crisis period, see Fig. 1. As the overall sample represents the period of higher interest rates as well as the period of unconventional monetary policy, the effects are partly diminished, indicating that a time-invariant analysis over the entire sample period does not reflect the underlying relations. Therefore, we focus on the sub-sample results in the following.

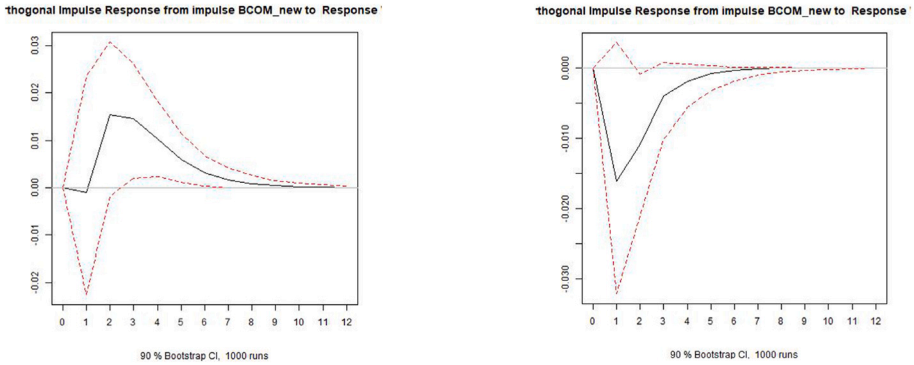
In the first sub-period, covering the period prior to the financial crisis, the shadow rate corresponds to the effective Federal Funds rate. Our analysis reveals that a contractionary monetary policy shock, indicated by an increase in the shadow rate, leads to a significant rise in commodity prices. This result contradicts the hypothesis of Frankel (2008) regarding an inverse relationship between interest rates and prices but aligns with the assertions of Svensson (2008), as prices, interest rates, and economic activity exhibit common patterns, as shown in Fig. 7.

Moreover, our findings align with Hammoudeh et al. (2015) who detect significantly positive reactions of metal prices in response to a positive shock in the interest rate. Hereby, Hammoudeh et al. (2015) theoretically explain the positive correlation by the reverse causality, as interest rates change in response to a "heating" economy. In particular, central banks react to a high inflation, probably caused by high commodity prices, via the interest rate, which is why prices may run ahead of the interest rate. While the interest rate changes might mitigate the rise in commodity prices, the continuously strong demand still pushes commodity prices upwards, leading to the observed common pattern, see also Baffes and Savescu (2014) for longer term interest rates.

In the following, we aim to verify the theoretical arguments of Hammoudeh et al. (2015) empirically. Hereby, we examine whether the commodity markets affect the monetary policy, reflected by the shadow rate of Wu and Xia (2016). As Hammoudeh et al. (2015) argue, the central banks react to higher inflation, caused by higher prices, we also consider the impact of prices on inflation as well as of inflation on interest rates. First of all, we investigate how a positive shock in the commodity markets affects the shadow rate, see Fig. 2. The impulse response analysis of the first sub-period reveals a positive shock to the commodity prices leads to a lagged increase in the shadow rate, indicating interest rates rise in the period before the financial crisis in response to higher prices. Hereby, the shadow rate remains at a high level in the mid- to long-term, underlining that higher prices cause a long-lasting reaction. While Fig. 3 indicates a commodity price shock causes a higher inflation rate in the short- to mid-term, Fig. 8 underlines that monetary policy responds with a lag to increasing inflation, as a shock to the inflation rate leads to a long-lasting increase in the shadow rate. Overall, our results reveal central banks react by monetary policy actions to changes in the commodity markets, possibly leading to the observed positive correlation, confirming the theoretical arguments and empirical evidence of Hammoudeh et al. (2015).

The objective of this study is to examine whether and how the zero interest rate environment changed the impact of monetary policy on commodity prices. Therefore, we apply the same analysis to the second sub-sample, covering the ZLB period, and investigate the differences. The impulse response analysis reveals that a contractionary unconventional monetary policy shock, reflected by a positive shock to the shadow rate, causes decreasing commodity prices in the short-term in the second sub-period, indicating that

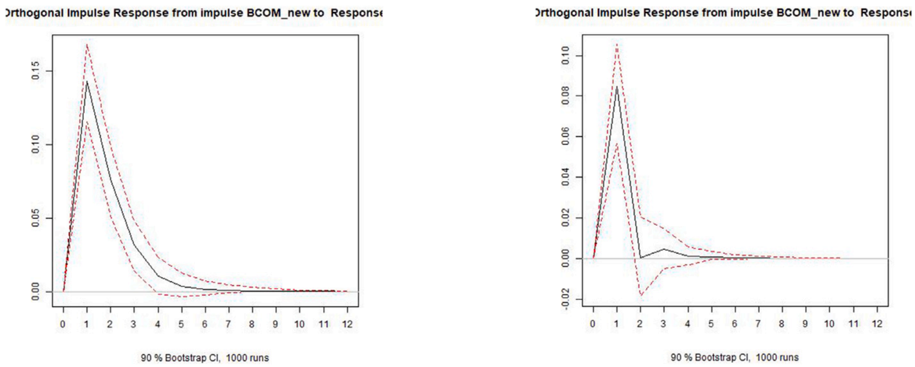
[10] Due to the symmetric responses in the VAR methodology, we consider a positive shock to the shadow rate, reflecting a contractionary monetary policy. However, the effects of expansionary monetary policy can easily be inferred.



(a) From 1996 until 2008

(b) From 2009 until 2019

Fig. 2. Response of the shadow rate of Wu and Xia (2016) to a one-sd shock in the BCOM index.



(a) From 1996 until 2008

(b) From 2009 until 2019

Fig. 3. Response of U.S. consumer price index (CPI) to a one-sd shock in the BCOM index.

the direction of the impact changed. Monetary policy reacts to higher prices and inflation in the first sub-period, whereas neither commodity prices nor the inflation rate affect unconventional monetary policy actions in the ZLB period, see Figs. 2 and 8. While a positive correlation between rates and prices is observed in the pre-crisis period, driven by the common influence of economic activity and the response to inflation, the post-crisis period sees a shift. The effects of higher capital costs for holding commodities and reduced demand for commodities as alternative assets predominate, empirically supporting the arguments of Frankel (2008). This shift leads to a negative response of commodity prices to a contractionary unconventional monetary policy shock. Overall, our findings for the second sub-period align with several empirical studies on the relationship between interest rates and commodity prices, including those by Akram (2009), Anzuini et al. (2013), Apergis et al. (2014), and Byrne et al. (2013).

However, our results suggest that the impact of monetary policy on commodity prices shifted during the ZLB period, highlighting the mixed evidence in the literature and the contradictory theoretical effects that characterize this relationship. Although Frankel (2008) confirms his theory of an inverse relation in the empirical analysis of commodity prices in the period from 1950 to 1979 (1950 to 2005), the observed relation between interest rates and commodity prices is positive in the period from 1980 to 2005 (1976 to 2005), indicating the direction of the correlation depends on the considered sample period. Further, the studies of Akram (2009), Anzuini et al. (2013), Apergis et al. (2014), and Byrne et al. (2013) exhibit an inverse relation in the period from 1989 to 2007, 1970 to 2008, 1981 to 2010, and 1900 to 2008, respectively, whereas the more recent studies of Siami-Namini (2021) and Zhu et al. (2015) do not detect any significant effect of interest rate changes on commodity prices in the period from 1992 to 2017 and 2006 to 2013. Aliyev and Kocenda (2023) even reveal a positive impact of European monetary policy on food and metal prices, and Papadamou and Sogiakas (2018) confirm this finding for precious metal prices.

Overall, our sub-sample analysis reveals that the impact of commodity markets on monetary policy changed due to the ZLB period. While a contractionary conventional monetary policy shock caused rising prices in the period before the financial crisis, an unconventional monetary policy shock led to decreasing prices in the ZLB period.

4.3. Results for several commodity classes

Our analysis reveals the relation between monetary policy and commodity markets, reflected by the general BCOM index, changed due to the zero interest rate environment. In the following, we examine whether this finding remains valid for several commodity classes. Therefore, we replace the BCOM index with several sub-indices, covering either the agricultural or energy commodities, precious or industrial metals, and re-estimate for each commodity class the structural VAR model. Overall, the results differ between the commodity classes, see Appendix D for the graphical illustration. While all commodity classes significantly react to unconventional monetary policy shocks, only the industrial metals exhibit strong positive correlations with interest rates in the first sub-period.

In the pre-crisis period, a positive shock to the shadow rate, reflecting increasing interest rates, causes slightly rising energy prices, while agricultural commodity prices are barely affected by conventional monetary policy. Hereby, neither agricultural nor energy price shocks cause a reaction in the shadow rate, since the FED bases its decisions on the core inflation rate, which excludes the volatile food and energy commodities to provide an indicator for the long-term inflation. Moreover, precious metal prices and conventional monetary policy seem to be unrelated. As the precious metal index is mainly determined by gold, which is mostly used for investments and jewelry rather than for industrial products and is oftentimes even regarded as a safe haven asset, the prices are disconnected from monetary policy actions.

In contrast, the industrial metal prices are highly correlated with interest rates. Hereby, we observe that a positive shock to the shadow rate causes a significant, long-lasting increase in the industrial metal prices. Moreover, an increase in the metal prices leads to a lagged significant, long-lasting rise in the interest rate, reflected by the positive reaction of the shadow rate. While industrial metal prices influence the inflation rate, metals are also highly related to the economy, which is why their prices exhibit a concurrent behavior with the economic activity and interest rates. Overall, the strong positive correlation between industrial metal prices and conventional monetary policy in the first sub-period probably explains the positive reaction of the overall commodity index to the conventional monetary policy shock.

However, the impact of monetary policy on commodity prices changed when the interest rate reached its zero lower bound. In the post-crisis period, energy, agricultural and precious metal prices significantly decreased in response to shocks in the shadow rate, indicating the impact of unconventional monetary policy on commodity markets is more pronounced than that of conventional monetary policy. Our findings align with those of Gomis-Porqueras et al. (2023), confirming that precious metal prices function as an inflation hedge. Contractionary unconventional monetary policy shocks lower future inflation expectations, subsequently reducing the demand for precious metals in their role as an inflation hedge. Moreover, industrial metal prices decrease in response to a contractionary unconventional monetary policy, implying even the direction of the impact of monetary policy changed. While central banks rise interest rates in response to a “heating” economy probably leading to synchronous patterns between industrial metal prices and interest rates in the first sub-period, see Hammoudeh et al. (2015), industrial metal prices do not affect unconventional monetary policy in the post-crisis period, underlining that the relation between monetary policy and commodity markets changed.

Overall, this brief analysis detects that the interrelation between monetary policy and commodity prices depends on the commodity class. While all commodities are affected by unconventional monetary policy actions, only industrial metals observe strong positive interdependencies with interest rates in the period prior to the financial crisis. Hereby, the results regarding the different commodity classes once again emphasize the importance of diverse mechanisms of action in different time periods.

5. Conclusion

In response to the financial crisis, the Federal Reserve (FED) continuously lowered interest rates to near zero in order to strengthen the U.S. economy. As a result of the zero interest rate environment posterior to the financial crisis, the FED implemented large-scale asset purchase programs and forward guidance, to maintain its support for the economy. However, this change in the monetary policy significantly affected the economic system, see for example Eksi and Tas (2017) and Keating et al. (2019).

In this context, the question arises whether and how the zero interest rate policy changed the impact of monetary policy on commodity markets, since previous studies reveal that interest rates are an important determinant of prices, see for example Akram (2009) and Frankel (2008). Therefore, we disentangle the different effects of monetary policy on commodity prices, in the period of conventional monetary policy as well as in the ZLB period.

Overall, the impact of monetary policy on commodity markets significantly changed. While synchronous patterns between interest rates and commodity prices are evident in the pre-crisis period, our results reveal an inverse relationship during the second sub-period under unconventional monetary policy. These findings align with those of Aliyev and Kocenda (2023) for Europe, emphasizing that the zero-interest rate policy significantly altered this relationship not only in the United States but internationally as well. Our analysis indicates the concurrent behavior in the first sub-period is mainly driven by the reaction of central banks to high inflation rates, in line with the arguments of Hammoudeh et al. (2015). In particular, interest rates are increased in response to high inflation, caused by high prices. Hereby, our results indicate agricultural and energy commodities are affected by the monetary policy actions, but do not affect the decisions of central banks, whereas industrial metal prices and interest rates exhibit strong positive correlations in the period prior to the financial crisis, in line with Hammoudeh et al. (2015). In contrast, a contractionary unconventional monetary policy in the period of zero interest rates, causes decreasing prices in all commodity classes considered, underlining the arguments of Frankel (2008).

Overall, the relationship between monetary policy and commodity prices is evidently context-dependent and varies across different periods in the United States. This variability suggests that Frankel’s theory, while foundational, cannot fully explain the nuances of this correlation, particularly under changing economic conditions.

The findings of this study are particularly valuable for regulators, as they demonstrate that the impact of monetary policy on commodity markets depends significantly on the specific channel of policy employed. Hereby, different commodity classes exhibit distinct responses, underscoring the need for regulators to carefully align their choice of monetary tools with their intended objectives. Understanding these dynamics is essential for designing effective policies that minimize unintended consequences and support market stability.

Additionally, this study provides critical insights for investors, revealing that the heterogeneous responses of commodity classes to various monetary policy channels have direct implications for portfolio diversification. Recognizing these differences allows investors to make more informed decisions, optimizing risk management strategies and improving potential returns.

For future research, a compelling question is how commodity markets will respond to the recent increases in interest rates. A time-varying analysis would be a feasible approach to address this. Moreover, it would also be interesting to examine whether the high inflation observed in recent years has influenced the relationship between monetary policy and commodity markets, as our findings revealed that changes due to crises significantly altered the impact of monetary policy on commodity markets.

CRediT authorship contribution statement

Amelie Schischke: Writing – original draft, Formal analysis, Methodology, Data curation. **Andreas Rathgeber:** Writing – review & editing, Funding acquisition, Supervision, Conceptualization.

Funding sources and declarations of interest

This work was supported by the German Federal Ministry for Economic Affairs and Energy [grant number 03ET4065B]. The above listed project analyzes the material demands for the transition of the German Energy System to CO_2 neutrality. However, this study is not related to the research project, nor was it or will it be reviewed by any government authorities prior to submission and/or publication. Therefore, we state no Conflict of Interest.

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Appendix A. Data

See Tables 2 and 3.

Table 2
Descriptive statistics of the covariates.

	Min.	5 % Q.	Median	Mean	95 % Q.	Max.	St.Dev.	Skew.	Kurt.	Obs.
IP	−0.05	−0.01	0.00	0.00	0.01	0.02	0.01	−0.44	1.71	360
CPI	−1.80	−0.37	0.01	0.00	0.38	0.97	0.27	−0.90	6.66	360
SR	−5.54	−4.30	0.04	0.02	3.99	5.62	2.75	−0.11	−1.06	360
FX	−0.07	−0.04	0.00	−0.00	0.04	0.09	0.02	0.28	0.82	360
BCOM	−0.23	−0.07	0.00	−0.00	0.07	0.13	0.04	−0.58	2.99	360
BCOM energy	−0.26	−0.14	0.00	0.00	0.13	0.32	0.08	0.08	1.15	360
BCOM agriculturals	−0.19	−0.08	−0.00	−0.00	0.08	0.15	0.05	−0.04	1.42	360
BCOM precious metals	−0.20	−0.08	−0.00	−0.00	0.08	0.14	0.05	−0.17	1.05	360
BCOM industrial metals	−0.31	−0.08	−0.00	−0.00	0.10	0.19	0.06	−0.32	2.41	348

This table presents the minimum (Min.), five percent quantile (5 % Q.), the median (Median) and mean (Mean), the ninety-five percent quantile (95 % Q.), the maximum value (Max.), as well as the standard deviation (St.Dev.), the skewness (Skew.), the excess kurtosis (Kurt.), and the number of observations (Obs.) of the covariates U.S. industrial production index (IP), the U.S. consumer price index (CPI), the BCOM index (BCOM), the BCOM energy index (BCOM Energy), the BCOM Agriculturals index (BCOM Agriculturals), the BCOM Precious Metals index (BCOM Precious Metals), the BCOM Industrial Metals index (BCOM Industrial Metals), the U.S. dollar index (FX), and the shadow federal funds rate of WuXia (SR). Hereby, the descriptive statistics of the starred covariates are based on the values from 2009 to the end of 2019, as they are included only in the expanded model within sub-sample two of our analysis, whereas the remaining values are based on the period from 1990 to 2019.

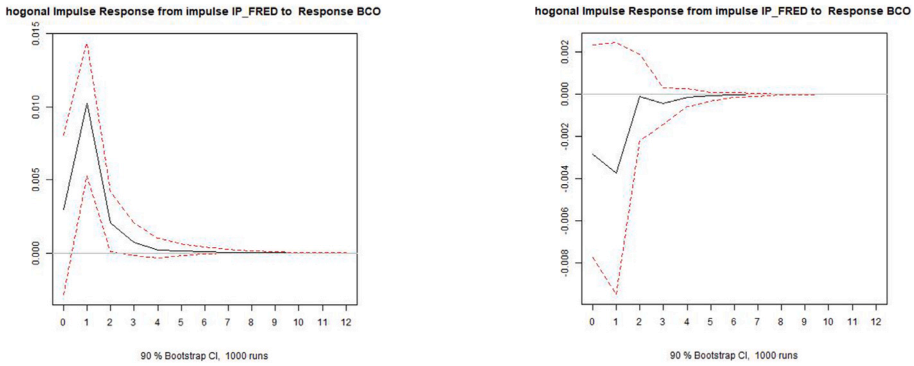
Table 3
Data description and sources.

Covariate	Name	Source	Available from
IP	U.S. Industrial Production	Board of Governors of the Federal Reserve System (U.S.) (2022)	01/1919
CPI	Consumer Price Index: Total, All Items for the United States	Organization for Economic Co-operation and Development (2022)	01/1960
SR	Wu-Xia Shadow Federal Funds Rate	Federal Reserve Bank of Atlanta (2022)	01/1990
BCOM	Bloomberg Commodity Index	Bloomberg Index Services Limited (2022)	01/1990
BCOM agriculturals	Bloomberg Agriculture Subindex	Bloomberg Index Services Limited (2022)	01/1990
BCOM energy	Bloomberg Energy Subindex	Bloomberg Index Services Limited (2022)	01/1990
BCOM precious metals	Bloomberg Precious Metals Subindex	Bloomberg Index Services Limited (2022)	01/1990
BCOM industrial metals	Bloomberg Industrial Metals Subindex	Bloomberg Index Services Limited (2022)	01/1991
FX	U.S. Dollar Index	ICE Futures U.S. (2022)	12/1970

This table displays the names, descriptions, sources, and dates of availability for each of the variables included in this study.

Appendix B. Impact of economic conditions on commodity prices

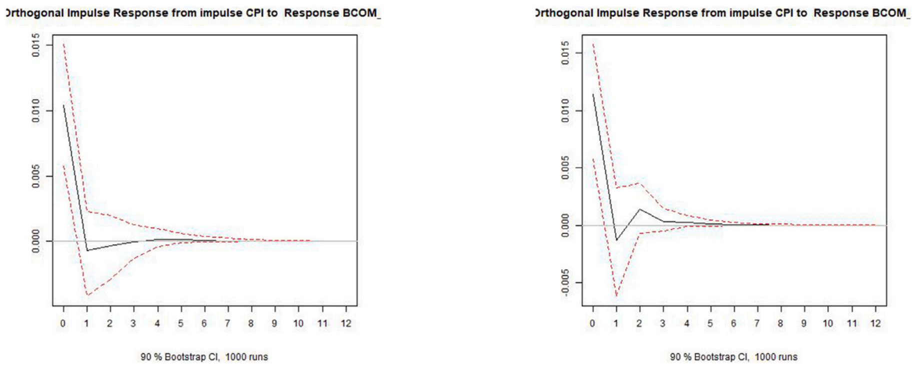
See Figs. 4–6.



(a) From 1996 until 2008

(b) From 2009 until 2019

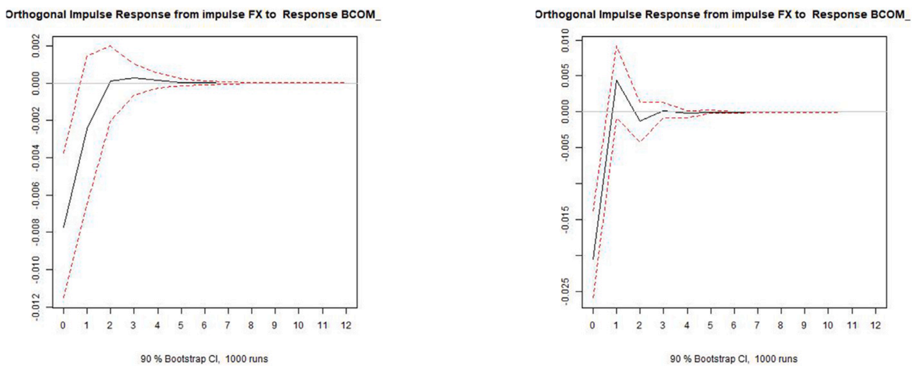
Fig. 4. Response of BCOM index to a one-sd shock in the U.S. industrial production (IP).



(a) From 1996 until 2008

(b) From 2009 until 2019

Fig. 5. Response of BCOM index to a one-sd shock in the U.S. consumer price index (CPI).



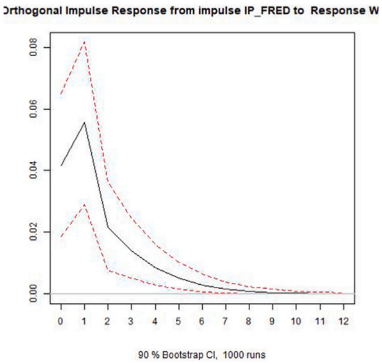
(a) From 1996 until 2008

(b) From 2009 until 2019

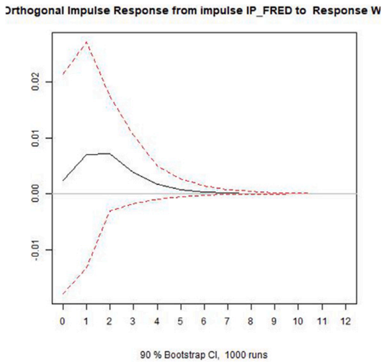
Fig. 6. Response of BCOM index to a one-sd shock in the U.S. dollar index (FX).

Appendix C. Impact of economic conditions on interest rates

See Figs. 7–9.

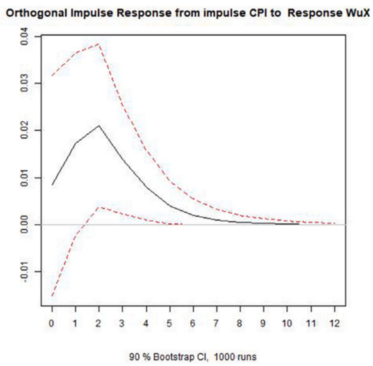


(a) From 1996 until 2008

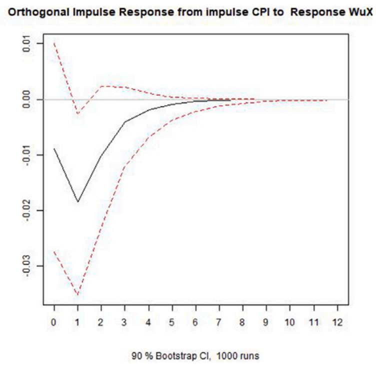


(b) From 2009 until 2019

Fig. 7. Response of the shadow rate of Wu and Xia (2016) to a one-sd shock in the U.S. industrial production (IP).

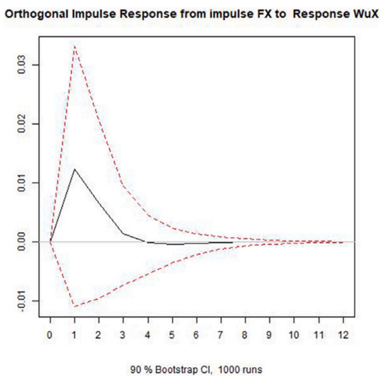


(a) From 1996 until 2008

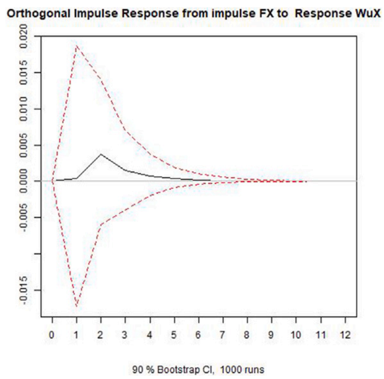


(b) From 2009 until 2019

Fig. 8. Response of the shadow rate of Wu and Xia (2016) to a one-sd shock in the U.S. consumer price index (CPI).



(a) From 1996 until 2008



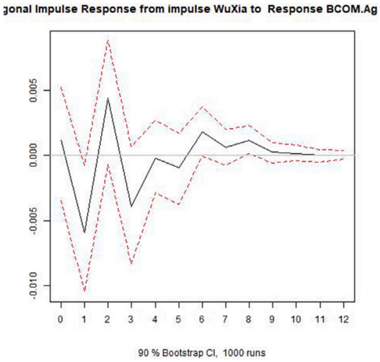
(b) From 2009 until 2019

Fig. 9. Response of the shadow rate of Wu and Xia (2016) to a one-sd shock in the U.S. dollar index (FX).

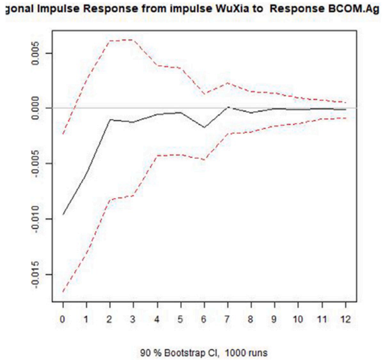
Appendix D. Results for several commodity classes

D.1. Results for the BCOM agriculturals index

See Figs. 10 and 11.

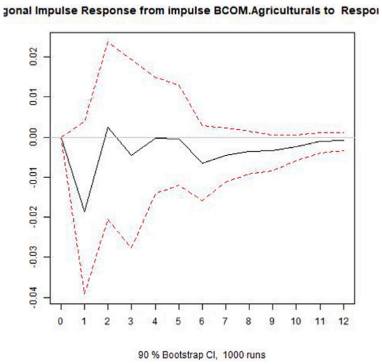


(a) From 1996 until 2008

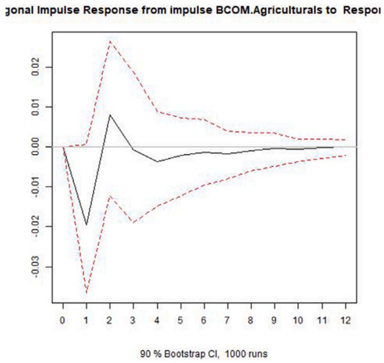


(b) From 2009 until 2019

Fig. 10. Response of BCOM Agriculturals index to a one-sd shock in the shadow rate of Wu and Xia (2016).



(a) From 1996 until 2008

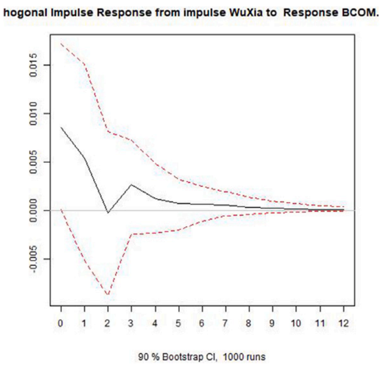


(b) From 2009 until 2019

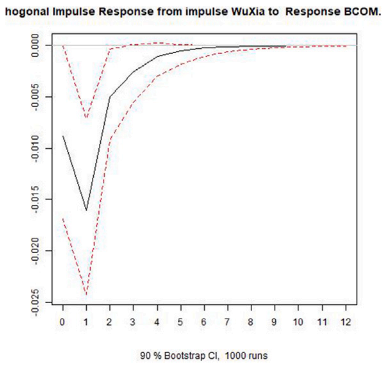
Fig. 11. Response of the shadow rate of Wu and Xia (2016) to a one-sd shock in the BCOM Agriculturals index.

D.2. Results for the BCOM energy index

See Figs. 12 and 13.

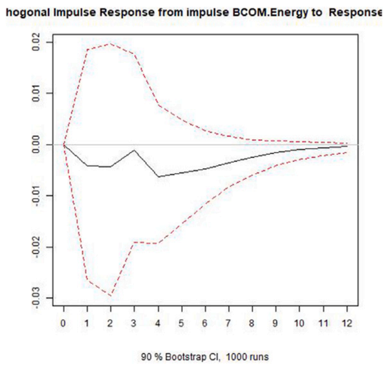


(a) From 1996 until 2008

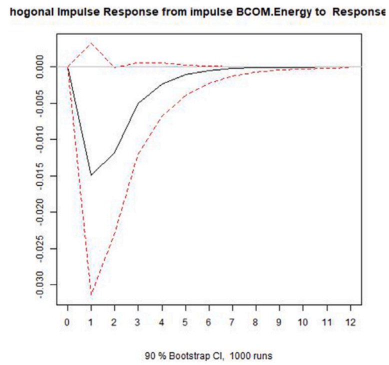


(b) From 2009 until 2019

Fig. 12. Response of BCOM Energy index to a one-sd shock in the shadow rate of Wu and Xia (2016).



(a) From 1996 until 2008

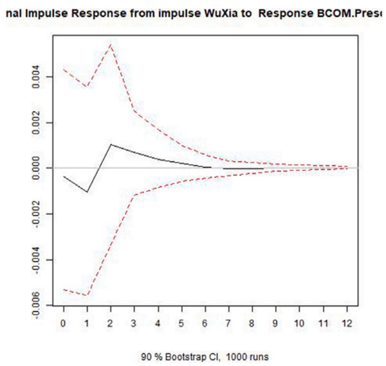


(b) From 2009 until 2019

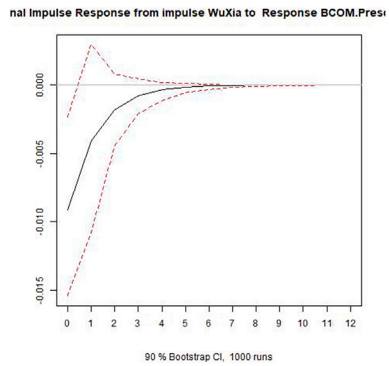
Fig. 13. Response of the shadow rate of Wu and Xia (2016) to a one-sd shock in the BCOM Energy index.

D.3. Results for the BCOM precious metals index

See Figs. 14 and 15.

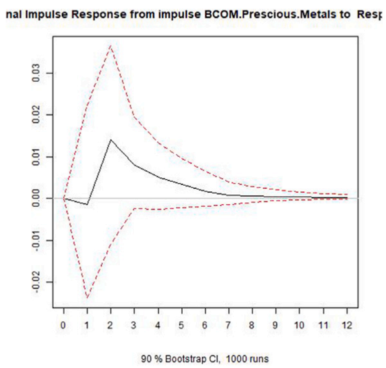


(a) From 1996 until 2008

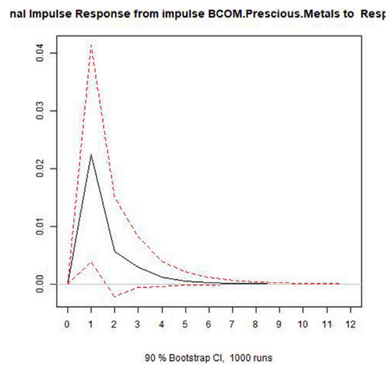


(b) From 2009 until 2019

Fig. 14. Response of BCOM Prescious Metals index to a one-sd shock in the shadow rate of Wu and Xia (2016).



(a) From 1996 until 2008

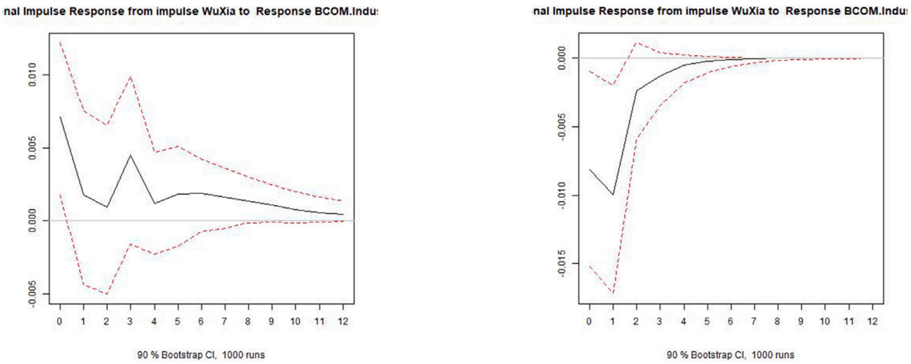


(b) From 2009 until 2019

Fig. 15. Response of the shadow rate of Wu and Xia (2016) to a one-sd shock in the BCOM Precious Metal index.

D.4. Results for the BCOM industrial metals index

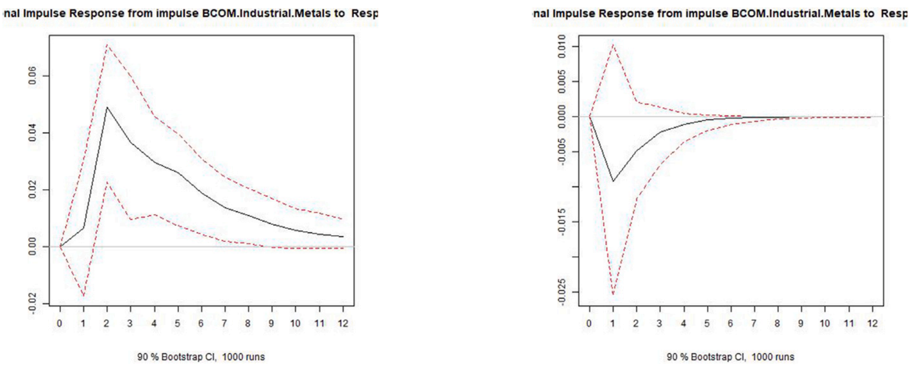
See Figs. 16 and 17.



(a) From 1996 until 2008

(b) From 2009 until 2019

Fig. 16. Response of BCOM Industrial Metals index to a one-sd shock in the shadow rate of Wu and Xia (2016).



(a) From 1996 until 2008

(b) From 2009 until 2019

Fig. 17. Response of the shadow rate of Wu and Xia (2016) to a one-sd shock in the BCOM Industrial Metals index.

Appendix E. Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jimonfin.2025.103416.

References

Ahumada, H., Cornejo, M., 2014. Explaining commodity prices by a cointegrated time series-cross section model. Empir. Econ. 48, 1667–1690.

Akram, Q.F., 2009. Commodity prices, interest rates and the dollar. Energy Econ. 31 (6), 838–851.

Aliyev, S., Kocenda, E., 2023. ECB monetary policy and commodity prices. Rev. Int. Econ. 31 (1), 274–304.

Amatov, A., Dorfman, J.H., 2017. The effects on commodity prices of extraordinary monetary policy. J. Agric. Appl. Econ. 49 (1), 83–96.

Anzuini, A., Lombardi, M.J., Pagano, P., 2013. The impact of monetary policy shocks on commodity prices. Int. J. Cent. Bank. 9 (3), 125–150.

Apergis, N., Chatziantoniou, I., Cooray, A., 2020. Monetary policy and commodity markets: unconventional versus conventional impact and the role of economic uncertainty. Int. Rev. Financ. Anal. 71.

Apergis, N., Christou, C., Payne, J.E., 2014. Precious metal markets, stock markets and the macroeconomic environment: a FAVAR model approach. Appl. Financ. Econ. 24 (10), 691–703.

Arias, J.E., Caldara, D., Rubio-Ramírez, J.F., 2019. The systematic component of monetary policy in SVARS: an agnostic identification procedure. J. Monet. Econ. 101, 1–13.

Baffes, J., Dennis, A., 2013. Long-term Drivers of Food Prices.

Baffes, J., Savescu, C., 2014. Monetary conditions and metal prices. Appl. Econ. Lett. 21 (7), 447–452.

Bernanke, B.S., Gertler, M., 2000. Monetary Policy and Asset Price Volatility.

Bernanke, B.S., Kuttner, K.N., 2005. What explains the stock market's reaction to Federal Reserve policy? J. Finance 60 (3), 1221–1257.

Bloomberg Index Services Limited, 2022. Bloomberg Commodity Index (BCOM). Data Retrieved from the Wall Street Journal. https://www.wsj.com/market-data/quotes/index/XX/BCOM/historical-prices.

Board of Governors of the Federal Reserve System (U.S.), 2021. Industrial Production: Total Index [INDPRO].

Board of Governors of the Federal Reserve System (U.S.), 2022. Industrial Production: Total Index (IPB50001N). https://fred.stlouisfed.org/series/IPB50001N.

Byrne, J.P., Fazio, G., Fiess, N., 2013. Primary commodity prices: co-movements, common factors and fundamentals. J. Dev. Econ. 101, 16–26.

Calvo, G., Exploding Commodity Prices, Lax Monetary Policy, and Sovereign Wealth Funds. VoxEU, 2008.

Eksi, O., Tas, B.K.O., 2017. Unconventional monetary policy and the stock market's reaction to Federal Reserve policy actions. N. Am. J. Econ. Finance 40, 136–147.
Federal Reserve Bank of Atlanta, Wu-Xia Shadow Federal Funds Rate, 2022, https://www.atlantafed.org/cqer/research/wu-xia-shadow-federal-funds-rate.aspx.
Frankel, J.A., 2008. The effect of monetary policy on real commodity prices. In: Asset Prices and Monetary Policy. National Bureau of Economic Research, Inc, pp. 291–333.
Frankel, J.A., Rose, A.K., 2010. Determinants of agricultural and mineral commodity prices. HKS Faculty Research Working Paper Series RWP10 (38), pp. 1–48.
Glick, R., Leduc, S., 2012. Central Bank announcements of asset purchases and the impact on global financial and commodity markets. J. Int. Money Finance 31 (8), 2078–2101.
Gomis-Porqueras, P., Rafiq, S., Yao, W., 2023. The impact of forward guidance and large-scale asset purchase programs on commodity markets. Stud. Nonlinear Dyn. Econom. 27(4), 519–551.
Gubler, M., Hertweck, M.S., 2013. Commodity price shocks and the business cycle: structural evidence for the U.S. J. Int. Money Finance 37, 324–352.
Haitsma, R., Unalmis, D., de Haan, J., 2016. The impact of the ecb's conventional and unconventional monetary policies on stock markets. J. Macroecon. 48, 101–116.
Hammoudeh, S., Nguyen, D.K., Sousa, R.M., 2015. US monetary policy and sectoral commodity prices. J. Int. Money Finance 57, 61–85.
ICE Futures U.S., 2022. US dollar Index DXY - Price Index (.DXY). data retrieved from Investing.com. https://de.investing.com/indices/usdollar-historical-data.
Kagraoka, Y., 2016. Common dynamic factors in driving commodity prices: implications of a generalized dynamic factor model. Econ. Model. 52, 609–617.
Keating, J.W., Kelly, L.J., Smith, L.A., Valcarcel, V.J., 2019. A model of monetary policy shocks for financial crises and normal conditions. J. Money Credit Bank. 51 (1), 227–259.
Kim, M., 2022. Transmission of U.S. monetary policy to commodity exporters and importers. Rev. Econ. Dyn. 43, 152–167.
Klotz, P., Lin, T.C., Hsu, S.-H., 2014. Global commodity prices, economic activity and monetary policy: the relevance of China. Resour. Policy 42, 1–9.
Lombardi, M.J., Osbat, C., Schnatz, B., 2012. Global commodity cycles and linkages: a FAVAR approach. Empir. Econ. 43 (2), 651–670.
New York Stock Exchange, 2022. US Dollar Index (DXY).
Nicola, F., Pace, P.D., Hernandez, M., 2016. Co-movement of major energy, agricultural, and food commodity price returns: a time-series assessment. Energy Econ. 57.
Organization for Economic Co-operation and Development, Consumer Price Index: Total All Items for the United States (CPALTT01USM657N), 2022, https://fred.stlouisfed.org/series/CPALTT01USM657N.
Organization for Economic Co-operation and Development (OECD), 2021. Consumer Price Index: Total All Items for the United States [cpaltt01usm657n].
Papadamou, S., Sogiakas, V., 2018. The informational content of unconventional monetary policy on precious metal markets. J. Forecast. 37 (1), 16–36.
Pfäuti, O., 2024. Inflation—who cares? Monetary policy in times of low attention. J. Money Credit Bank. 57 (5), 1211–1239.
Raza, S.A., Shah, N., Suleman, M.T., Mamun, M.A., 2022. A multifractal detrended fluctuation analysis of housing market: a role of financial crises in developed economies. Int. J. Hous. Mark. Anal. 15 (5), 1145–1169.
Schischke, A., Papenfuß, P., Rathgeber, A., 2023. Three co's to jointly model commodity markets: co-production, co-consumption and co-trading. Empir. Econ.
Siami-Namini, S., 2021. U.S. monetary policy and commodity prices: a SVECM approach. Econ. Pap. 40 (4), 288–312.
Smiech, S., Papiez, M., Dabrowski, M.A., 2015. Does the Euro area macroeconomy affect global commodity prices? Evidence from a SVAR approach. Int. Rev. Econ. Financ. 39, 485–503.
Svensson, L.E.O., 2008. The effect of monetary policy on real commodity prices: comment. In: Campbell, J.Y. (Ed.), Asset Prices and Monetary Policy. University of Chicago Press.
Swanson, E.T., 2021. Measuring the effects of Federal Reserve forward guidance and asset purchases on financial markets. J. Monet. Econ. 118, 32–53.
Umar, Z., Sayed, A., Gubareva, M., Vo, X.V., 2023. Influence of unconventional monetary policy on agricultural commodities futures: network connectedness and dynamic spillovers of returns and volatility. Appl. Econ. 55 (22), 2521–2535.
Wu, J.C., Xia, F.D., 2016. Measuring the macroeconomic impact of monetary policy at the zero lower bound. J. Money Credit Bank. 48 (2–3), 253–291.
Zeileis, A., Leisch, F., Hornik, K., Kleiber, C., 2002. Strucchange: an R package for testing for structural change in linear regression models. J. Stat. Softw. 7 (2), 1–38.
Zhu, X., Chen, J., Zhong, M., 2015. Dynamic interacting relationships among international oil prices, macroeconomic variables and precious metal prices. Trans. Nonferrous Met. Soc. China 25 (2), 669–676.