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Identification using prices of gold and oil**

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Disentangling Supply-Side and Demand-Side Effects of Uncertainty Shocks on U.S. Financial Markets: Identification using Prices of Gold and Oil*

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Abstract

This paper investigates the effects of uncertainty shocks on selected U.S. financial asset prices by decomposing a traditional uncertainty shock into its supply-side and demand-side components. Following the approach by [Piffer and Podstawski \(2018\)](#), we identify uncertainty shocks using the price of gold and enhance this strategy by introducing the price of oil as a second variable. By examining daily price changes during significant events that trigger uncertainty, we provide evidence suggesting that despite an increase in gold prices, supply-side uncertainty shocks (e.g. armed conflicts or natural disasters) tend to result in higher oil prices, while demand-side uncertainty shocks (e.g. political and economic events) lead to declining oil prices. By exploiting this information with help of sign restrictions, we create two proxy variables and estimate Bayesian Vector Autoregression (BVAR) models to identify supply-side and demand-side uncertainty shocks. Our findings indicate that while gold prices alone can identify uncertainty shocks for most variables, the inclusion of oil prices reveals an additional dimension. The effects of these shocks differ in their impact on inflation expectations and may thus be a potential source of price puzzles if only the price of gold is considered.

Keywords: uncertainty, proxy VAR, sign restrictions

JEL classification: E43, E47, E52.

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1 Introduction

Uncertainty plays a crucial role in economic decision-making and has significant implications for various economic variables. The literature has explored different interpretations and measures of uncertainty, including GARCH effects, uncertainty indices, and structural shocks. One popular method to identify structural uncertainty shocks is the proxy VAR approach by [Piffer and Podstawski \(2018\)](#), which uses changes in the price of gold around major events as a proxy for uncertainty. However, this approach may overlook the multidimensional nature of uncertainty, particularly when different types of events (e.g. armed conflicts or natural disasters vs political or economic uncertainty) have distinct impacts on asset prices.

This paper aims to provide evidence suggesting that an uncertainty shock identified with help of the price of gold alone may overlook important aspects of uncertainty. To highlight these aspects, we disentangle the supply-side and demand-side dimensions of these uncertainty shocks by examining the daily price changes of gold and oil at important events.¹ We assume that supply-side shocks (e.g. armed conflicts or natural disasters), and demand-side shocks (e.g. political or economic events) affect gold and oil prices differently. Armed conflicts or natural disasters are likely to cause supply-side disruptions or stockpiling for oil, leading to increases in both gold and oil prices. In contrast, political and economic uncertainty typically leads to increased gold prices as investors seek safe-haven assets, while oil prices may decrease due to anticipated lower economic activity and demand.

To identify these distinct effects, we use sign restrictions on the price changes of gold and oil and derive two proxy variables. Our analysis then employs a proxy BVAR model to estimate the impact of these shocks on various economic variables. This approach allows us to differentiate between the impacts of supply-side shocks and demand-side shocks. Our findings provide valuable insights into the multidimensional nature of uncertainty shocks and their varied effects on economic variables.

Understanding the dynamics of uncertainty shocks is essential for both policymakers and market participants. Prior research has shown that uncertainty can lead to significant economic fluctuations, affecting investment, consumption, and overall economic stability. The role of safe-haven assets like gold in times of uncertainty is well-documented, but the inclusion of oil prices can provide a more comprehensive view of how different types of uncertainty impact the economy.

2 Literature Review

The literature on uncertainty and its economic effects is extensive. [Bloom \(2009\)](#) highlights the role of uncertainty in driving economic fluctuations, showing that uncertainty shocks can lead to significant declines in economic activity. He emphasizes the importance of understanding the sources and impacts of uncertainty to better inform policy responses.

From an econometric point of view, one key question is how global uncertainty shocks can be identified. Several papers do not directly identify uncertainty shocks but use

¹Note that supply-side and demand-side uncertainty do not refer to aggregate supply and demand.

established uncertainty measures such as the economic policy uncertainty approach by Baker, Bloom, and Davis (2016). Other work in this area includes Agoraki, Wu, Xu, and Yang (2024), Choi, Ciminelli, and Furceri (2023), Grebe, Kandemir, and Tillmann (2024), and Bondarenko, Lewis, Rottner, and Schüler (2024), for example. In other papers, uncertainty is modeled with help of large-scale VARs or factor models with stochastic volatility components (see Mumtaz and Theodoridis (2017), Mumtaz and Musso (2021) and, Berger and Grabert (2018).

Recently, another identification strategy has become popular. Piffer and Podstawski (2018) use changes in gold prices as a proxy for uncertainty shocks, arguing that gold, as a safe-haven asset, reacts strongly to events that increase uncertainty. Their study demonstrates that changes in gold prices around major events can serve as a useful proxy for identifying uncertainty shocks in a VAR framework. This approach has been employed, for example, by Beckmann and Bettendorf (2024) with a focus on fund flows or Georgiadis, Müller, and Schumann (2024) with a focus on the U.S. dollar.

As we will argue in the following paragraph that the price of oil helps in disentangling supply-side and demand-side uncertainty shocks, this paper is also linked a strand of literature that deals with the effects of oil on the economy. Kilian (2009) and Hamilton (2009), for instance, discuss the impact of oil price shocks on the economy, highlighting the importance of distinguishing between supply-side and demand-side shocks. In particular, Kilian emphasises the need to disentangle different types of oil price shocks to understand their distinct economic effects.

Pinchetti (2024) proposes an approach that is more closely related to the present paper. He uses the Caldara and Iacoviello (2022) geopolitical risk index to disentangle the impact of geopolitical shocks associated with disruptions in energy markets from geopolitical shocks associated with economic contractions unrelated to energy markets. However, the paper differs from the current approach in two important aspects: first, Pinchetti (2024) focuses on geopolitical risk, which is a narrower measure than the one used by Piffer and Podstawski (2018). In this sense, our approach captures uncertainty in a much broader way. Second, the present paper models financial markets in such a way that the model can be adjusted to a higher frequency for policy analysis on a high-frequency basis.

3 The proxy variables

To identify structural uncertainty shocks, we utilize proxy variables that are expected to be highly correlated with the corresponding underlying structural shock but uncorrelated with all other shocks. Our methodology is grounded in the fundamental assumption proposed by Piffer and Podstawski (2018), which posits that the price of gold increases within short intraday windows following an event that triggers unexpected uncertainty. It is reasonable to assume that, given a sequence of potential events, no other shock would exhibit the same temporal pattern.

We slightly modify this assumption by relying on daily changes.² This adjustment allows us to work with publicly available data while still producing robust results. Additionally, we introduce the price of oil as a second variable to help identify different

²Note that Piffer and Podstawski (2018) rely on data providing them with two observations per day.

dimensions of uncertainty, namely supply-side and demand-side uncertainty. This strategy is based on the assumption that supply-side uncertainty immediately leads to rising oil prices. Supply-side events, such as armed conflicts, typically require significant amounts of fuel. Furthermore, such conflicts or natural disasters can disrupt oil production or supply chains, prompting countries to increase their strategic reserves. Speculation is also a factor that can drive up prices in such events. Conversely, we assume that demand-side uncertainty translates into declining oil prices due to lower demand, as the economy is expected to cool down.

We plot the reactions of oil and gold prices on days of selected events in Figure 1. The events are selected in such a way that they capture the 95th percentile of events with the strongest movements in the gold price. This simplifies the identification while still considering the most important information for the proxy variable. Indeed, we observe that oil prices tend to move in the same direction as gold prices when an event can be interpreted as supply-side event, such as an armed conflict.³ In contrast, the prices move in opposite directions when the event is of demand-side nature, such as political or economic uncertainty. Note that the figure also displays inverse shocks, such as Operation Desert Storm, a military operation to liberate Kuwait from Iraqi occupation. Following Iraq's invasion of Kuwait (second plot in Figure 1), there was significant speculation and fear regarding oil supply, which drove up the prices of oil and gold as safe-haven assets. However, Operation Desert Storm (third plot in Figure 1) led to a resolution of uncertainty and increased confidence in oil supply.⁴ In contrast, events such as Black Monday or Brexit are primarily demand-side events that are expected to lead to economic slowdowns. On the other hand, when clinical trials by Pfizer/Biontech increased the probability of an effective vaccine against COVID-19 symptoms, it brought relief and confidence regarding economic recovery after the collapse in early 2020.⁵

It is also essential to consider that events can trigger both supply-side and demand-side shocks simultaneously. For instance, an armed conflict could coincide with concerns regarding political stability, implying that oil prices are affected by both supply-side and demand-side effects at the same time. Therefore, it is important to ensure that the proxies are created in such a way that both shocks can occur simultaneously. However, this does not imply any correlation over the sample period.

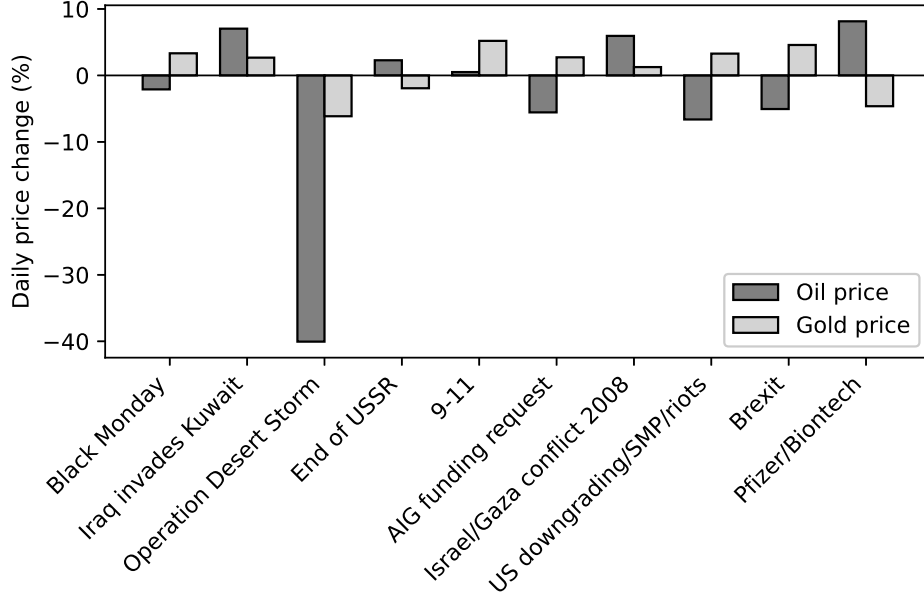
To accommodate for all these considerations, we create the proxy variables as follows: first, we obtain the daily changes in the prices of gold and oil at important events (see Table 2). It is essential to ensure that the occurrences of these events correspond to the time zones of the price fixings. Second, we standardise the time series. Third, we decompose the series using the sign restrictions shown in Figure 1. More specifically, we

³Since there is no natural disaster with similarly strong effects on the prices of gold and oil, our sample does not include any natural disasters. However, the effects are expected to be similar. When the proxy variable is incorporated into the VAR model, the identification strategy should recognize any uncertainty shock related to a natural disaster primarily as a supply-side shock.

⁴The daily changes at 9/11 can also be considered as a form of supply-side uncertainty. Here it is important to note that NYBOT trading had commenced before the terrorist attacks occurred and was halted due to the attacks. This gives us a data observation of this day, even though NYSE did not open.

⁵We acknowledge that the occurrence of COVID-19 was also an event that caused significant uncertainty, impacting both financial markets and the real economy. However, it was a gradual process in which financial market participants priced in the effects of COVID-19 into asset prices over time. Therefore, the emergence of COVID-19 is not ideal for identifying a structural shock. We believe that the potential availability of a vaccine serves as a much better proxy for this purpose.

Figure 1: Daily price changes in gold and oil at important events



employ the median-target approach by [Fry-McKibbin and Pagan \(2007\)](#).⁶ Finally, we disaggregate the two decomposed series into monthly data. If there are two occurrences in one month, we sum them. This strategy ensures that both types of shocks can occur at the same time.

Table 1: Sign restrictions for identifying uncertainty shocks

	Supply-side	Demand-side
Price of gold	+	+
Price of oil	+	-

4 Methodology

4.1 Proxy BVAR Model

We estimate a Bayesian Vector Autoregression (BVAR) model with a Minnesota prior to identify structural uncertainty shocks according to [Ferroni and Canova \(2021\)](#), following the approach by [Stock and Watson \(2012\)](#) and [Mertens and Ravn \(2013\)](#).⁷ The model is specified as follows:

$$y_t = c + \sum_{i=1}^p A_i y_{t-p} + u_t \quad (1)$$

⁶This methodology is borrowed from the literature on the identification of pure monetary policy shocks and central bank information shocks. [Alessi and Kerssenfischer \(2019\)](#), for example, employ exactly the same procedure on changes in yields and stock prices.

⁷The hyper-parameters of the prior are computed to maximise the marginal data density (see [Giannone, Lenza, and Primiceri \(2015\)](#))

where y_t is the vector of endogenous variables, c is a vector of constants, A_i are the coefficient matrices for lagged data with $p = 6$ lags, and u_t is the vector of reduced-form residuals.

The structural shocks are identified using the following relationship:

$$u_t = B\epsilon_t \quad (2)$$

where B is the matrix of contemporaneous relationships, and ϵ_t is the vector of structural shocks.

We further decompose the reduced-form residuals as:

$$u_t = b^u \epsilon_t^u + B^* \epsilon_t^* \quad (3)$$

where ϵ_t^u is the uncertainty shock, and ϵ_t^* are other structural shocks. The proxy variable m_t is used to identify the uncertainty shock:

$$E(\epsilon_t^u m_t) = \phi_u \neq 0 \quad (4)$$

$$E(\epsilon_t^* m_t) = 0 \quad (5)$$

Since the two proxy variables for supply-side and demand-side uncertainty shocks are orthogonal to each other, we estimate separate models for each proxy variable. The variable m_t is thus a placeholder for each proxy, but only one proxy is considered in each model.

5 Data

We use monthly data for the U.S. financial market from July 1982 to December 2023. The advantage of this model is its flexibility, allowing for estimation with higher frequency data if necessary. The variables included in the analysis are obtained from the St. Louis FRED database: The volatility index VXO (in levels), the S&P 500 stock price index (in log levels), the 10Y government security benchmark yield (GS10; in levels) the Wu and Xia shadow short rate (in levels), the BIS narrow nominal effective exchange rate of the US dollar (NEER; in log levels) and Cleveland Fed 1Y expected inflation (in levels). The variables for the proxies are obtained from Bloomberg: Prices of oil (Generic 1st 'CL' Future) and gold (Bloomberg Generic Price) – both with closing time 17:00 ET – enter the model in log levels. We use the same series for the creation of the proxy variables and assume that the time gap between fixings is of minor importance.

6 Results

Before comparing the effects of supply-side and demand-side uncertainty shocks, we show how an uncertainty shock identified using changes in the price of gold alone would propagate. Then, we highlight the differences between the original shock and the effects of supply-side and demand-side shocks. We start by discussing the estimated shocks and present the impulse response functions (IRFs) for the original, supply-side and demand-side uncertainty shocks and explore the important implications for economic policy and

market behavior. The IRFs show the response of the economic variables to a one-standard-deviation shock.

6.1 Estimated shocks

Figure 2 presents the instruments and the estimated shocks (median over all 1,000 draws) for the supply-side, demand-side and original shocks. Note that the *original* shock is not identical to the shock in Piffer and Podstawski (2018). We use daily and not intraday changes in the price of gold to proxy uncertainty and we rely on fewer events – but use the most important ones with respect to changes in the price of gold. Moreover, we use a Bayesian VAR framework, while Piffer and Podstawski (2018) rely on a frequentist approach.

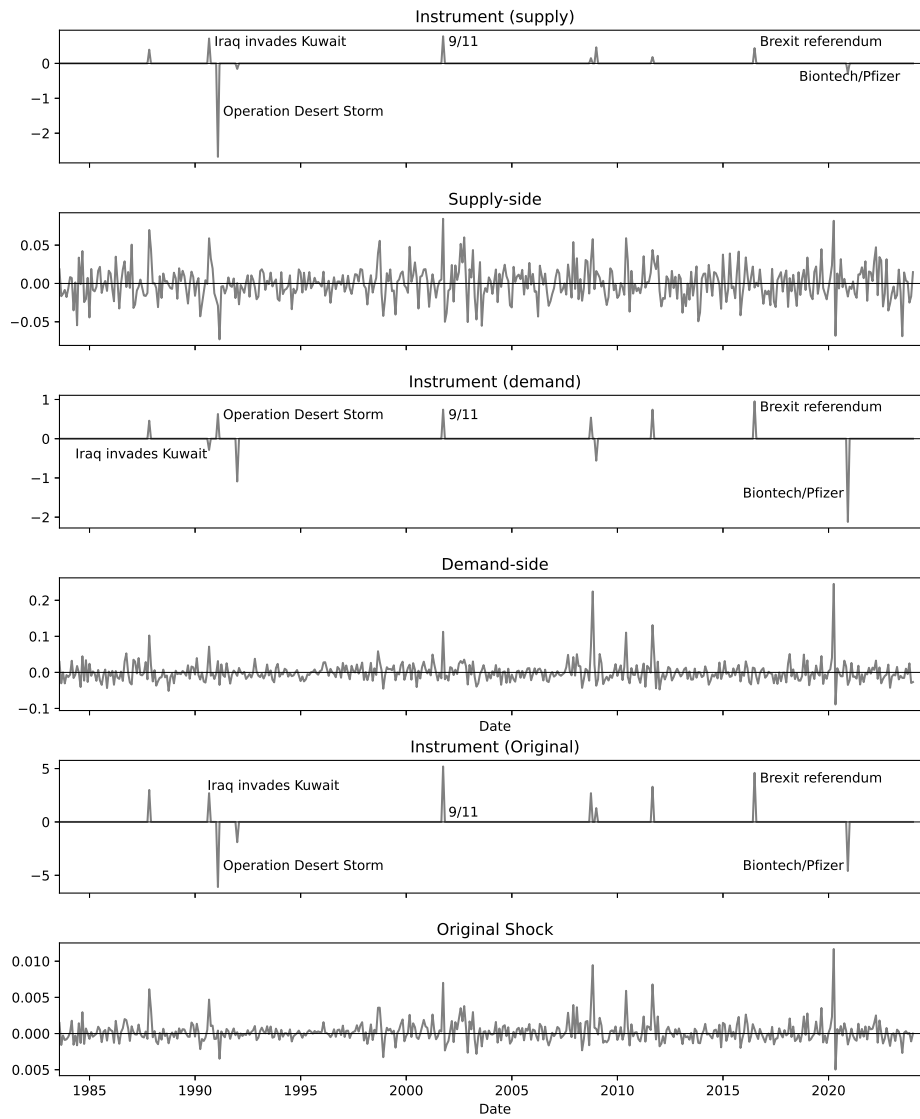
We observe that all estimated shocks exhibit numerous peaks that align with their corresponding proxies. For instance, the supply-side components of Black Monday, Iraq’s invasion of Kuwait, Operation Desert Storm, and 9/11 are prominently reflected in both the instrument and the estimated series. However, the estimated series also captures events that were not considered in the instrument, such as the COVID-19 pandemic and Russia’s war of aggression against Ukraine.

Similarly, for the demand-side shocks, peaks corresponding to Black Monday, 9/11, and AIG’s request for emergency lending are well pronounced in both the instrument and the estimated series. Nevertheless, the largest peak, associated with COVID-19, is not covered by the instrument.

These observations indicate that the estimation procedure effectively identifies the supply-side and demand-side components of structural uncertainty shocks.

Interestingly, the demand-side shocks and the original shocks exhibit a very similar pattern. The correlation between both series is very high, given a correlation coefficient of 0.86. Hence, we can expect that the impulse response functions can be biased towards a demand-side shock.

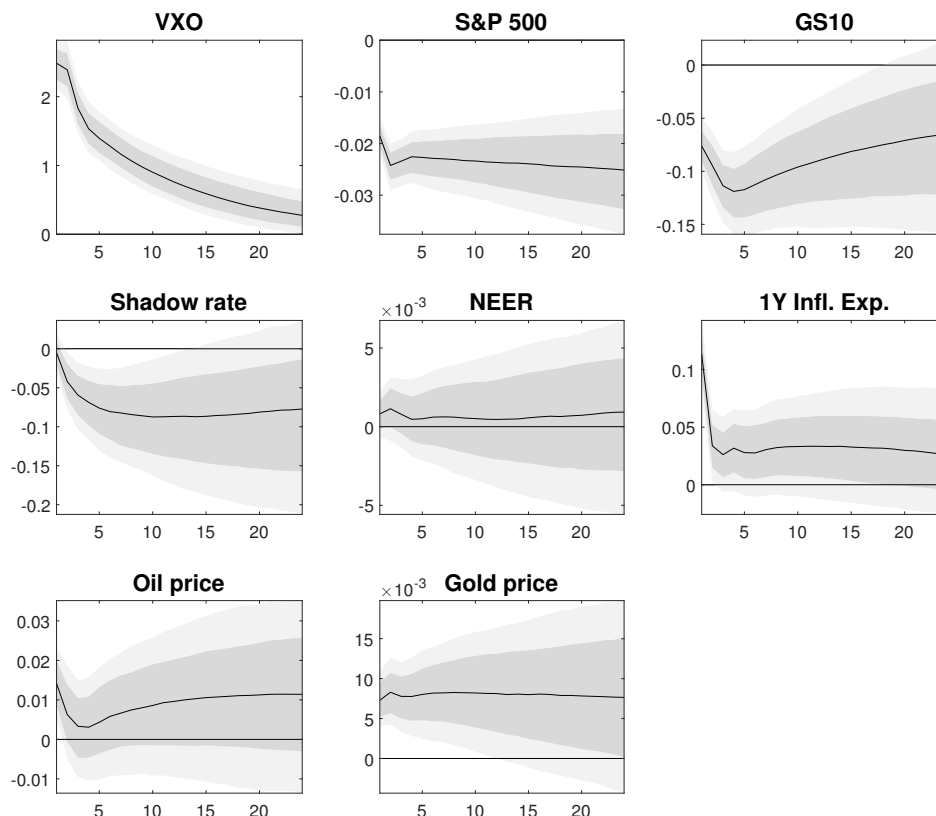
Figure 2: Instruments and estimated structural shocks



Notes: The figure displays instruments as well as the corresponding estimated supply-side, demand-side and original gold price related shocks. The estimated shocks represent the median over all 1,000 draws.

6.2 Supply-side-related uncertainty

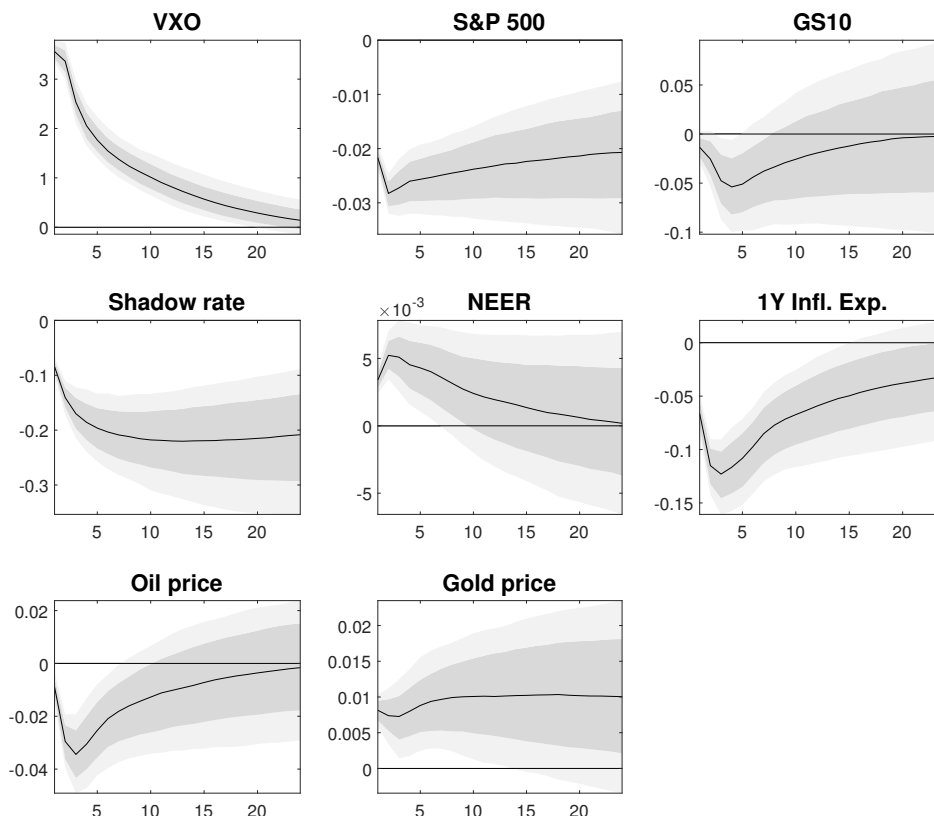
Figure 3: IRFs following supply-side-related uncertainty shocks



The IRFs for supply-side uncertainty shocks indicate that such shocks lead to a significant increase in the price of gold, reflecting its role as a safe-haven asset. Additionally, the price of oil increases. Note that we do not impose restrictions on the impulse response functions of the different variables. The responses instead indicate that the shock is correctly identified by the model given the proxy variable. The VXO increases and the S&P 500 index shows a decline, consistent with the negative impact of uncertainty on stock markets. The 10-year yield and shadow rate also decrease, suggesting a flight to safety and lower interest rates in response to heightened uncertainty. There is very weak evidence of an appreciation of the NEER, in line with flights to safety. Inflation expectations increase, reflecting higher oil prices and a potential disruption of supply chains – if the shock is related to an armed conflict or a natural disaster, for instance.

6.3 Demand-side-related uncertainty

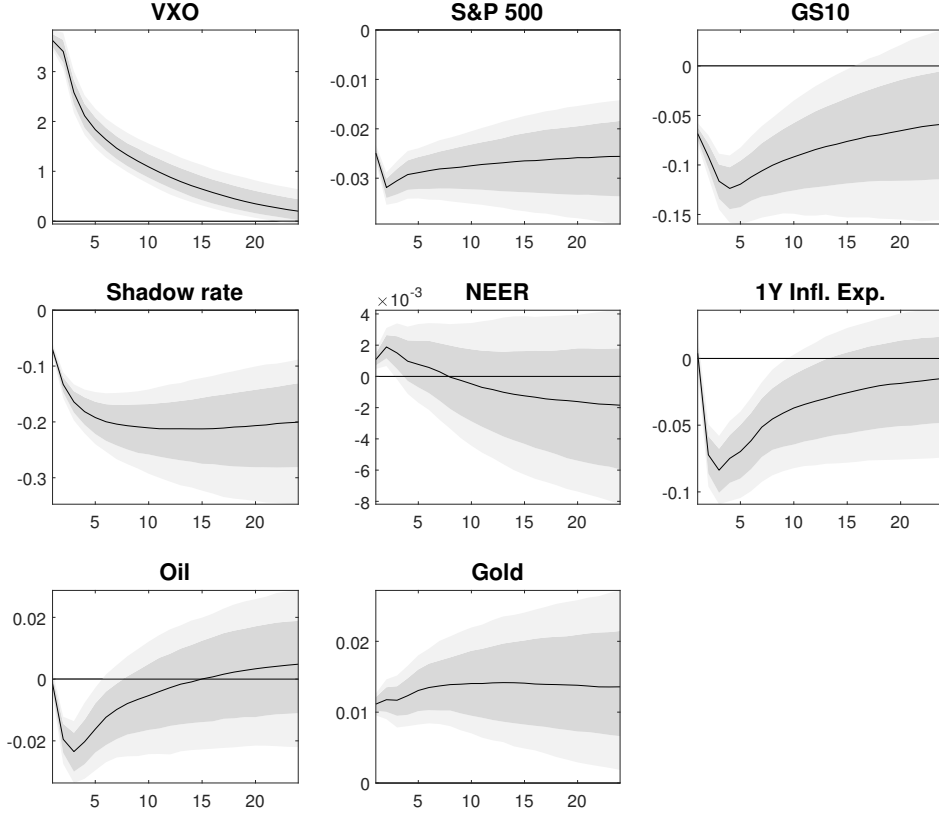
Figure 4: IRFs following demand-side-related uncertainty shocks



The IRFs for demand-side uncertainty shocks indicate that such shocks also lead to a significant increase in the price of gold, underscoring its role as a safe-haven asset. However, the price of oil declines, reflecting a decrease in demand. The VXO, the S&P 500 index, the 10-year yield and the shadow rate exhibit similar responses to those observed with supply-side uncertainty shocks, although the response of the 10-year yield is somewhat weaker. The Nominal Effective Exchange Rate (NEER) appreciates, as expected during flights to safety. Inflation expectations decline, reflecting reduced demand pressures. Therefore, inflation expectations appear to be the variable that differentiates between the discussed types of uncertainty.

6.4 Gold-price-related uncertainty shock

Figure 5: IRFs following gold-price-related uncertainty shocks



To stress just how much the use of two proxy variables matters for the outcomes of the estimation, we also report the IRFs of an uncertainty shock that is identified by changes in the price of gold alone. As indicated by the structural shock series in Figure 2, we observe that the impulse response functions correspond to those of the demand-side-related uncertainty shock. The responses of the oil price and inflation expectations are negative and significant, while the effective exchange rate of the U.S. dollar appreciates. The results indicate that the demand shocks dominate the sample and cause the corresponding responses.

6.5 Discussion

The IRF patterns of supply-side and demand-side uncertainty shocks exhibit that the two types of uncertainty shocks yield very similar results. They vary only with respect to one variable in our sample, namely expected 1 year inflation. With respect to expected inflation, we tested information from the term structure up to 10 years. However, only the 1 year expected inflation showed the expected behaviour. This can be interpreted as evidence suggesting that U.S. inflation expectations are well anchored.

Overall, these results are in line with other findings in the literature. [Bloom \(2009\)](#); [Baker et al. \(2016\)](#); [Piffer and Podstawski \(2018\)](#) and many more emphasize the importance of uncertainty in driving economic fluctuations. [Pinchetti \(2024\)](#) shows that oil prices can help in unveiling different dimensions of geopolitical risk-related shocks. Our results support this view, showing that uncertainty shocks lead to significant declines in stock prices and interest rates, for instance.

[Piffer and Podstawski \(2018\)](#) use gold prices alone as a proxy for uncertainty shocks. Depending on the research question, this is the less complex and thus superior approach. However, our results suggest that this approach may overlook important dimensions of uncertainty. In our case, for example, demand-side shocks dominate the sample and overshadow potential supply-side effects. By incorporating oil prices, we capture the differing effects of supply-side and demand-side uncertainty on the economy. This highlights the need for a more nuanced approach to identifying and analyzing uncertainty shocks if expected inflation is part of the research question.

Hence, our results also support the views by [Kilian \(2009\)](#) and [Hamilton \(2009\)](#), who discuss the importance of distinguishing between supply-side and demand-side shocks in the context of oil prices.

7 Conclusion

Our analysis demonstrates that identifying uncertainty shocks using the price of gold alone is generally appropriate for most economic variables and research questions. However, the inclusion of oil prices reveals an additional dimension of uncertainty. This multidimensional nature of uncertainty shocks has important implications for economic research and policy analysis.

The price of oil and, consequently, inflation expectations can be affected differently depending on the type of uncertainty shock. Researchers should be aware of these distinctions to avoid potential biases (e.g. price puzzles) in their results. Future research could further explore the implications of supply-side and demand-side uncertainty shocks on various economic outcomes.

Our findings suggest that policymakers should consider the multidimensional nature of supply-side and demand-side uncertainty when designing policy responses. For example, monetary policy may need to be more expansive in response to demand-side uncertainty shocks such as political or economic crises, while supply-side measures may be more appropriate in the context of supply-side uncertainty.

A Tables

Table 2: Oil and gold price changes on major historical events

Date (d/m/y)	Event	Oil price change	Gold price change
19.10.1987	Black Monday	-2.1%	3.3%
02.08.1990	Iraq invades Kuwait	7.0%	2.7%
17.01.1991	Operation Desert Storm	-40.0%	-6.1%
12.12.1991	End of USSR	2.3%	-1.9%
11.09.2001	9-11	0.5%	5.2%
15.09.2008	AIG funding request	-5.6%	2.7%
29.12.2008	Israel/Gaza conflict 2008	5.9%	1.3%
08.08.2011	US downgrading/SMP/riots	-6.6%	3.3%
24.06.2016	Brexit	-5.1%	4.6%
09.11.2020	Pfizer/Biontech	8.1%	-4.6%

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