Impact of U.S. monetary policy on China's commodity prices in the background of COVID-19 pandemic Based on Experimental Analysis

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Abstract—U.S. monetary policy is an important influencing factor for international commodity price volatility. In order to empirically analyze the spillover effect of U.S. monetary policy on China's commodity price volatility during COVID-19, this paper estimates the cumulative abnormal returns during the important monetary policy window based on an event study model using daily returns of various Chinese commodity futures indices and conducts statistical significance tests. The study shows that the announcement of "unlimited" quantitative easing monetary policy in the U.S. on March 23, 2020, significantly raised commodity prices in China in the short term in the precious metals, energy, coal, coke, steel, mining, non-metallic building materials, oil, and oilseeds sectors, while most commodity prices in China did not respond significantly to the announcement of large-scale lending policy in the U.S.

Keywords—Monetary policy; Spillover effect; Event study model; Abnormal rate of return.

1 INTRODUCTION

Since the global spread of COVID-19, developed countries represented by the United States lowered interest rates to near-zero interest rate levels immediately and restarted large-scale quantitative easing monetary policy in order to alleviate the problem of tight corporate liquidity funds and stimulate economic activities. With the improvement of the pandemic situation and economic recovery, the international commodity prices surged, and the prices of a part of commodities rose to the highest levels in years, leading to rising PPI and increased production costs of enterprises directly, which has brought great challenges to the global economic recovery and caused widespread concern in the international community.

The monetary policies and economic stimulus programs of developed countries and emerging economies faced with the pandemic have had a great influence on the financial markets. Hartley and Rebucci (2020) used an event study approach to show that quantitative easing monetary policy significantly reduces 10-year government bond yields in the short run, and the

average impact of announcements of quantitative easing monetary policy is greater in emerging economies [1]. Harjoto et al. (2021) found that the epidemic had a negative impact on global stock markets based on an event study approach, while stimulus measures of the Federal Reserve brought remarkable positive returns to stock markets [2]. Zaremba et al. (2021) indicated that the government's economic policies in response to the pandemic reduced the volatility of local sovereign bonds greatly [3]. Zhu et al. (2021) argued that the expectation and liquidity will have an important influence on the short-term commodity prices in the post-pandemic era, but it is the demand for the real economy that is the root of the sustained increase of commodity prices [4].

The impact of monetary policy on commodity prices has long been a key topic that draws academic attention. Hamilton (2009) demonstrated that the rise in commodity prices is usually attributed to accommodative monetary policies and a continuous low-interest-rate environment [5]. Apergis et al. (2020) examined the impact of conventional and unconventional monetary policies in the U.S. and the euro area on the mean values and fluctuations of certain commodity prices based on an EGARCH model, showing that both monetary policies affect the yields of commodities and fluctuations in similar directions, but the unconventional monetary policies have a greater effect [6]. Marfatia et al. (2021) showed that the announcements of the monetary policy of the Federal Reserve have an impact on the yields and volatility of oil futures by employing an event study approach, and greater policy uncertainty leads to higher volatility [7]. Liang and Mu (2015) showed that the real economy is a persistent driver of the volatility of commodity prices, and the monetary and financial factors, especially the interest rate factors in developed countries and monetary policies in emerging market countries, are also important factors influencing commodity prices [8]. Zhang (2015) indicated that there is a long-term equilibrium asymmetric relationship between the global liquidity glut and commodity prices [9]. An et al. (2016) used an event study approach to show that the announcement of the QE policy of the Federal Reserve has a significant effect on the gold price in the short run and a time-varying shock effect in the long run [10].

In summary, existing studies provide good ideas and methods for this paper, but the study on how U.S. monetary policy affects China's commodity prices in the context of the COVID-19 pandemic is lacking. Because of this, the innovation of this paper is to perform an empirical analysis on the impact of key U.S. monetary policies during the pandemic on the volatility of various commodity prices in China in the short run.

Under the background of the outbreak of the COVID-19 pandemic, it is of great practical significance to understand how the U.S. monetary policy affects the volatility of China's commodity prices. This paper first summarizes the relevant research progress; secondly, the key announcements of U.S. monetary policy in response to the pandemic are clarified and based on the Event study model, the short-term responses of various commodity prices in China to key U.S. monetary policies are examined; finally, the conclusions and corresponding countermeasures are given.

2 RESEARCH METHODOLOGY AND DATA SOURCES

One of the most common approaches in analyzing the short-term impact of monetary policy on financial markets is the event study approach, which is widely used to measure the short-term impact of major event announcements on asset prices. The event study approach assumes that the market is efficient, and the asset prices will respond to the announcement event if there are no other confounding factors that affect the asset price within the event window.

2.1 Determine the event date, event window, and estimation window.

To alleviate the economic recession brought by the COVID-19, the Federal Reserve implemented a series of accommodative monetary policies. In the early stage of the pandemic, the policies were mainly to alleviate the lack of corporate liquidity and prevent the increase of unemployment due to the closure of small and medium-sized enterprises, and in the late stage of the pandemic, the United States mainly implemented a large-scale economic stimulus program. According to Table 1, there are three key monetary policy announcements by the Federal reserve, and since March 16 Federal Reserve monetary policy announcement is close to March 23 date, in order to avoid overlapping of events. This paper selects March 23, 2020, the announcement of "unlimited" quantitative easing, and April 9, 2020, the announcement of a massive $2.3 trillion loan program as representative event dates. The event windows are set to [-1,2], [-1,2], [-1,3], and estimation windows are set to [-250, -20].

Table 1 Monetary Policy Announcements

Date	Monetary Policy Announcements
March 16, 2020	The Federal Reserve urgently cut interest rates by 150 basis points to a level of 0% to 0.25%, initiated a $700 billion quantitative easing program (QE) of dollar Treasuries and $200 billion of agency MBs, and will use all its tools (e.g., discount window, deposit reserve requirements, bank capitalization) to provide credit support to residents and businesses.
March 23, 2020	The Federal Reserve launched "unlimited" QE, including on-demand purchases of Treasuries, agency MBAs, and agency commercial MBS, to keep the federal funds rate within a target range of 0 to 0.25 percent. The Committee also continued to operate term and overnight repurchase agreements to ensure that the supply of reserves remains adequate and to support the smooth functioning of the short-term dollar funding market.
April 9, 2020	The Federal Reserve announced a massive $2.3 trillion lending program, primarily to help small and medium-sized businesses retain employees.

2.2 Sample selection

To measure the response of different types of commodity prices in China to the Federal Reserve's monetary policy, the daily prices of Wind commodity indices and 10 sub-categories of industry indices were selected around the event date, and the log returns were calculated to

represent the price changes of various types of commodities. All commodity indices are sourced from the Wind database and the federal benchmark interest rate is sourced from the Federal Reserve website.

2.3 Estimation of normal and abnormal returns.

The market model is the most common method for estimating normal returns using the Event study model and has good statistical properties, so it is selected to estimate the commodity normal returns in this paper.

The market model formula:

$$E(R_{it}) = \alpha_i + \beta_i R_{mt}$$

(1)

$E(R_{it})$ is the normal rate of return of each commodity index i in period t, R_{mt} is the market return of the commodity composite index in period t. In this paper, we use the log-returns of the wind commodity indices to represent commodity market returns. The normal returns of various commodities can be estimated based on the estimation window and historical data on the returns of various commodity indices.

The abnormal rate of return is equal to the actual rate of return minus the normal rate of return estimated in the previous step.

$$AR_{it} = R_{it} - E(R_{it})$$

(2)

For each trading day of the event window, the sum of the abnormal returns equals the cumulative abnormal return.

$$CAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{it}$$

(3)

2.4 Statistical tests.

Assuming that the commodity returns obey a normal distribution with mean zero, the cumulative abnormal return t-statistic is constructed, and the t-values obey a t-distribution with degrees of freedom n-1, and then a t-test can be used to verify whether the cumulative abnormal return is significantly zero during each event window.

3 ANALYSIS OF RESULTS

When the Federal Reserve's "unlimited" quantitative easing monetary policy was implemented on March 23, 2020, in the event windows [-1, 1], [-1, 2], and [-1, 3], it had different degrees of positive effects on some commodity prices in China. Among them, precious metals, energy, coal, coke, steel and ore, non-metallic building materials, oils, and oilseeds industry commodity prices were the most affected, all of which showed significant positive cumulative abnormal returns. However, commodity prices in the grains, chemicals, agricultural commodities, soft

commodities, and non-ferrous metals sectors did not react significantly to the announcement of "unlimited" quantitative easing monetary policy. Therefore, the Federal Reserve's "unlimited" quantitative easing monetary policy has significantly increased commodity prices in China's precious metals, energy, coal, coke, steel and ore, non-metallic building materials, oils, and oilseeds industry in the short term, while commodity prices in grains, chemicals, agricultural by-products, soft commodities, and non-ferrous metals industries have not changed significantly. The reason for this situation is mainly due to the large trading volume of commodities such as precious metals, energy, coal, coke, steel, and ore, especially oil, which has a high price elasticity and is more sensitive to the response of monetary policy.

Table 2 Results of the event study on March 23, 2020, when the Fed announced "unlimited" QE

Name of the index	CAR [-1,1]	CAR [-1,2]	CAR [-1,3]
Wind Nonmetallic building materials	4.20%**	6.53%***	8.46%***
Wind Grains	1.38%	2.03%**	1.79%
Wind Precious Metals	6.42%***	8.17%***	7.61%***
Wind Chemical	1.64%	2.74%	3.57%*
Wind Coal, Coke, Steel & Mining	4.84%***	5.52%***	4.81%**
Wind Energy	5.35%***	5.68%**	5.00%*
Wind Agricultural Products	1.27%	2.14%	0.20%
Wind Soft Commodities	2.72%	2.00%	1.72%
Wind oils & oilseeds	4.20%***	5.49%***	3.54%*
Wind Non-Ferrous Metals	0.38%	2.00%	1.74%

Note: ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.

The results in Table 3 show that the massive $2.3 trillion loan program announced by the Federal Reserve on April 9, 2020, has a small impact on China's commodity prices in event windows [-1, 1], [-1, 2], [-1, 3], among them, only the cumulative abnormal returns of commodities in the coal, coke, steel, and mining industries are significantly positive in all three event windows, and the cumulative abnormal returns of non-metallic building materials are positive only at the 10% significance level in the [-1, 2] and [-1, 3] windows, while all other commodity prices do not respond significantly. The Federal reserve's massive increase in corporate loans was in response to the corporate liquidity crisis and to prevent corporate failure and had no apparent direct impact on most commodity prices in China.

Table 3 Results of the event study for April 9, 2020, announcement of the Federal Reserve's massive lending program

Name of the index	CAR [-1,1]	CAR [-1,2]	CAR [-1,3]
Wind Nonmetallic building materials	2.42%	3.74%*	4.14%*
Wind Grains	0.47%	0.55%	0.84%
Wind Precious Metals	1.06%	1.24%	0.11%
Wind Chemical	2.15%	2.67%	1.56%

Wind Coal, Coke, Steel & Mining	3.43%**	3.86%**	3.30%*
Wind Energy	0.32%	0.28%	0.89%
Wind Agricultural Products	3.27%	3.83%	3.73%
Wind Soft Commodities	0.74%	0.01%	0.03%
Wind oils & oilseeds	0.43%	0.86%	0.09%
Wind Non-Ferrous Metals	2.05%	2.24%	2.34%

Note: ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively.

4 CONCLUSION

In the background of the global spread of the COVID-19, the U.S. immediately lowered interest rates to near-zero interest rate level and employed an "unlimited" quantitative easing monetary policy, the scale of which far exceeded that in the financial crisis in 2008. How such a series of policies affect global commodity prices has attracted widespread attention in the academic community. This paper analyzes the short-term response of China's commodity prices to key U.S. monetary policy announcements based on an event study approach. The results show that the "unlimited" quantitative easing monetary policy announced by the U.S. on March 23, 2020, had a significant positive impact on China's commodity prices of precious metals, energy, coal, coke, steel and ore, non-metallic building materials, oils, and oilseeds in the short term, while commodity prices of grains, chemicals, agricultural by-products, soft commodities, non-ferrous metals did not respond significantly. And the $2.3 trillion loan program announced by the U.S. on April 9, 2020, had a relatively small impact on China's commodity prices, with only a significant positive impact on commodities in the sectors of coal, coke, steel and mining, and non-metallic building materials, while other commodity prices had little reaction.

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