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Assessing the extent and persistence of major crisis events in the crude oil market and economy: evidence from the past 30 years

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This study investigates the extent and persistence of major crisis events in the crude oil market and economy and searches for general rules of event impact. Although the short-term effects of such crises may quickly become evident, their long-term implications can be challenging to uncover. To this end, we analyzed 50 major crisis events across four categories using a Proxy structural vector autoregressive (Proxy-SVAR) model. The results show that these events substantially impacted crude oil production, world crude oil prices, and inflation in China and the United States. Generally speaking, major crisis events have a more severe impact on the crude oil market, but their impact on the economy lasts longer. Notably, geopolitical conflicts have led to a sharp decline in S&P500, resulting in a simultaneous reduction in the industrial production indices of the world, China, and the US. Among the different types of crises, the financial crisis had the most prolonged impact, persisting for approximately four years. The public health emergency represented by COVID-19 resulted in a decline in actual oil prices, with its impact on the oil market continuing for over three years. Considering our findings, we suggest four policy measures to enhance economic resilience.

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Introduction

Recent years have witnessed a surge in major crises, causing significant impacts on the crude oil market and the global economy. The performance of the world economy has been declining since the Sino-US trade war in March 2018, with global economic growth rates of 3.3 and 2.6% in 2018 and 2019, respectively. The outbreak of COVID-19 further exacerbated the situation; on April 20, 2020, the price of West Texas Intermediate (WTI) crude oil futures dropped to a harmful level for the first time in history. On April 21, 2020, the intraday low of WTI crude oil futures prices fell to 6.470 US dollars/barrel, while on April 22, 2020, the intraday low of Brent crude oil futures prices fell to 15.980 US dollars/barrel, marking a historic low since the turn of the century (Zhang et al. 2023). While crude oil prices eventually rebounded due to the mitigation of the epidemic situation and inventory effects, another crisis occurred in February 2022 when Putin announced a special military operation against Ukraine, leading to a rapid rise in crude oil prices. Because of the subsequent sanctions imposed by the United States and Western countries, oil prices fluctuated at high levels. However, as the US released its strategic oil reserves and the Fed raised interest rates, the US dollar strengthened, and crude oil prices slowly declined to around $80 per barrel. In March 2023, the significant and rapid interest rate hikes in the United States and Europe raised global financial system risks, and the bankruptcy of Silicon Valley banks intensified market concerns. Crude oil prices fell nearly 15% to $67 per barrel. In April 2023, although multiple OPEC (Organization of the Petroleum Exporting Countries) member countries such as Saudi Arabia and Iraq jointly reduced production, the oil price rose to $87 per barrel but dropped to $70 per barrel. In August 2023, Hurricane Idalia, a Category 4 hurricane, impacted crude oil production and exports in the Gulf of Mexico, causing crude oil prices to skyrocket. On September 27th 2023, Brent crude oil futures prices reached $96.55 per barrel, while WTI crude oil futures prices reached $93.68 per barrel. In October 2023, the outbreak of the Israeli-Palestinian conflict and the Red Sea crisis drove up oil prices slightly in the short term but failed to change the pressure brought by the supply and demand fundamentals. International crude oil prices fluctuated and fell to $70 per barrel. In 2024, OPEC+ reduced production, and the conflict between Iran and Israel resulted in crude oil prices rising to $85 per barrel. The short-term impact of major crisis events on the crude oil market and economy has emerged. How long will the impact of these events last? What is the general rule of the impact of these events on the crude oil market and economy? Are the magnitudes and timings of the impacts of different types of events the same? These questions are explored in this study.

Compared to the immediate impacts of major crises, paying more attention to their long-term effects is crucial. On the one hand, these enduring consequences possess greater potential to alter market dynamics, such as efficiency and equilibrium, in the long run (Joo et al. 2020), warranting more consideration than short-lived fluctuations in oil prices. Conversely, unanticipated events are challenging to predict, making it difficult to anticipate and respond effectively to short-term disruptions, and stakeholders can only react retroactively. However, long-term event effects can be scrutinized and predicted, providing decision-makers ample time and scope to respond adequately and implement the necessary measures to mitigate long-term adverse impacts.

In economics, there is a lack of a clear delineation between short- and long-term periods in terms of duration. The long run typically refers to a period where all production factors are variable and in equilibrium. Conversely, the short run is characterized by constraints as some factors of production remain immutable, leading to an incomplete or unstable market equilibrium. However, the distinction between these terms is clearer in financial markets. For example, short-term interest rates refer to those on financial assets with maturities of less than one year, whereas long-term interest rates denote those with maturities exceeding one year. Similarly, the classification of long- and short-term debt is based on a one-year period. When major crises occur, such as those affecting oil prices, short-term effects are generally realized through investor expectations, whereas long-term changes in the supply and demand balance ultimately determine prices. Crude oil is considered a basic resource product sold in a seller's oligopolistic market in which OPEC+ plays a significant role in price formation. The quotas for crude oil production by OPEC+ were determined via ministerial meetings held by both OPEC and non-OPEC countries. Before 2020, the production quota adjustment cycle for OPEC+ was approximately one year. As such, the impact of major crises on oil prices is divided into short-term impacts of one year or less and long-term impacts of more than one year. Furthermore, the degree of financialization of petroleum products continues to increase. Referring to the term division of the financial market, the term is also one year.

The expeditious effects of significant crisis events are apparent and have been extensively researched (Bae et al. 2017; Ma et al. 2021; Zhang et al. 2009). However, there is a dearth of literature on the enduring impact of such events. The primary challenge in this regard is the difficulty in quantifying events. In the short term, this issue can be circumvented by overlooking the influence of other factors and employing event analysis methodologies (Ji and Guo 2015; Zhang et al. 2009; Zhu et al. 2018). Nonetheless, this problem is intractable in the long term. Without a reasonable quantification of events, examining their lasting effects on the oil market and economy is impossible. Scholars have attempted to address this issue by constructing quantification indices such as the Geopolitical Risk Index (GPRI), which has been utilized to study the long-term impacts of geopolitical conflicts (Antonakakis et al. 2017). However, the current index construction is solely applicable to geopolitical conflicts, and the long-term effects of major crisis events, such as the financial crisis and COVID-19, remain unstudied. There is also no mature method to incorporate all events into one model and obtain general rules of event impact.

This study makes noteworthy contributions in three key areas:

Firstly, integrate all major crisis events into a unified framework while examining the long-term impact of all major crisis events on the crude oil market and economy. Existing literature mainly focuses on the impact of a specific type of event or a single event, analyzing the changes in the crude oil market and economy before and after the event, but cannot obtain the time-varying characteristics of the event's impact. The conclusions and policy implications obtained from them can only be specific to specific events and are not universal. However, studying all major crisis events simultaneously can reveal the main characteristics and changes in the long-term impact of the events. We cannot make precise predictions about future events, but we can take basic preventive measures based on their main characteristics to cope with the impact of future events.

Secondly, significant crisis events were reasonably quantified. The biggest challenge in studying the long-term impact of all events on the crude oil market and economy simultaneously is the difficulty quantifying the events. The most commonly used event analysis method is no longer applicable due to long-term factor mixing and only applies to individual event studies. This article constructs a proxy variable for major crisis events based on the oil market, solving the problem of difficult quantification of events. It can simultaneously consider the impact of all events and help

relevant entities such as governments and investors respond effectively in the long term. On the other hand, in existing research, only a few events can be considered simultaneously when using major crisis events as control variables. After quantifying the events reasonably, the impact of all events can be controlled simultaneously, avoiding the problem of missing variables.

Thirdly, the endogeneity of the event has been addressed using the Proxy-SVAR model. Although major crisis events have a certain degree of suddenness, there are still economic incentives and many events related to oil resources, such as the Gulf War and the Syrian War. Therefore, it is necessary to consider the endogeneity of events in research. However, existing literature only considers the endogeneity of OPEC production announcements in the crude oil market (Känzig 2021; Shioji 2021). If the proxy variables of major crisis events are directly introduced into the model analysis, it can easily cause coefficient estimation errors and questionable results. The article selects reasonable instrumental variables and uses the Proxy-SVAR model to solve endogeneity problems, obtaining more reliable conclusions.

Specifically, this study uses the Proxy-SVAR model to analyze the effects of major crisis events on the crude oil market and economy by selecting monthly data from January 1990 to December 2022. This study identifies 50 specific events across four categories, namely geopolitical conflicts, natural disasters, economic and financial crises, and public health emergencies. It examines the percentage change in WTI crude oil futures prices before and after each event as a proxy variable for research. The proxy variable's reliability is supported by the F-value of the first stage and the historical decomposition results of the actual crude oil price. The study finds that major crisis events generally lead to increased crude oil prices and a decline in global crude oil production. The Standard and Poor's 500 (S&P500), the world industrial production index, and the US industrial production index responded positively in the early stages, whereas the Chinese industrial production index responded negatively. Furthermore, major crisis events resulted in an increase in the Consumer Price Index (CPI) and inflation in both the United States and China. Geopolitical conflicts and natural disasters led to higher crude oil prices, whereas financial crises and public health emergencies led to lower crude oil prices. The S&P500 responds more strongly to geopolitical conflicts, while natural disasters have short-lived impacts. The response time of China's economy was longer than that of the United States for all major crisis events, and the impact on the CPI was more severe in China than in the United States. The financial crisis had a long-lasting effect, affecting the crude oil market for more than three years and the economy for more than four years. In contrast, the impact of natural disasters is the shortest, lasting approximately one and a half years.

The follow-up arrangement of the article is as follows: Section "Literature review" is a literature review, reviewing the relationship between major crisis events, oil prices, and the economy; Section "Materials and methods" introduces the research methods and data used; Section "Results" is the overall result analysis; Section "Further discussion" further discusses the different impacts of different types of events; Section "Conclusion and policy implications" is conclusions and policy recommendations.

Literature review

A major crisis event is characterized by the sudden and widespread occurrence of events that result from substantial economic and public security crises, as well as natural disasters in a country that is not in a state of war. There has always been a complex problem to solve in studying major crisis events: the events are challenging to quantify. Therefore, econometric methods cannot be used to study the impact of major crisis events on the crude oil market and economy. Scholars are attempting to use other methods for research.

The first type is based on the occurrence time of major crisis events, constructing 0-1 dummy variables and conducting quantitative research using econometric methods. Karali and Ramirez (2014) incorporated the Asian financial crisis, the 9/11 attacks, the US invasion of Iraq, and the financial crisis into their models to analyze the time-varying volatility and spillover effects of energy prices. The method of handling events is to set the date of occurrence to 1. Otherwise, it is 0. Wen et al. (2021) used regression models to study the relationship between extreme events and energy price risk. The events considered include natural disasters (drought, epidemic, extreme temperatures, storms, floods, and wildfires) and terrorism, where the natural disaster variable also takes a value of 1 during the event. Otherwise, it is 0. Research has found that extreme events significantly impact oil price risk. This method is only a rough estimate of the impact of the event. Especially when considering all events together in the model, it is impossible to distinguish the intensity of different events nor to depict the degree of impact of events over time.

The second type is to use the event analysis method for research. For example, Zhang et al. (2009) used an event analysis method based on EMD decomposition to analyze the Persian Gulf War in 1991 and the Iraq War in 2003. Zhang et al. (2024) studied the net impact of the Russo-Ukrainian war on crude oil prices using event analysis based on multi-resolution causal testing and VMD decomposition. Further, they used the CRP-MIF method to investigate the channels through which the Russo-Ukrainian conflict affects crude oil prices. They found that the Russo-Ukrainian war mainly affects crude oil prices through speculation, inventory, and supply and jointly affects crude oil prices through OPEC+production announcements (Zhang et al. 2023). Bae et al. (2017) classified conflicts into three categories: international conflicts, such as the Gulf War in 1991; Conflicts between countries, such as the 1990 Iraq-Kuwait War; A domestic conflict, such as the Syrian Civil War, uses event analysis to study the impact of different types of conflicts on oil company returns. It was found that national oil companies received positive returns after internationalization and domestic conflicts, while multinational oil companies received positive returns after domestic conflicts in the Middle East region. This method is effective for studying the short-term impact of a particular event. However, over time, more factors or other events affect oil prices, and the impact of that event no longer dominates. Therefore, the event analysis method is no longer applicable in long-term analysis.

The third type uses econometric methods to segment regression or calculate indicators and compare the performance before and after the event. Li and Li (2014) found through the VAR and HP filtering decomposition models that international crude oil prices showed a significant upward trend after the March 2011 earthquake in Japan. Joo et al. (2020) found that the 2008 financial crisis changed the scale-invariant nature of the oil market and hurt market efficiency and long-term equilibrium by comparing hurst exponent, entropy, and power-law components before and after the financial crisis. Zavadska et al. (2020) found through segmented regression before and after the crisis that the 1997 Asian financial crisis and the 2008 global financial crisis had an indirect impact on the oil market through financial markets, resulting in higher volatility in oil prices. However, this method can only study the impact of a specific event, and in segmented regression, it may also mix the effects of other events, resulting in unreliable results.

The fourth type is to construct indices for different types of events or use specific indicators for research. The Geopolitical Conflict Index (GPR) is the most commonly used among them. This index is represented by Caldara and Iacoviello (2022) based on the proportion of geopolitical conflict articles in 10 newspapers, such as The New York Times, Financial Times, and The Wall Street Journal. Subsequently, many scholars used this index to study the impact of war and geopolitical conflicts on energy prices (Antonakakis et al. 2017; Liu et al. 2019; Gong et al. 2022). Some articles also use specific indicators to express events, such as confirmed cases (Le et al. 2021), mortality (Algamdi et al. 2021), and news reports (Atri et al. 2021) to study the impact of COVID-19 on crude oil prices, and find that it has a significant negative impact (Zhou et al. 2022). This method is effective for specific types of events and does not apply to all types of major crisis events, nor can the impact of all events be studied simultaneously.

So far, only a few empirical studies have systematically analyzed the impact of major crisis events on the crude oil market and economy. The method is to construct virtual variables of 0,1, which can only make rough estimates of events. More literature focuses on specific types of events or a particular event and cannot obtain general impact of major crisis events. In addition, focusing only on one or a specific type of event may overlap with other events in exploring long-term impacts, and the net impact of the event of interest cannot be obtained. The above methods also cannot solve the endogeneity problem of events. Although major crisis events have a certain degree of suddenness, there are still economic incentives and many events related to oil resources, such as the Gulf War and the Syrian War. Therefore, it is necessary to consider the endogeneity of events in research.

In order to obtain general rules of the impact of events, this paper adopts the Proxy-SVAR model to solve the problem of difficult quantification of events. It constructs a unified framework for the long-term impact of major crisis events on crude oil prices. The Proxy-SVAR model was proposed by Stock and Watson (2012) and Mertens and Ravn (2013), while Piffer and Podstawski (2018) extended the model to simultaneously use two instrumental variables to collectively identify uncertainty shocks and news shocks in the Proxy-SVAR model. Känzig (2021) introduced this model into the crude oil market and used the changes in oil futures prices before and after the OPEC production announcement as an instrumental variable to identify the impact of the OPEC production announcement on the actual crude oil price and economy.

In this paper, we select the changes in oil futures prices before and after major crisis events in the past 30 years as instrumental variables to solve the problem of difficult quantification of events. At the same time, we use the Proxy-SVAR model to study the endogeneity of events. Firstly, analyze all events to obtain the long-term common impacts of major crisis events on the crude oil market and global economy, search for the general patterns of event occurrence, and then classify and study each type of event to obtain the long-term characteristics of the impact of different types of events on the crude oil market and global economy, and find the special patterns of each type of event occurrence. Finally, based on the research findings, policy recommendations are proposed to assist relevant entities in making long-term decisions and responses.

Materials and methods

Proxy-SVAR. The SVAR model is a commonly used method for studying the impact of variables on the oil market. Kilian (2009) used the SVAR model to identify different types of shocks to oil prices, including supply shocks, global demand shocks, and specific oil shocks. Subsequent scholars have used the SVAR model to study the impact of energy market shocks from multiple perspectives (Naccache 2010; Herwartz and Plödt 2016; Ahmadi et al. 2016; Zhang et al. 2023). The difficulty in using the SVAR model to study the impact of major crisis events on the oil market is that events cannot be quantified, and events such as exogenous shocks cannot be directly introduced into the SVAR model as endogenous variables. Therefore, this article adopts the Proxy-SVAR proposed by Stock and Watson (2012) and Mertens and Ravn (2013) for research. The main idea of Proxy-SVAR is to impose constraints on external instrumental variables, which are related to the shocks of interest and orthogonal to other structural shocks. Using these moment conditions to supplement the limitations of variance covariance in general VAR models, avoiding direct assumptions about structural parameters, and achieving model identification (Mertens and Ravn 2013). This method can solve the endogeneity problem of events, and the selection of external instrumental variables can simultaneously solve the problem of difficult quantification of events. The specific settings and estimates of the model are as follows:

Assuming that Y_t is an $n\times 1$ endogenous variable, then the reduction formula of VAP(P) with lag p order is:

$$Y_t = a + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + u_t \tag{1}$$

Among them, u_t is a vector of $n\times 1$ reduced-form VAR innovations with the covariance $Var(u_t) = \Sigma_u$,a is the constant vector of $n\times 1$, A_1,A_2,$\cdots A_p$ are the coefficient matrix of $n\times n$.

Suppose u_t has the following linear relationship with structural shock ε_t:

$$u_t = B\varepsilon_t \tag{2}$$

Among them, $B=[B_1\cdots B_n]$ is a $n\times n$ non-singular structural impact matrix. $\varepsilon_t=\varepsilon_{1,t},\varepsilon_{2,t},\cdots\varepsilon_{n,t}$ is the $n\times 1$ structural shock vector, $\varepsilon_{1,t}$ is the first shock. Structural shocks are not correlated with each other, that is, $Var(\varepsilon_t)=\Sigma_\varepsilon$ is a diagonal matrix.

Without loss of generality, the shock of interest is defined as the first $\varepsilon_{1,t}$ of the structural shock vector. At this time, it is not necessary to obtain all the elements of the matrix B during estimation, but only the first column elements of the matrix B.

According to Stock and Watson (2012) and Mertens and Ravn (2013), $\varepsilon_{1,t}$ can be identified using external tools. Suppose there is an external instrumental variable (surrogate variable) z_t satisfies the following conditions:

$$E\left(z_t\varepsilon_{1,t}\right) = \alpha \neq 0 \tag{3}$$

$$E\left(z_t\varepsilon_{j,t}\right) = 0, \text{where} j = 2,\cdots,n \tag{4}$$

Among them, formula (3) is the correlation condition, and formula (4) is the externality condition.

Let $B_1=(b_{1,1},b_{2,1},\cdots b_{n,1})'$, where $b_{j,1}$ is the response of $\varepsilon_{1,t}$ to a one-unit shock of $u_{j,t}$, according to Eqs. (3) and (4) B_1 can be identified as sign and scale:

$$\widetilde{b}_{j,1} \equiv \frac{b_{j,1}}{b_{1,1}} = \frac{E\left(z_t u_{j,t}\right)}{E\left(z_t u_{1,t}\right)}, \text{where} j = 2,\cdots,n \tag{5}$$

Assuming $E\left(z_t u_{1,t}\right)\neq 0$, $\widetilde{b}_{j,1}$ can be viewed as a population analog of the IV estimator of $u_{j,t}$ on $u_{1,t}$ with z_t as the instrumental variable.

Set $b_{1,1}$ to obey $\Sigma_u = B\Sigma_\varepsilon B'$ by standardization, let $\Sigma_\varepsilon = diag(\sigma^2_{\varepsilon 1},\cdots,\sigma^2_{\varepsilon n})$, $b_{1,1}=x$, which means that a positive change of one unit of $\varepsilon_{1,t}$ has a positive effect of x units in Y_{1t}.

This paper refers to Känzig (2021), the shock is 10% higher than the oil price.

Overview of the major crisis event data. This study focused on four major crisis event categories. The first category pertains to geopolitical conflicts. Conventional conflict is a contested incompatibility that concerns government or territory where the use of armed forces between two parties, one of which is the government of a state. It can be categorized along two further dimensions: fatalities and actors. Fatalities: (1) minor armed conflict (0–25 deaths), (2) Intermediate armed conflict (25–1000 deaths) and (3) War (1000+ deaths). Actor: (1) Extrasystemic, (2) Interstate, (3) Internal, and (4) Internationalized. Geopolitical conflict refers to inter-state conflicts (Wallace et al. 2013), such as the Russia-Ukraine War and 9/11. The second category concerns natural disasters. A natural disaster is a highly harmful impact on a society or community following a natural hazard event. Some examples of natural hazard events include flooding, drought, earthquakes, tropical cyclones, lightning, tsunamis, volcanic activity, and wildfires. A natural disaster can cause loss of life or damage property and typically leaves economic damage in its wake. The third category comprises economic and financial crises. A financial crisis is any of a wide variety of situations in which some financial assets suddenly lose a large part of their nominal value, including banking crises, stock market crashes and the bursting of other financial bubbles, currency crises, and sovereign defaults. The fourth category encompasses public health emergencies. A public health emergency is defined as "an occurrence or imminent threat of an illness or health condition, caused by bioterrorism, epidemic or pandemic disease, or an infectious agent or biological toxin, that poses a substantial risk to humans by either causing a significant number of human fatalities or permanent or long-term disability." Public health emergencies also include influenza, or "the Flu", such as the COVID-19 pandemic.

The period selected for the article is from 1990 to 2022. This is because since 1990, the process of globalization has accelerated, productivity has skyrocketed, income has increased, and global economic growth has entered a new stage. Studying this period can better clarify the impact of major crisis events on the modern economy and has more reference significance for future development. Selecting representative events on a global scale for research can help obtain more universal conclusions and general patterns of the long-term impact of events.

We employed various sources to identify the events of interest. For wars and geopolitical conflicts, we consulted Wikipedia's list of wars[1] and selected events with a magnitude of the social-systemic impact index equal to or greater than 5[2]. For natural disasters, we used the Emergency Events Database (EM-DAT)[3] and selected significant disasters with more than 10 million affected people and economic losses (after adjustment) exceeding 10 billion U.S. dollars. For economic and financial crises, we refer to Wikipedia's list[4], Piffer and Podstawski (2018) for selection. For public health emergencies, we consulted Wikipedia's list of epidemics[5] and selected landmark disease events worldwide. After screening, we identified 50 events of concern, including 21 landmark events of war and geopolitical conflicts, 16 landmark events of natural disasters, seven landmark events of economic and financial crises, and six public health emergency events, as presented in Table 1.

The quantification of events presents a challenge that necessitates using alternative metrics. In this study, the change in the WTI futures prices served as a stand-in variable for significant crisis events. While any asset price that adequately responds to major crisis events can be utilized, in principle, the response speeds of various asset prices to events remain similar, with differing degrees of reaction. Notably, oil futures prices are particularly suitable substitutes for significant crises involving oil market research because they rely on market fluctuations and economic conditions (Känzig 2021).

Specifically, the percentage change in the end-of-day closing price from the first trading day following the event to the last trading day before the event represents the substitute variable for the event. These variables are combined to generate monthly data by summing the daily price changes.

Figure 1 illustrates the trend chart of the proxy variable of major crisis events (MCE), marking the events that caused a sharp reaction in WTI futures prices. The chart reveals that most events increased the WTI futures prices. Wars and natural disasters were primarily responsible for the increase in WTI futures prices. Notably, the First Gulf War led to a 7.29% increase in oil prices. Similarly, after the Russia-Ukraine War, US sanctions banning Russian oil imports caused oil prices to increase by 3.6%. Conversely, economic and financial crises, along with public health emergencies, have primarily contributed to the downward trend in WTI futures prices. For example, the 2008 financial crisis, marked by the bankruptcy of Lehman Brothers, resulted in a 5.4% drop in oil prices. Similarly, the COVID-19 outbreak caused a 13.6% decline in oil prices.

Data. This study focuses on the impact of major crisis events on the oil market and economy by selecting endogenous variables as follows.

Crude oil prices (Price). The U.S. West Texas Intermediate crude oil spot price (WTI Spot Price FOB) was selected to represent the crude oil price in the market, and U.S. CPI ratio data were used to convert the crude oil price based on 2015. The time interval was monthly data from January 1989 to December 2022. The data were obtained from the U.S. Energy Information Administration (EIA)[6].

World oil production (OP). We selected the monthly world oil production data included in the Datastream database, and the unit was MBBL/DAY.

Standard and Poor 500 Index (S&P500). This variable was chosen to observe the impact of major crises on the stock market. The data are obtained from Investing.com[7].

Production index of major countries worldwide (OECD + 6 IPI). This variable was chosen to observe the impact of major crises on global production. The production indices of the OECD countries and six other countries (Brazil, China, India, Indonesia, Russia, and South Africa) were constructed by Baumeister and Hamilton (2019). The data were obtained from Baumeister's webpage[8].

US Production Index (USIPI). This variable was chosen to observe the impact of major crisis events on US production, and the data were obtained from FRED[9].

US Consumer Price Index (USCPI). We chose this variable to observe the impact of major crisis events on US inflation and chose 2015 as the monthly data of the fixed base; the data were obtained from FRED[10].

China Production Index (ChinaIPI). This variable was chosen to observe the impact of major crisis events on China's production. The current Chinese production index ranges from January 2010 to October 2015, which does not meet the data requirements of this study. Therefore, the industrial added value was selected to replace the fixed base index of 100 in 2010. It should be noted that the fixed-base index of industrial added value in the database was counted from January 2011, and the author used year-on-year data on industrial added value to

Table 1 Selected events and proxy variables.

#	Date	$\triangle P_{WTI-future}$	Event	Event type
1	1990/8/2	7.29%	Iraq invades Kuwait, first Gulf War	1
2	1991/6/1	0.00%	East China Floods	2
3	1991/8/19	5.49%	Attempted coup in Moscow	1
4	1991/12/12	0.26%	Ratification of the Accords declaring end of the USSR	1
5	1992/4/1	2.06%	Bosnian War	1
6	1992/9/16	0.95%	UK Black Wednesday	3
7	1993/7/8	1.29%	Indian floods	2
8	1994/4/7	−1.20%	Genocide in Rwanda	1
9	1994/6/9	1.80%	China flood	2
10	1994/12/11	−1.28%	Russia sent troops to Chechnya, the first Chechen war	1
11	1995/5/15	0.30%	Floods in the Xiangjiang River Basin, China	2
12	1995/8/30	−0.17%	NATO announces air strikes against Serbia in Sarajevo	1
13	1996/6/30	2.92%	China flood	2
14	1997/7/2	1.09%	Thailand unpegs currency	3
15	1998/5/13	−1.90%	Ethiopian-Eritrean War	1
16	1998/7/1	1.34%	Chinese catastrophe	2
17	1998/8/17	−1.12%	Ruble crisis	3
18	1998/12/17	−10.90%	US and UK air strikes on Iraq, Operation Desert Fox fail	1
19	1999/3/24	−1.10%	Clinton announces US join NATO bombing in Kosovo	1
20	1999/6/23	4.77%	Flooding in Taiping Lake Basin, China	2
21	1999/8/26	1.80%	Second Chechen War	1
22	2001/9/11	6.88%	9/11 attacks	1
23	2001/10/7	0.27%	War in Afghanistan	1
24	2003/2/26	4.55%	Darfur conflict (Sudan)	1
25	2003/3/12	3.02%	WHO issues global alert on SARS	4
26	2003/6/23	−5.35%	Floods in the Yangtze River Basin, China	2
27	2008/1/10	−2.05%	Snow disaster in southern China	2
28	2008/5/12	−1.37%	China's Sichuan earthquake of magnitude 8	2
29	2008/6/9	−3.02%	Great Flood in the American Midwest	2
30	2008/9/14	−5.41%	AIG requests emergency loan + Lehman Brothers goes bankrupt	3
31	2009/6/11	1.89%	WHO declares influenza A (H1N1) a pandemic	4
32	2010/4/27	−2.09%	Downgrading of Greece + Portugal	3
33	2010/5/10	2.25%	EFSF adopted	3
34	2010/7/28	−0.66%	Pakistan floods	2
35	2011/3/15	0.28%	Syrian War	1
36	2013/11/8	0.42%	Super Typhoon Haiyan makes landfall in Philippines	2
37	2013/12/16	0.91%	South Sudan civil war	1
38	2014/3/25	−0.41%	WHO says Ebola virus disease outbreak in Guinea	4
39	2014/8/8	0.32%	WHO declared the outbreak a public health emergency of international concern	4
40	2015/9/30	−0.31%	Russian air strikes Syrian rebels	1
41	2016/6/28	3.28%	Floods in southern China	2
42	2017/4/7	1.04%	U.S. and others directly attack Syrian government military installations	1
43	2018/3/22	−1.33%	US-China trade war	3
44	2020/1/23	−4.26%	Wuhan is closed due to COVID-19 / COVID-19 found in other countries	4
45	2020/3/11	−13.57%	WHO announced that COVID-19 constitutes a global pandemic + the epidemic situation in the United States worsened, triggering the third circuit breaker mechanism	4
46	2020/5/20	3.05%	Super cyclone Amphan makes landfall in India, causing storm damage	2
47	2021/7/20	1.51%	Heavy rain and flood in Henan, China	2
48	2022/2/24	0.77%	Russia takes special military action against Ukraine	1
49	2022/3/8	3.60%	Biden announces ban on U.S. imports of Russian energy	1
50	2022/6/3	1.71%	EU announces ban on imports of Russian crude oil and petroleum products by sea	1

Event type 1 is war or geopolitical conflict, 2 is natural disaster, 3 is economic and financial crisis, and 4 is public health emergency.

calculate the fixed-base index from January 1989 to December 2010. All the data were obtained from the WIND database.

China Consumer Price Index (ChinaCPI). We chose this variable to observe the impact of major crisis events on China's inflation and chose 2015 as the fixed monthly data. All the data were obtained from the WIND database.

To construct a Proxy-SVAR model for analysis, it is crucial to ensure that the time-series data are stationary. To this end, we conduct unit root tests, specifically the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The results of these tests are presented in Table 2. The findings reveal that, except for the proxy variable MCE for major crisis events, the original series of other variables exhibit non-stationarity. However, after taking the logarithm of the remaining variables and applying first-order differencing, all the variables become stationary. Thus, we selected the original MCE sequence and first-order logarithmic difference of the other variables for further analysis.

Results

This study examines the overall effects of four distinct categories of major crisis events on the crude oil market and economy. All

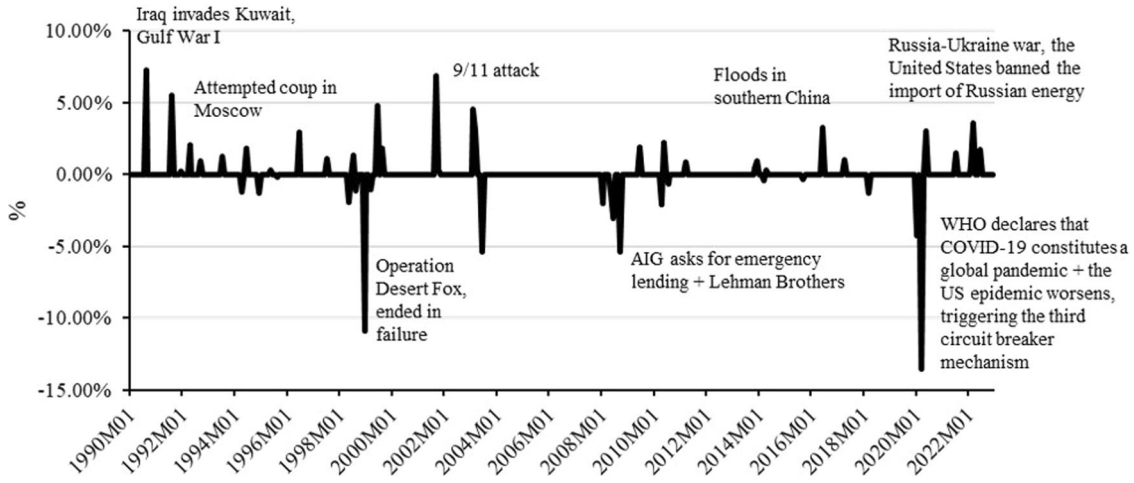

Fig. 1 Proxy of major crisis events based on the WTI futures price.

Table 2 Variable unit root test.

Variable	ADF test	PP test	Result
MCE	−18.641***	−18.685***	I (0)
Price	−1.996	−2.536	I (1)
D.lnPrice	−15.238 ***	−14.848 ***	
OP	−1.333	−1.262	I (1)
D.lnOP	−20.886 ***	−20.993 ***	
S&P500	0.434	0.629	I (1)
D.lnS&P500	−20.013***	−20.022***	
OECD + 6IPI	−0.162	−0.280	I (1)
D.lnOECD+6IPI	−17.090***	−17.340***	
USIPI	−1.614	−1.600	I (1)
D. ln USIPI	−16.303***	−16.123***	
USCPI	2.533	1.624	I (1)
D. ln USCPI	−11.538***	−11.166***	
ChinaIPI	−1.647	0.356	I (1)
D. ln ChinaIPI	−32.993***	−56.367***	
ChinaCPI	−1.635	−1.467	I (1)
D. ln ChinaCPI	−13.931***	−13.850***	

D. indicates the first-order difference; *, **, *** indicate the significance level of 10%, 5% and 1%, respectively.

major crisis events are viewed as shocks to the crude oil market, and the focus of the investigation is on the first day of each event, notwithstanding the varying length of the event window for different types of events. This approach is justified because the initial day chiefly reflects the net response of the futures market, whereas subsequent market fluctuations tend to be confounded by expectations and countermeasures. Hence, the proxy variables of all the events are unified and can be studied together, which is consistent with Piffer and Podstawski's (2018) treatment of uncertain shocks. Furthermore, aggregate analysis can provide a general understanding of the common impact of major crisis events on the crude oil market and economy, which is more comprehensive than scrutinizing specific event categories. Subsequently, the four categories of major crisis events are examined separately, revealing the unique characteristics of their impacts on the crude oil market and economy.

Impulse response analysis. Figure 2 depicts the impulse response of the crude oil market and the global economy to major crisis events, where the solid line represents the point estimate and the dark and light-shaded regions depict the 68 and 90% confidence intervals based on 10,000 bootstraps, respectively. Additionally, the figure indicates the F-test results of the initial stage regression and the robust F-value of 19.70, which is above 10, indicating no weak instrumental variable problems.

An analysis of the crude oil market's perspective revealed that a significant crisis initially led to a sharp surge in crude oil prices. However, this effect gradually weakened over time and became negative in the subsequent period. The response curve subsequently oscillated around zero and gradually trended towards zero after 20 periods. The observed response trends may be attributed to two primary factors: firstly, overreactions to significant crisis events (Borgards et al. 2021) and, secondly, the impact of these events on crude oil production. During the current period, global oil production declined and gradually recovered after the first period. Restoring production capacity shifted expectations and changed supply-demand dynamics, leading to a gradual decline in crude oil prices.

From an economic perspective, the occurrence of major crisis events has been observed to have a positive impact on the S&P500 index, followed by a gradual weakening of the positive response, eventually leading to a negative trend in the second period and approaching zero in the long run. Major crisis events can increase investor attention, increasing speculative activity (Xiao et al. 2023). The increase in speculative activity can amplify the volatility of stock prices in the short term (Sornette 2000). Similarly, major crisis events were found to promote an increase in the world industrial production index, with a peak of 0.358% in the first period, followed by a gradual decline, ultimately tending to zero in the long term. This trend may be attributed to the fact that only a few major crisis events have occurred in OECD countries, whereas extreme events in other regions may partly boost industrial production in developed countries through increased exports of daily necessities and post-disaster reconstruction materials to the affected country. This is also reflected in the positive response of the US Industrial Production Index. However, China's industrial production index initially responded negatively due to numerous major crisis events, particularly natural disasters with significant losses, such as the Wenchuan earthquake in May 2008 and heavy rain and floods in Henan in May 2021, resulting in weakened industrial production. Nonetheless, the response became positive from the first period, reaching a peak of 1.61% in the third period, primarily because of temporary production growth for efficient post-disaster reconstruction. However, the response became negative in the fourth period and eventually tended to zero in the long term. Notably, major crisis events have a more significant impact on oil prices than

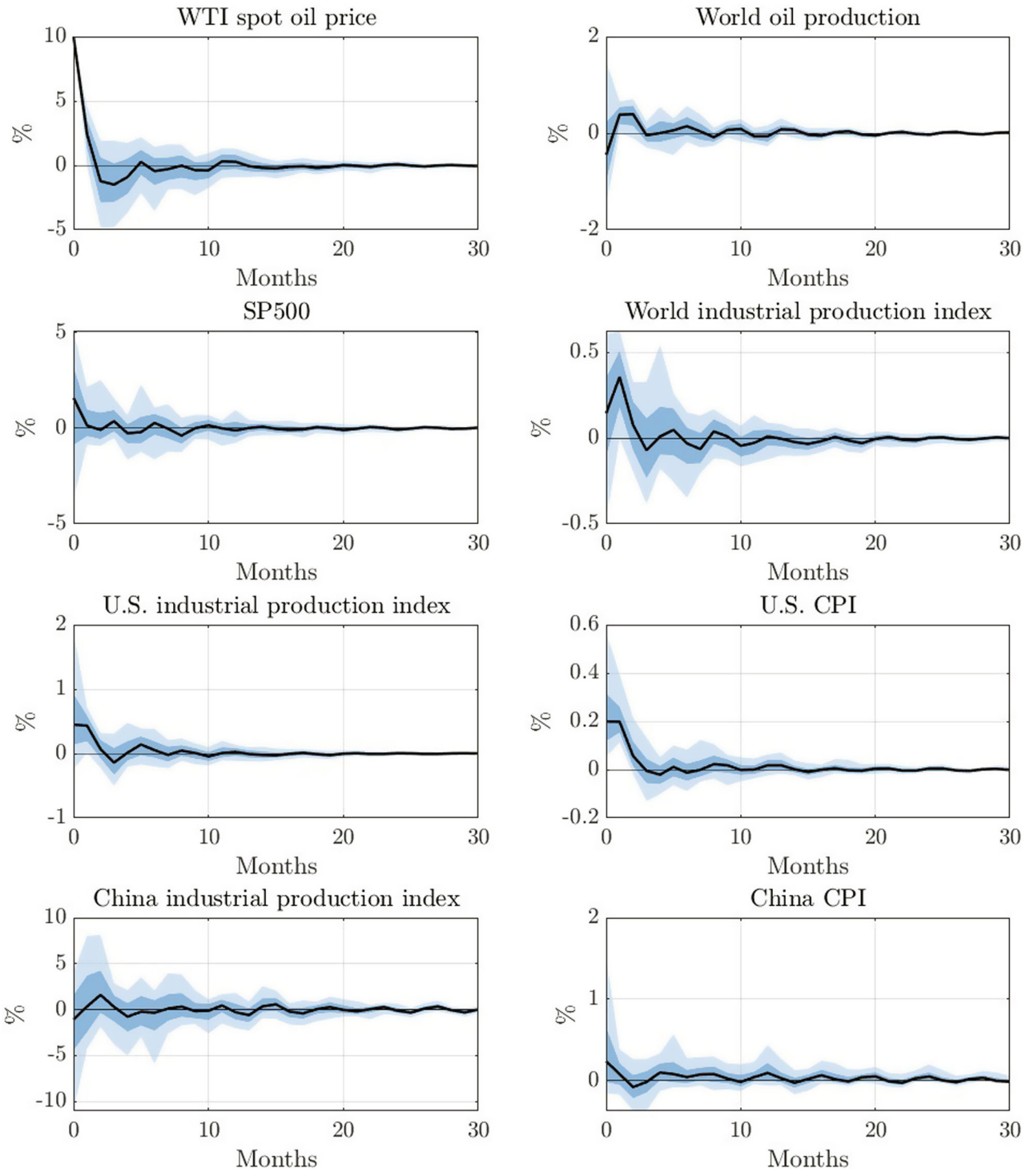

Fig. 2 Impulse responses to a major crisis events shock.

on industrial production indices, consistent with the findings of Zhang et al. (2022).

Simultaneously, major crisis events stimulated a rapid increase in the CPI, potentially resulting in inflation. On the one hand, during wartime, governments may resort to printing more money to bolster their revenue, leading to inflation (Adam et al. 2008). On the other hand, major crisis events, such as the 2008 financial crisis and the global COVID-19 pandemic, can severely damage the economy. To restore economic vitality, governments may implement measures like lowering interest rates and engaging in

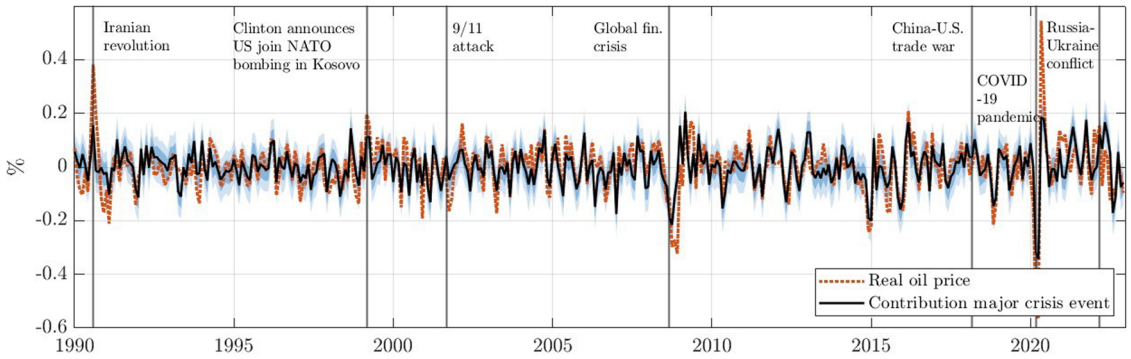

Fig. 3 Historical decomposition of the real price of oil.

large-scale asset purchases (i.e., "quantitative easing"), which can fuel inflation. Figure 2 indicates that the positive response of the CPI in the United States was initially greater than that in China until the fifth period. Thereafter, China's CPI response exceeded that of the United States. In addition to China's economic stimulus policy, the States' expansionary monetary policy has an international spillover effect that positively impacts China's inflation through three channels: international short-term capital flows, commodity prices, and foreign trade (Neri and Nobili 2010), intensifying China's CPI response in the later period.

Overall, the impact of major crisis events on the crude oil market typically lasts for approximately two years, whereas the impact on the economy persists for approximately two and a half years.

Major crisis events as a driver of the real price of oil. Subsequently, an analysis is conducted to decompose the actual price of crude oil over time and examine the cumulative contribution of major crisis events to fluctuations in crude oil prices. The findings are presented in Fig. 3, which indicates that significant crisis events significantly affect changes in crude oil prices, particularly sudden fluctuations. Notably, the first Gulf War in August 1990, initiated by Iraq's invasion of Kuwait, substantially increased crude oil prices. In the following years, oil prices remained relatively stable, with minor variations of approximately $20 per barrel. However, NATO's attack on Yugoslavia in March 1999 resulted in a modest increase in oil prices, while the impact of the "9/11" incident in 2001 was comparatively insignificant. Subsequently, crude oil prices mostly experienced positive changes, exhibiting a steady upward trajectory until the onset of the global financial crisis in September 2008. This event triggered a sharp decline in oil prices, with actual crude oil prices plummeting by 70%. However, because of the stimulus policies implemented by various countries, the economy began to recover, leading to an increase in oil prices (He et al. 2010). The trade war between China and the United States in March 2018 had a marginal impact on oil prices, causing only a slight drop. However, when the COVID-19 pandemic emerged in March 2020, it significantly affected production activities, resulting in a substantial decrease in oil demand and a drop in crude oil prices by more than 71%. Following the gradual control of the epidemic, the impact of the Russia-Ukraine War and its subsequent events overlapped, pushing oil prices to a new peak in June 2022. Hence, it is evident that major crisis events exert a considerable influence on historical actual crude oil price formation, especially with jumps or falls, leading to a shift in mechanisms (Chai et al. 2018). Therefore, such events must be appropriately considered when analyzing crude oil prices.

Further discussion

In the Results part, the article discusses the impact of major crisis events on the crude oil market and economy. Do different event types have different impact levels and durations? The following sections discuss this in detail.

The impact of wars and geopolitical conflicts. Figure 4 displays the effect of war or geopolitical conflict on the crude oil market and economy. The robust F value of the initial stage regression is 13.54, which surpasses 10, indicating the reliability of the proxy variable.

Notably, the influence of war on the crude oil market aligns with the results obtained for the overall events. The analysis reveals that wars instigate a surge in crude oil prices during the initial two periods; however, these effects gradually fade and converge toward zero in the long run. Furthermore, wars initially triggered a dip in crude oil production, followed by a gradual recovery. Relative to the overall trends, wars have a more noteworthy effect on global crude oil production, as most of the 21 captured wars or geopolitical conflicts occur in oil-producing countries. Consequently, the impact of the war on oil production became more pronounced. This corresponds to the global distribution of crude oil. Based on EIA data, a significant proportion of the world's crude oil occurs in regions susceptible to political turmoil or oil production disruptions due to historical political events (Monge et al. 2017).

In contrast to general market trends, the S&P500 index experienced a rapid decline of 2.99% in the current period, which slowed down in the first period, increased again in the second period, gradually decreased after the third period, turned into a positive response, and tended to zero in the long term. The observed response pattern resembled a "V" shape, which can be attributed to investor panic induced by the uncertainty of the event, leading to the decline of the S&P500 index. However, as the uncertainty subsided, the S&P500 index quickly rebounded. The impact of the war was not limited to China's current production index but also affected the production indices of the United States and the world, indicating a global reduction in production.

The CPI responses of both countries are consistent with the overall results, as war and geopolitical conflicts tend to cause inflation (Adam et al. 2008). The uncertainty surrounding postwar economic policies also contribute to hyperinflation (Lopez and Mitchener 2021). The war had a more prolonged impact on China's industrial production and CPI than on the United States, potentially due to the latter's leading role in the global economy and the core position of the US dollar in the international monetary system, which may have rendered the US economy less vulnerable.

Overall, the war had a lasting impact on the crude oil market for approximately three years, on the US economy for approximately two and a half years, and on China for four years.

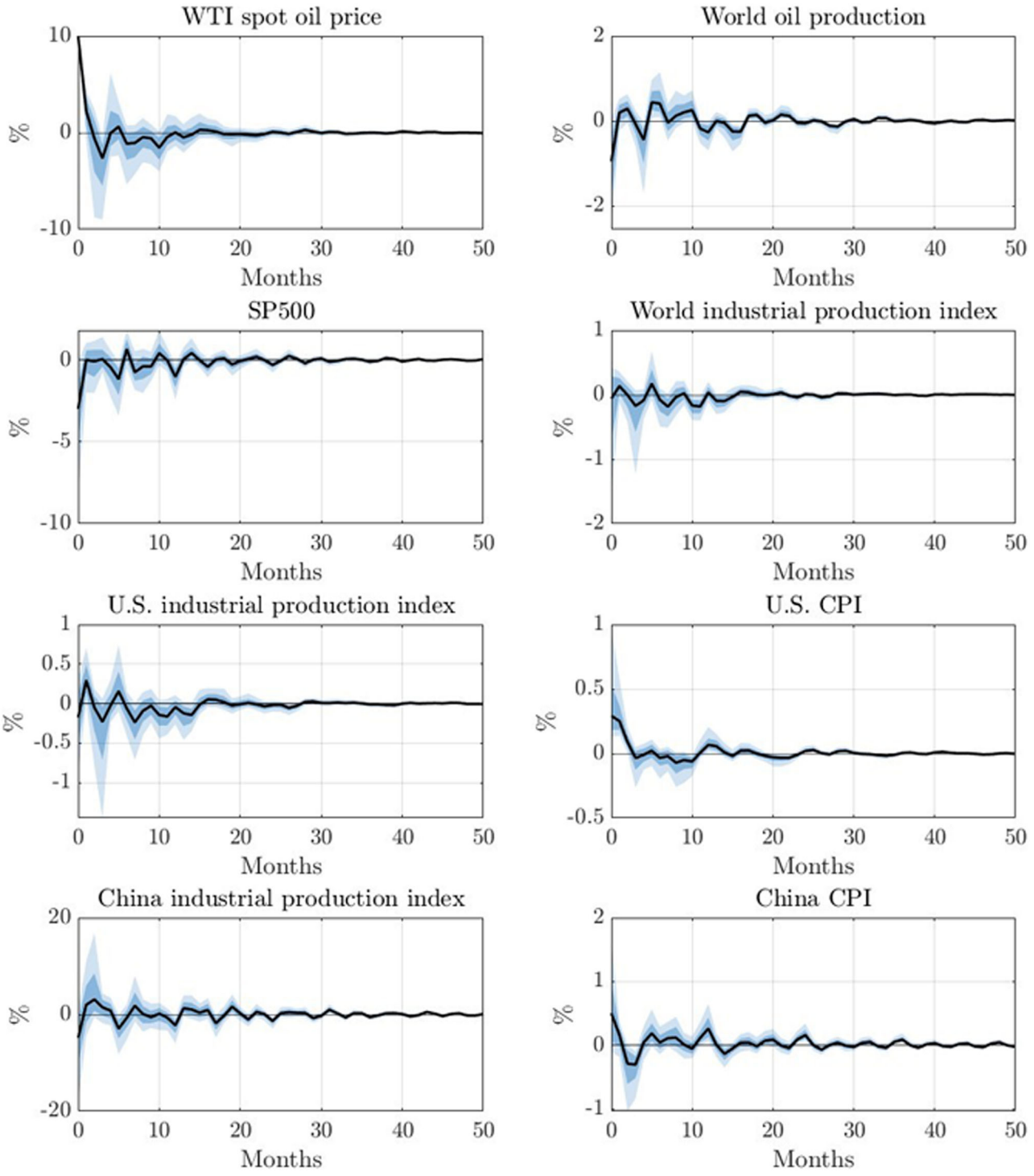

Fig. 4 Impulse responses to a war or geopolitical conflict shock.

The impact of natural disasters. Figure 5 illustrates the responses of the crude oil market and economy to natural disasters. The initial-stage regression produced a robust F value of only 0.52, which fell markedly below the threshold of 10, indicating a weak instrumental variable. Nonetheless, the impulse response function provides a preliminary explanation for the impact of natural disasters.

The impact of natural disasters on the crude oil market is similar to the wars. Specifically, crude oil prices initially surged, then retreated, and ultimately converged to zero in the long term.

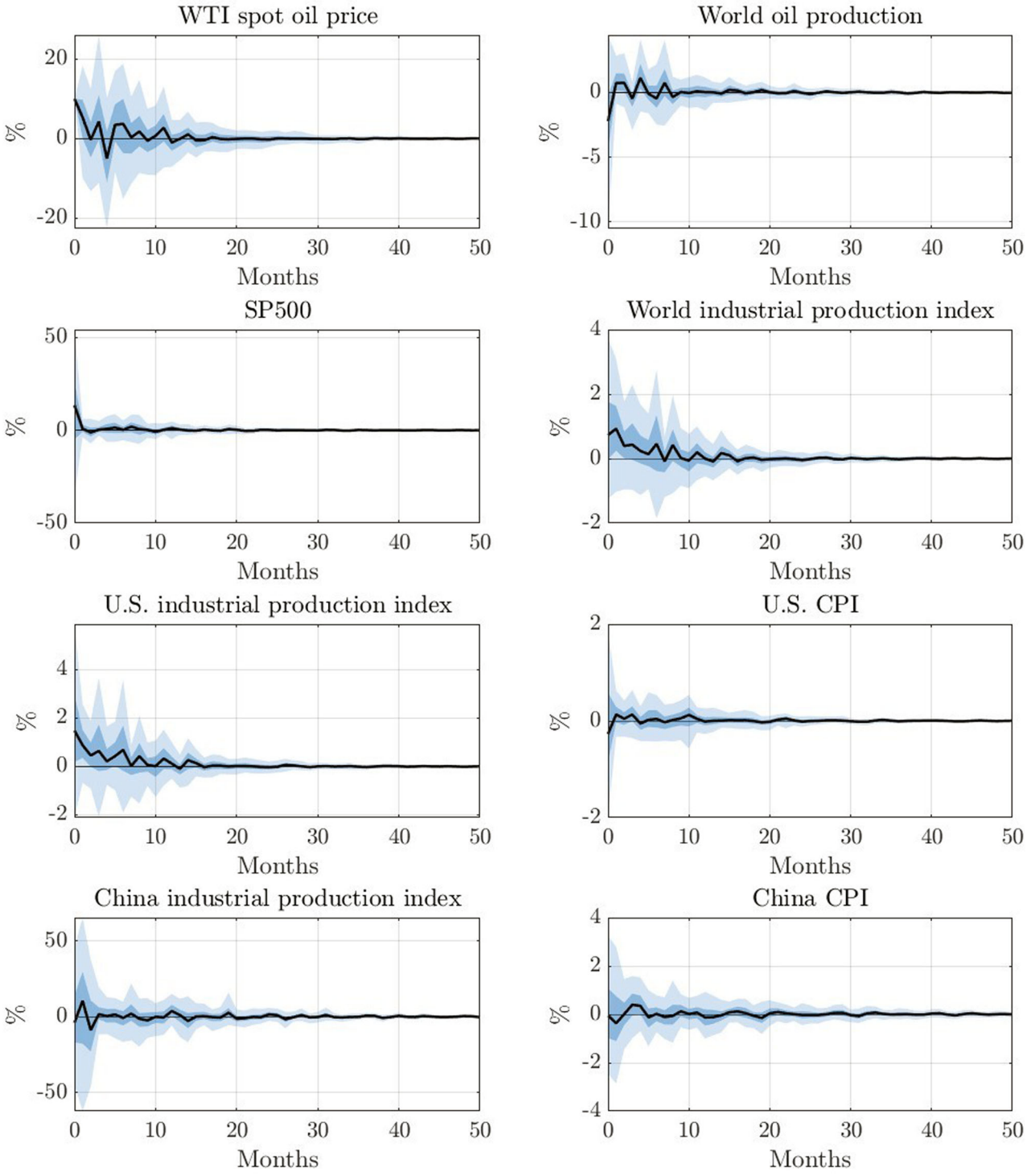

Fig. 5 Impulse responses to a natural disaster shock.

However, in the context of natural disasters, the adjustment in oil prices was even more pronounced. Additionally, the global crude oil output exhibited a trend of initially declining, rebounding, and ultimately approaching zero for an extended period. Natural disasters and geopolitical conflicts both affect the crude oil market through supply channels, decreasing crude oil production, causing supply interruption panic, and ultimately increasing crude oil prices.

In contrast to the negative impact of war, natural disasters elicit a positive response from the S&P500, which quickly dissipates to

zero. The response of the World industrial production index and the U.S. industrial production index to natural disasters was positive in the first ten periods and gradually weakened to zero. This is largely because natural disasters with destructive solid power and severe losses are predominantly concentrated in Asia, particularly in China, which accounts for 93.75% of these events. As a result, the impact on OECD countries, including the United States, is negligible but provides opportunities for increased export of relief and post-disaster reconstruction materials. The China industrial production index was negative in the current period, followed by a positive response in the following two periods and a negative response before tending towards 0, consistent with the overall pulse result. As mentioned earlier, the positive response is the temporary production growth formed to complete post-disaster reconstruction efficiently.

The initial reaction of the CPI in the United States and China to natural disasters is negative, indicating that disasters may lead to deflation to some extent. Because disasters can trigger adverse demand shocks, reduce the consumption tendency of entities, and exert downward pressure on actual factor prices, actual marginal costs, and inflation (Brede 2013; Isoré and Szczerbowicz 2017). Afterwards, the response of CPI was positive, as monetary authorities adopted expansionary monetary policies to stimulate economic growth. Klomp (2020) proved that policy interest rates will decrease in the first year after an earthquake. In addition, the positive response of China's CPI in the following periods is greater than that of the United States because developing countries prioritize economic recovery over price stability after natural disasters and tend to adopt expansionary monetary policies to stimulate the economy. In contrast, monetary authorities in developed countries are more concerned with reducing inflationary pressures (Klomp 2020).

Overall, the impact of natural disasters on the crude oil market and the global economy is short-lived, lasting approximately one and a half years. However, in China, the impact was more prolonged, lasting for two years, owing to the country's economic fragility and the concentration of natural disasters in the region.

The impact of an economic and financial crisis. Figure 6 demonstrates the reactions of the crude oil market and economy during an economic and financial crisis. Although instrumental variables have limitations, applying impulse response analysis can offer preliminary insights.

Economic and financial crises, distinct from the previous two event categories, resulted in a swift decrease in oil prices while sustaining a positive effect on global oil production. This situation arose from the impact of the crisis on the demand side of the crude oil market. For instance, during the 2008 financial crisis, the subprime mortgage fiasco triggered a liquidity crisis, leading to the closure of numerous financial institutions and an economic recession. During this period, crude oil demand was sluggish, and the supply exceeded demand, inducing a sharp fall in prices (Baumeister and Kilian 2016).

After the financial crisis, China's industrial production index fluctuated much more than that of the United States. After the 2008 financial crisis, China took ten measures to expand domestic demand, such as accelerating major infrastructure construction, such as railways, highways, and airports. Implementing these measures has dramatically improved China's industrial production index but also caused the consequence of overcapacity. Therefore, China's industrial production index has significantly changed, with positive and negative responses. Although the United States has also launched an economic stimulus package worth $787 billion, emphasizing re-industrialization and manufacturing revitalization, the long-term hollowing out of industries has resulted in poor policy implementation and limited response to industrial production indices.

The economic and financial crisis has rapidly increased the CPI index of the United States and China. After the 2008 financial crisis, the United States adopted a quantitative easing policy, and China proposed a "package plan" to expand domestic demand further and promote economic growth (Mi et al. 2018). These measures have significantly increased the domestic inflation level. Similar to the impact of the war, China's CPI response and duration are greater than those of the United States, mainly due to the spillover effect of the U.S. monetary policy on inflation. For example, in 2008, China increased its holdings of U.S. treasury bonds by more than $200 billion.

Overall, the impact of the financial crisis on the crude oil market and economy lasted for an extended period, affecting the crude oil market for over three years and the global economy for over four years. This finding was consistent with the observations of Li et al. (2020).

The impact of public health emergency. Figure 7 shows the influence of global public health emergencies on the crude oil market and economy. The robust F-value of the first-stage regression of 77.88, exceeding 10, confirms the reliability of the proxy variable.

Despite a slight initial surge in oil prices in the crude oil market, crude oil prices continued to diminish from the second to the tenth period, ultimately approaching zero owing to the dire impact of the epidemic on the world economy. The pandemic has severely affected production and life, inducing a sharp decline in global oil demand, economic panic, and oil price adjustments. During the first four periods, global crude oil production exhibited a constructive response. Notably, 2020 marked the worldwide spread of COVID-19, the unexpected termination of the Vienna Alliance Agreement, and the absence of a production-reduction agreement. Simultaneously, Saudi Arabia instigated a "price war," leading to a considerable cut in oil prices, which significantly contributed to the substantial drop in actual crude oil prices. The output manifested as a negative response only after the fifth phase.

The response of S&P500 to sudden public health emergencies is more intense, but the duration is short, and it quickly turns into a negative response. This is an apparent overreaction (Scherf et al. 2022). During the pandemic, stock returns are more sensitive to market-wide news, and this overreaction to macro information leads to incorrect pricing corrections for future returns (Xu et al. 2023). The response of the global industrial production index is similar to that of the U.S. industrial production index, with positive responses in the first two periods and a negative response in the third period, ultimately approaching zero in the long run. China's industrial production index demonstrates a more intense response that persists for an extended period. In December 2019, COVID-19 began to spread in China. In March 2020, the World Health Organization classified COVID-19 as a "global pandemic". China implemented strict control measures, resulting in widespread stagnation of industrial production activities and decreased factor inputs, which were the main reasons for the economic downturn (Jia et al. 2021; Rothwell et al. 2024).

Initially positive, the response of the CPI in the United States rapidly declined in the second period and gradually approached zero. In response to the impact of COVID-19, the Federal Reserve has implemented a significant interest rate cut and an "unlimited" quantitative easing policy, which has resulted in high inflation. In China, the CPI response fluctuates around zero, ranging from negative to positive, with an amplitude continuously decreasing and ultimately converging to zero in the long run.

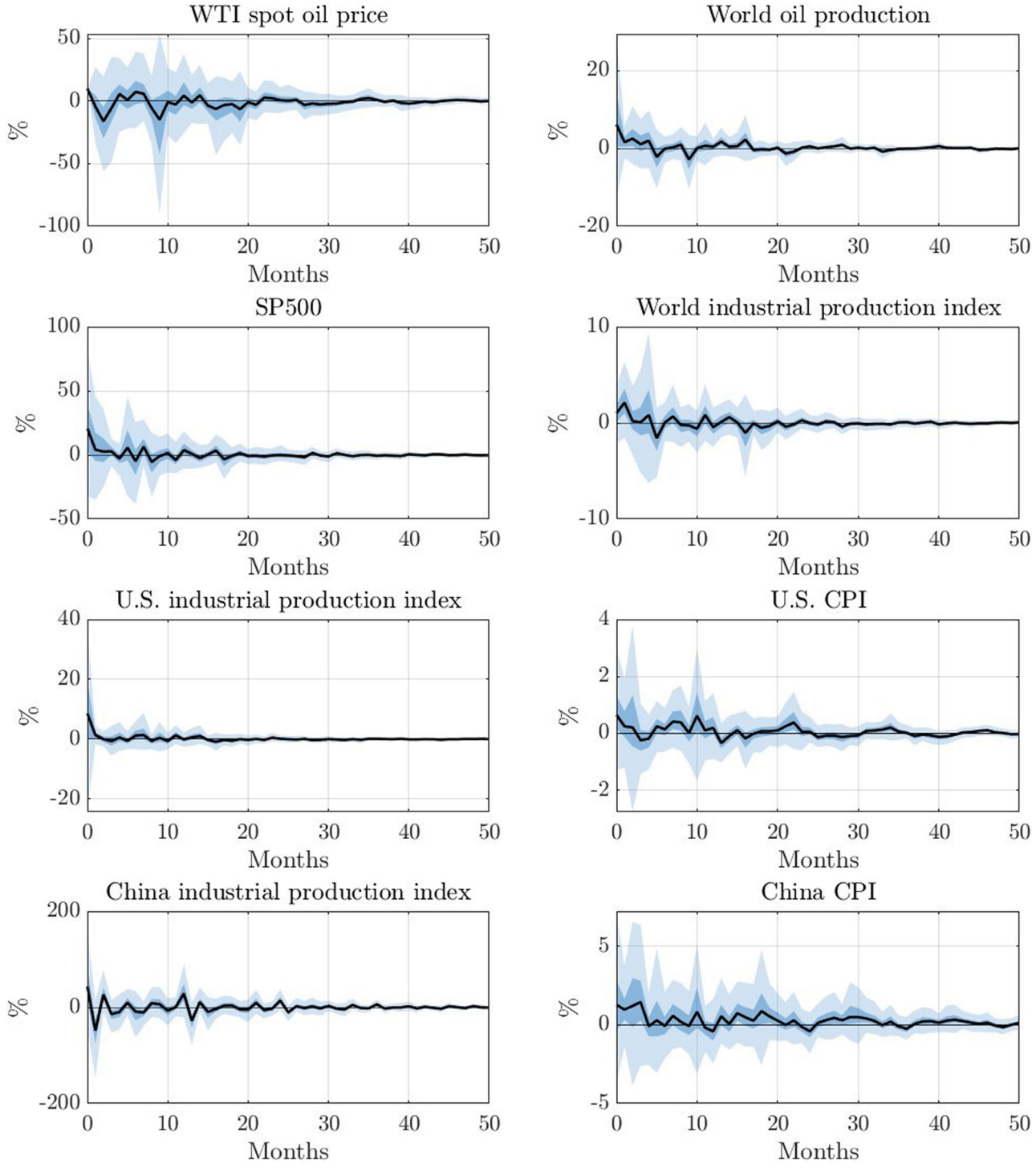

Fig. 6 Impulse responses to economic or financial crisis shock.

Overall, public health emergencies, particularly the COVID-19 pandemic, have had a prolonged impact on the crude oil market and economy, persisting for approximately two and a half years. In comparison, its impact on China's economy has endured for approximately three years.

Geopolitical conflicts and natural disasters affect the crude oil market and economy from the supply side. Both types of events will lead to a decrease in crude oil production and an increase in crude oil prices, but the impact of geopolitical conflicts will be more severe and long-lasting. In addition, both

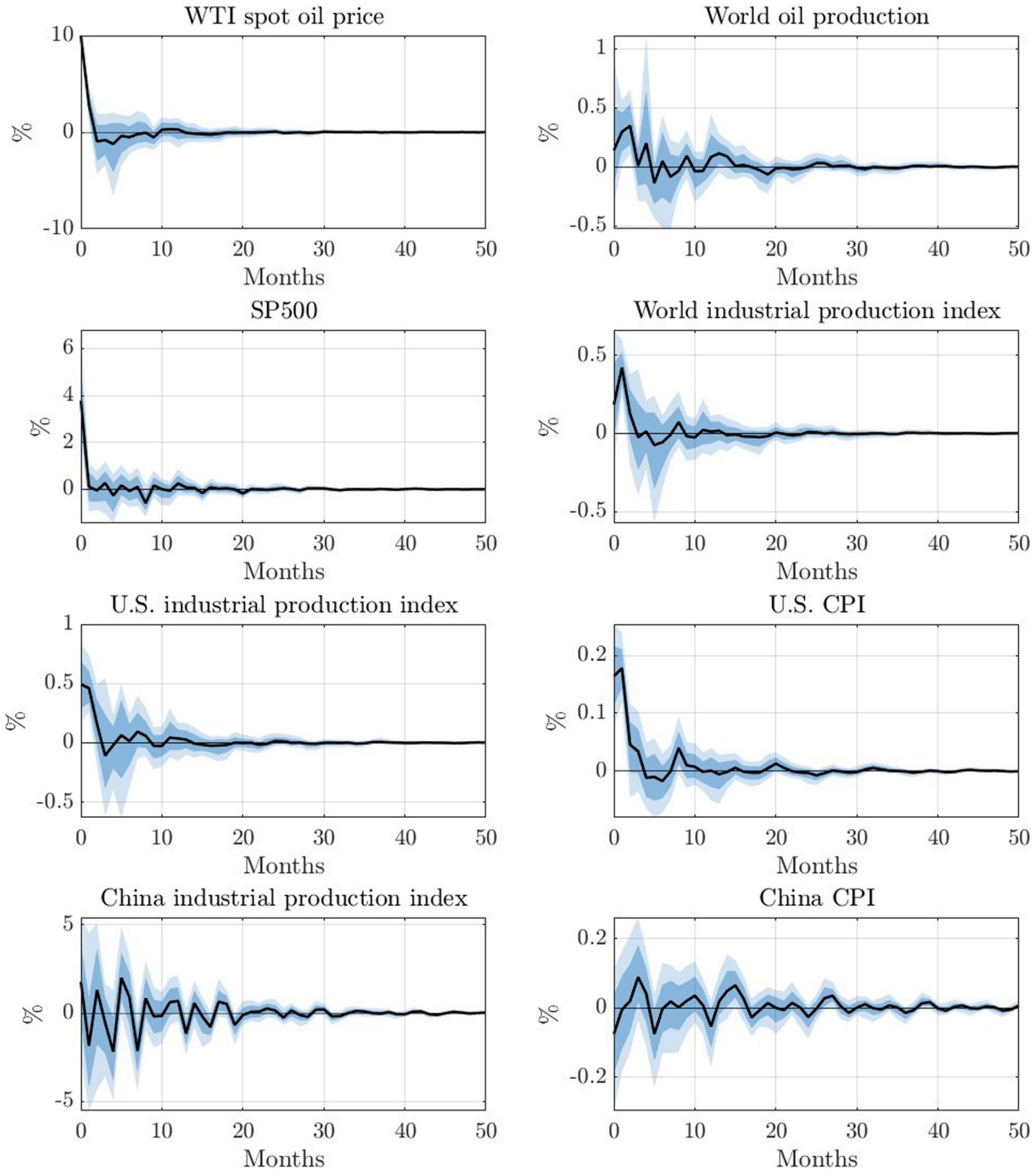

Fig. 7 Impulse responses to a public health emergency shock.

types of events harm China's industrial production index, but natural disasters positively impact the world and the US industrial production index. This is because most natural disasters selected based on their intensity occur in Asia and have a relatively small impact on OECD countries. Geopolitical conflicts can bring considerable inflation to China and the United States, but natural disasters can cause deflation.

The financial crisis and sudden health emergencies impact the crude oil market and economy from the demand side. These two types of events will increase crude oil production and decrease

crude oil prices, but the impact of financial crises will be more prolonged. Compared to industrial production in the United States, these two types of events have a more severe impact on China's industrial production index. The difference is that financial crises can lead to inflation in both countries, but sudden health emergencies only cause inflation problems in the United States.

Conclusion and policy implications

The short-term impacts of major crisis events on the crude oil market and economy appear quickly, but the long-term effects are difficult to expose. This study aims to identify the degree and duration of the impact of major crisis events on the crude oil market and economy and explore the commonalities and characteristics of event impacts. Using monthly data from January 1990 to December 2022, a Proxy-SVAR model was employed to analyze the impact of 50 selected events, including 21 wars and geopolitical conflicts, 16 natural disasters, seven economic and financial crises, and six public health emergencies. The proxy variable is the percentage change in WTI crude oil futures prices before and after the events.

This paper has several new findings as follows: (1) There are common characteristics in the impact of major crisis events on the crude oil market and economy. The impact of events on the crude oil market is more severe, but the duration is shorter, and the impact on the economy is weaker, but the duration is longer. The impact on the crude oil market lasts about two years, while the impact on the economy lasts about two and a half years. (2) The impact of major crisis events on the crude oil market can be divided into two categories: wars and natural disasters that affect oil prices from the supply channel, economic/financial crises that affect oil prices from the demand channel, and sudden public health emergencies. Events that affect the supply side will lead to increased crude oil prices and decreased industrial production indices. In contrast, events that affect the demand side will lead to a decrease in crude oil prices and an increase in industrial production indices. (3) Financial crises and sudden health emergencies affect the crude oil market from a demand perspective, and the two have essential similarities in uncertainty, economic recession, and monetary and policy authorities' responses. However, there is still a significant difference between the two. The financial crisis spreads from the financial market to the market economy. At the same time, sudden public health emergencies lead to business shutdowns and supply chain disruptions, ultimately affecting the financial sector. In contrast, the financial crisis has a more prolonged impact on the crude oil market and economy. (4) Major crisis events can lead to inflation and have powerful spillover effects. To cope with the impact of major crisis events, the US government often adopts economic stimulus policies such as expanding its balance sheet, leading to widespread inflation. The core position of the US dollar in the international monetary system helps the United States shift inflation, thus having a more substantial and longer-lasting impact on China's CPI.

Based on the above conclusions, this article proposes the following suggestions: (1) Establish and improve an economic monitoring and early warning system. Major crisis events not only directly impact the economy but also impact the economy through the crude oil market, resulting in a longer negative response time for economic activities. Therefore, in the face of major crisis events such as geopolitical conflicts, government authorities need to act quickly to curb economic risks, such as responding to supply chain shocks through proactive hoarding, expanding the sharing of import risks among other importing countries, improving financial risk monitoring, and strengthening macroeconomic prudential policies. (2) Be cautious in preventing the impact of major crisis events on the crude oil market. For energy-importing countries, events such as geopolitical conflicts and natural disasters, which are shocks from the supply side, will have a more significant impact. Therefore, it is necessary to build a diversified energy import pattern, reduce excessive dependence on a particular country or region, and prevent the crisis of energy supply interruption. In the long run, it is necessary to transform the energy development mode and vigorously develop renewable energy. On the one hand, it can reduce the impact of energy price fluctuations caused by major crisis events on the macro economy. On the other hand, it can ensure national energy security through a diversified energy system. (3) Persist in preventing and resolving major financial risks. Although financial crises and sudden health emergencies affect the economy from the demand side, the harm of financial crises that spread from the financial market to the crude oil market and economy is greater than that of sudden health emergencies that spread from the real economy. In the context of global economic interconnectivity, the contagion effect of major financial risks is powerful. We need to optimize the governance of the financial system, strengthen and improve modern financial supervision, and scientifically prevent financial risks. (4) Multiple measures should be taken simultaneously to prevent the spillover and transfer of inflation. Monetary authorities should flexibly apply exchange rate policies and foreign exchange management systems, intervene in the exchange rate market promptly, and maintain the stability of their domestic currency. At the same time, control over import inflation should be strengthened through trade policies and tariffs to prevent external inflation from being transmitted to the country through imported commodity prices. (5) Enterprises should establish emergency mechanisms and use financial instruments reasonably to hedge risks. The impact of major crisis events on the crude oil market and the economy will also significantly affect the operation of enterprises. Enterprises should strengthen risk management, establish a risk management system and corresponding emergency plans, and reasonably use financial instruments such as futures, options, and hedge funds to reduce risk exposure and achieve safe and effective operations.

Data availability

The datasets analyzed during the current study are available in the Harvard Dataverse, https://doi.org/10.7910/DVN/DZJDYU.

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Notes

1 https://www.systemicpeace.org/warlist/warlist.htm.
2 The number listed represents a scaled indicator of the destructive impact, or magnitude, of the violent episode on the directly-affected society or societies on a scale of 1 (smallest) to 10 (greatest). Magnitude scores reflect multiple factors including state capabilities, interactiveintensity (means and goals), area and scope of death and destruction, population displacement, and episode duration.
3 https://public.emdat.be/data.
4 https://en.wikipedia.org/wiki/Financial_crisis.
5 https://en.wikipedia.org/wiki/List_of_epidemics.
6 https://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm.
7 https://www.investing.com/indices/us-spx-500-historical-data.
8 https://sites.google.com/site/cjsbaumeister/datasets.
9 https://fred.stlouisfed.org/series/INDPRO.
10 https://fred.stlouisfed.org/series/USACPIALLMINMEI.

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Competing interests

The authors declare no competing interests.

Ethical approval

This article does not contain any studies with human participants performed by any of the authors.

Informed consent

Informed consent is not applicable. The study used secondary data. The authors did not directly engage any participants.

Additional information

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