University of Pretoria
Department of Economics Working Paper Series

The Impacts of Oil Price Volatility on Financial Stress: Is the COVID-19 Period Different?

Xin Sheng
Anglia Ruskin University
Won Joong Kim
Konkuk University
Rangan Gupta
University of Pretoria
Working Paper: 2021-84
December 2021

Department of Economics
University of Pretoria
0002, Pretoria
South Africa
Tel: +27 12 420 2413

The Impacts of Oil Price Volatility on Financial Stress: Is the COVID-19 Period Different?

Xin Sheng
Lord Ashcroft International Business School,
Anglia Ruskin University, Chelmsford, United Kingdom.
Email: xin.sheng@anglia.ac.uk

Won Joong Kim*
Department of Economics, Konkuk University, Seoul, Republic of Korea
Email: wjkim72@konkuk.ac.kr

Rangan Gupta
Department of Economics, University of Pretoria, Pretoria, South Africa
Email: rangan.gupta@up.ac.za

Abstract

Utilising both high frequency (daily) and monthly data this study analyses the effects of oil price volatility on financial stress with various measures. The study places a special focus on comparing the pattern of these effects during the Great Recession period and the COVID-19 recession period. Using the local projection approach, the paper finds that oil price volatility has a positive and persistent effect on financial stress. However, the magnitude and the degree of persistency of oil price volatility impacts on financial stress are much greater for the Great Recession period than for the COVID-19 recession period. A possible explanation for this result would be that the COVID-19 is better thought of as a "natural disaster" in which companies in stress were not being mismanaged. Another explanation would be that active intervention by the government through monetary and fiscal channels reduces the sensitivity of financial instability to oil price volatility during the COVID-19 period.

Keywords: Oil price volatility, financial stress index (FSI), local projection, impulse response, global financial crisis (GFC), COVID-19 recession

JEL Classifications: G01, G10, Q41

* Corresponding author.

1. Introduction

There are limited studies on the relationship between oil price volatility and financial stress while there is a large amount of literature that analyses the effects of oil price (and/or its volatility) on economic activity and/or financial markets.[1]

According to Holló et al. (2012), the main aim of using financial stress indices (FSI) is "to measure the current state of instability, i.e., the current level of frictions, stresses and strains" in the financial system. FSI has obvious benefits for all participants in the financial markets who need a tool for monitoring the functioning of the financial markets, as it provides information on systemic stress events which are not as easily captured with the stress measures of individual markets or sectors (Huotari 2015). FSI also makes it easier to determine the likelihood of the occurrence of any financial crisis. It is also useful by macroprudential authorities during their macroprudential decision-making process (Ilesanmi and Tewari 2020).

Apostolakis et al. (2021) analyse the effects of both positive and negative oil price shocks on FSI. However, their focus was to examine the effects of one standard deviation of the structural oil price shock on FSI and they do not account for the time-varying characteristic of oil price volatility itself. Using a structural VAR approach, Polat (2018) studies the effect of oil price volatility on the financial stress index for the U.S. and finds that the oil price volatility shock has a statistically positive and persistent effect on FSI. However, Polat (2018) does not account for the time-varying characteristic of oil price volatility. Nazlioglu et al. (2015) investigate the volatility transmission between oil prices and financial stress and find that oil price volatility has a statistically positive and persistent effect on FSI.

In this paper, we study the effect of oil price volatility shock on FSI with a special focus on the global financial crisis (GFC) and COVID-19 pandemic periods. To account for a structural change in the relationship between oil volatility and financial stress, we adopt a regime-switching local projection model, a variation of the local projection approach of Jordà (2005).

Existing literature refers to the GFC as a period of severe systemic financial stress, in which instability in the financial system spills over to the real economy and causes the Great Recession in 2007-2009 (Duprey et al., 2017). It is widely agreed that the GFC was an episode of extreme stress in global financial markets that was transmitted to the real economy and

[1] For an extensive survey on the effects of oil prices on output, inflation, interest rate, exchange rate, risk premium, investment and consumption decisions, see Apostolakis et al. (2021).

caused the Great Recession. Before the global economic recession as a direct result of the COVID-19 pandemic in 2020 (the COVID-19 Recession), the Great Recession was viewed by many economists to have been the most severe global economic crisis since the Great Depression in the 1930s.

However, it is noteworthy that there are also dramatic differences between the economic crises caused by the COVID-19 and the GFC. As pointed out by Harvey (2020), the COVID-19 is better thought of as a "natural disaster" in which companies in stress were not being mismanaged. There were no severe structural problems in the economy and no sectors to point to for blame. This was in contrast with the GFC that was caused by mismanagement of large financial institutions and causing severe damage to the financial system. As a result, it is interesting to investigate if there are any potential differences in the impacts of oil volatility on financial stresses during the Great Recession and the COVID-19 Recession since our data sample covers both recession periods.

The rest of the paper proceeds as follows. Section 2 presents the data and the methodology used in this paper. Section 3 presents our main findings and Section 4 provides concluding remarks.

2. Data and methodology

2.1. Data

We use the Composite Indicator of Systemic Stress (CISS) developed by Holló et al. (2012) as a measurement of contemporaneous stress in the financial system. The indicator measures the current state of instability in the financial system and captures the idea that financial stress can be of a systemic nature and thus is more harmful to the economy if financial stress spreads more widely across different sectors in the financial system. Data for the CISS are obtained from the statistical data warehouse (SDW) of the European Central Bank (ECB). The CISS dataset includes 10 European Union (EU) countries (i.e., Austria, Belgium, Germany, Spain, Finland, France, Ireland, Italy, Netherlands, and Portugal) plus the United Kingdom (UK) and the United States (US). We use the Chicago Board Options Exchange (CBOE) Crude Oil ETF Volatility Index (OVX) as a proxy for oil price volatility. OVX is a forward-looking implied oil price volatility inferred from market option prices on the United States Oil Fund (USO) exchange traded fund (ETF) and reflects the market estimation of expected 30-day volatility of oil prices. Existing literature suggests that implied volatility is a more accurate measure of the volatility process than other volatility measures, such as realised volatility (RV) that is calculated based on historical data (Blair et al., 2001; Maghyereh et al., 2016). Our data for OVX are obtained from the CBOE website.[2] The panel dataset is at the daily frequency and covers the sample period from 10 May 2007 to 1 September 2021. We also split the full sample into three sub-samples that cover the period in the Great Recession (10 May 2007 to 31 December 2009), the period between the Great Recession and the COVID-19 Recession (1 January 2010 to 19 February 2020), and the period during the COVID-19 recession (20 February 2020 to 1 September 2021). Table 1 provides a brief summary of statistics on CISS and OVX across these samples.

Table 1. A Summary of Statistics

	CISS_FULL	CISS_GR	CISS_BTW	CISS_COVID
Mean (%)	14.57	14.66	14.48	14.21
Std. Dev. (%)	18.30	18.26	18.15	18.22
	OVX_FULL	OVX_GR	OVX_BTW	OVX_COVID
Mean	36.79	36.99	36.92	36.56
Std. Dev.	19.67	20.50	19.79	20.26
Observations	44868	8292	31728	4848

Notes: OVX represents the implied oil price volatility as measured by the CBOE Crude Oil Volatility Index (OVX) index. CISS represents the systemic financial stress as captured by the Composite Indicator of Systemic Stress (CISS). Suffix FULL represents the full sample. Suffixes GR, BTW, and COVID represent the three sub-samples that cover the period during the Great Recession, the period between the Great Recession and the COVID-19 Recession, and the period during the COVID-19 recession.

2.2. Methodology

The linear model for computing IRFs using the local projection (LP) approach of Jordà (2005) is specified as follows:

$$CISS_{i,t+s} = \alpha_{i,s} + \beta_s OVX_t + \epsilon_{i,t+s},\ for\ s = 0,1,2, \dots H \quad (1)$$

where $CISS_{i,t+s}$ is Composite Indicator of Systemic Stress (*CISS*) of country i at time $t + s$, s is the maximum length of forecast horizon H,[3] $\alpha_{i,s}$ measures the fixed effect for the panel

[2] https://www.cboe.com/us/indices/dashboard/ovx.
[3] s is set to 24, corresponding to a maximum length of the 24-period ahead forecast horizon.

dataset, and β_s captures the responses of *CISS* at time $t + s$ to oil volatility OVX_t at time t. The LP-IRFs are calculated as a series of β_s which are estimated separately at each horizon (s).[4]

This study also tests whether the impacts of oil volatility on financial stress are sensitive to a structural change. Equation (1) can then be rewritten into a regime-switching model (Ahmed and Cassou, 2016). To investigate any potential difference in impacts, a dummy variable that distinguishes recession periods is included in the nonlinear model defined as follows:

$$CISS_{i,t+s} = (1 - D)\left[\alpha_{i,s}^{R1} + \beta_s^{R1} OVX_t\right] + D\left[\alpha_{i,s}^{R2} + \beta_s^{R2} OVX_t\right] + \epsilon_{t+s}, for\ s = 0,1,2, \dots H \quad (2)$$

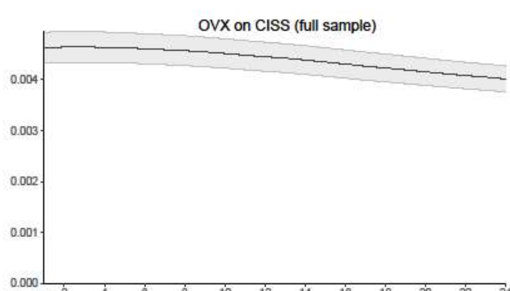
where D is a dummy variable that takes a value of 1 during the Great Recession period in 2007-2009 (or the COVID-19 Recession in 2020-2021), and 0 otherwise.

3. Results and Analysis

3.1. Linear Results: Full Sample Analysis

Figure 1 shows the linear impulse response functions calculated by the local projection method to a one-unit increase in OVX on the future path of CISS along with the 95% confidence bands, using the full data sample from 10 May 2007 to 1 September 2021.

Figure 1. Responses of CISS to an OVX Shock (Full Sample)



Notes: OVX represents the implied oil price volatility as measured by the CBOE Crude Oil Volatility Index (OVX) index. CISS represents the systemic financial stress as captured by the Composite Indicator of Systemic Stress (CISS). The shaded areas represent the 95% confidence bands.

[4] See Jordà (2005) for more details about the LP methodology.

We find that OVX has a statistically significant and positive impact on CISS over the 24-period-ahead forecast horizon, and this effect is consistent over time.[5] This finding aligns with the work from Nazlioglu et al. (2015) who report evidence of volatility spillovers from oil prices to US financial stress.[6] Our results are also in line with existing studies that highlight the important role of oil price volatility in affecting the real and financial economy (see, Apergis, 2019 for a review of the relevant literature). For example, high oil price volatility tends to increase volatility and uncertainty in other economic and financial variables (see, e.g., Englama et al., 2010; Ji and Fan, 2012; Park and Ratti, 2008; Malik and Hammoudeh, 2007; Malik and Ewing, 2009), adversely affect economic growth (see, e.g., Ferderer, 1996; Rahman and Serlets, 2012; Van Eyden et al., 2019), incite firms to delay investment decisions (see, e.g. Pinkdyck, 1991), and negatively impact on firm profitability and stock market returns (e.g., Diaz et al., 2016; Masih et al., 2011).

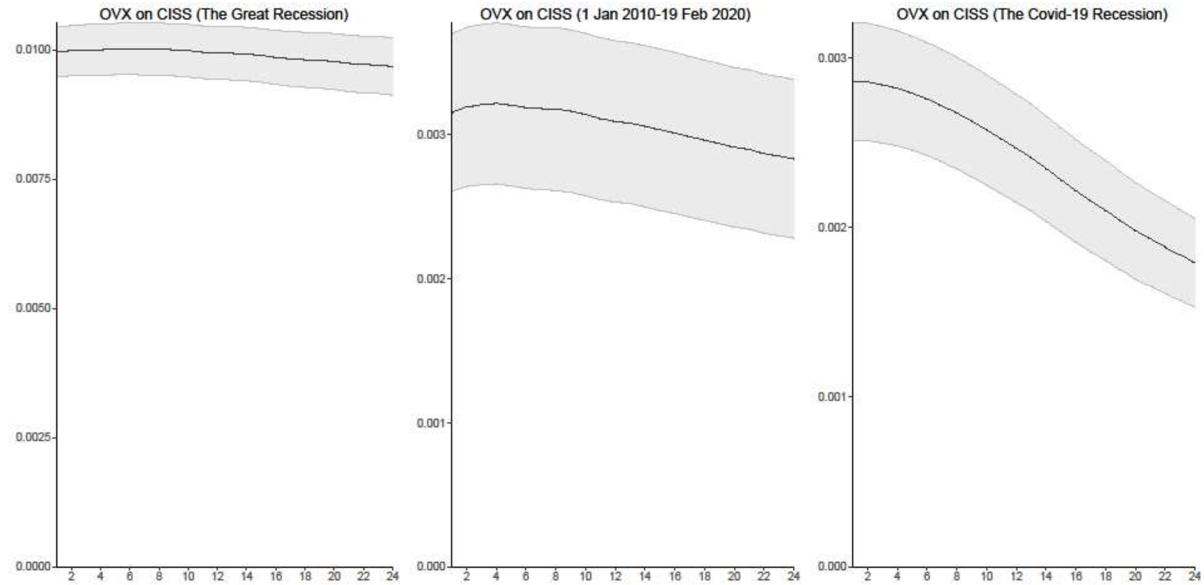
3.2. Linear Results: Subsample Analysis

Using the subsample analysis, we split our full sample into three subsamples and examine the extent to which OVX has impacted CISS in the Great Recession period (10 May 2007 to 31 December 2009), the period between the Great Recession and the COVID-19 Recession (1 January 2010 to 19 February 2020), and the COVID-19 recession period (20 February 2020 to 1 September 2021).

[5] We also use the Office of Financial Research (OFR) Financial Stress Index (FSI) as a measurement of systemic financial stress in global financial markets. Data for OFR FSI are available to download from https://www.financialresearch.gov/financial-stress-index/. We construct the panel dataset that consists of the FSIs of three regions (i.e., the US, other advanced economies, and emerging markets) and the one that includes the FSIs of five macroeconomic indicators (i.e., credit, equity valuation, funding, safe assets and volatility). The sample period is from 10 May 2007 to 1 September 2021 at the daily frequency. By replacing daily CISS with FSI and re-estimating Equation (1), we find that OVX also has a statistically significant and positive impact on FSI over the 24-period-ahead forecast horizons in both datasets. See Figure A1. in the Appendix for the results.

[6] Nazlioglu et al. (2015) concentrate on a bivariate volatility analysis between oil prices and US financial stress. The study uses the Cleveland Financial Stress Index (CFSI) as a measurement of financial stress in the US. However, it is noted that CFSI has been discontinued by the Federal Reserve Bank of Cleveland from 6 May 2016 so that the index can no longer be used to capture US financial stress in more recent events such as the COVID-19 recession.

Figure 2. Responses of CISS to an OVX Shock (Subsamples)



Notes: See Notes to Figure 1.

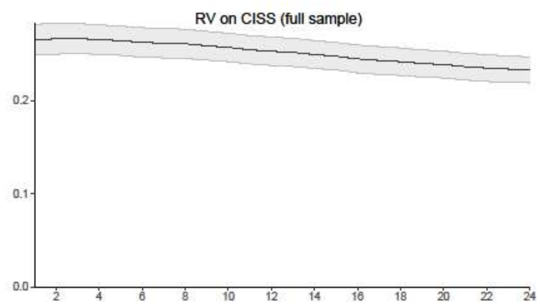
Our results show that OVX has a persistent and positive impact on CISS across all three subsamples. Notably, OVX has a considerably large effect on CISS during the Great Recession period. The magnitude of the effect of OVX on CISS in the Great Recession sample period is more than three times larger than that in the other two subsample periods. This finding is in line with the existing literature (e.g., Balcilar et al., 2020; Belhassine, 2020; Kang and Lee, 2019; Nazlioglu et al., 2015; Wen et al., 2020; Qin, 2020; among others) showing that volatility and risk spillover effects from the oil market to other financial markets intensified during the period of the GFC. Interestingly, we do not observe the same large impact on CISS from OVX during the COVID-19 recession period.

3.3. Robustness Analyes

Since many studies (e.g., Van Eyden et al., 2019; Bonato et al., 2020; Karim and Masih, 2021; among others) also use realised volatility (RV) to examine the effects of the oil price volatility, we re-estimated Equation (1) by replacing daily OVX with RV as an alternative measure of oil price volatility for robustness analysis. The new set of results for the impact of RV on CISS, based on datasets that cover the full sample period (10 May 2007 to 18 June 2021) and three subsample periods (10 May 2007 to 31 December 2009, 1 January 2010 to 19

February 2020, and 20 February 2020 to 18 June 2021), are presented in Figure 3 and Figure 4, respectively.

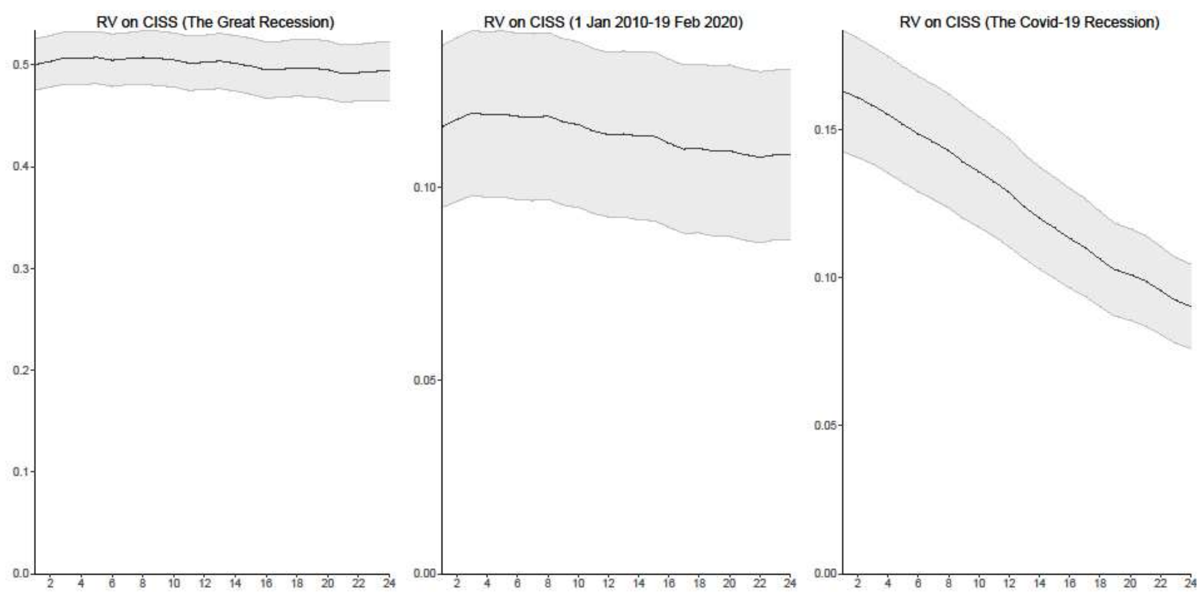
Figure 3. Responses of CISS to an RV Shock (Full Sample)



Notes: See Notes to Figure 1. RV represents realised volatility.

Figure 3 shows that RV exerts a positive and statistically significant influence on CISS over the whole forecast horizon, confirming that oil price volatility tends to increase systemic financial stress.[7] The responses of CISS to an RV shock (as shown in Figure 3) display the same pattern as the responses of CISS to an OVX shock, showing that the information contents in implied and realised oil price volatility are both important in explaining systemic financial stress.

Figure 4. Responses of CISS to an RV Shock (Subsamples)



Notes: See Notes to Figure 1 and Figure 3.

[7] We also replace CISS with FSI as a proxy of systemic financial stress. Our results show that RV also has a positive and statistically significant impact on FSI. See Figure A2. in the Appendix for the results.

Figure 4 shows that RV also has a persistent and positive impact on CISS across all three subsamples and this impact is the strongest during the Great recession period. Furthermore, we also employ a nonlinear model to examine any potential difference in impacts of oil price volatility on financial stress during the Great Recession (or the COVID-19 Recession). The nonlinear impulse response results are consistent with the linear results and confirm the larger impact of oil price volatility on financial stress during the Great Recession, but not during the COVID-19 Recession.[8]

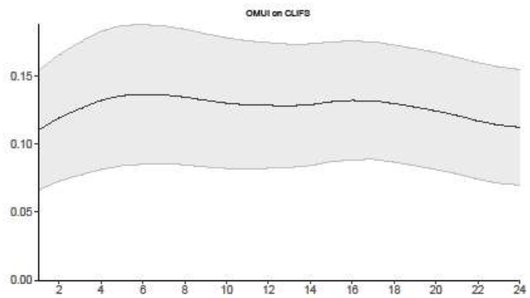
3.4. Additional analyses

Given oil price volatility typically is associated with a sense of uncertainty in the oil market, we conduct additional analysis on the impact of oil price uncertainty on financial stress by using the Oil Market Uncertainty Index (OMUI) recently developed by Nguyen et al. (forthcoming). OMUI is derived from the conditional volatility of the unpredictable component of oil prices and can capture uncertainty events that are specific to the oil market. Data for the oil market uncertainty index (OMUI) are available at the monthly frequency over a period from February 1975 to May 2020.[9] In addition, we use the Country-Level Index of Financial Stress (CLIFS) from the Statistical Data Warehouse (SDW) of the European Central Bank (ECB) as the measurement of financial stress. Data for CLIFS cover the same sample period as OMUI and include 27 European Union (EU) countries.[10]

In Figure 5, our results show evidence for the consistent and positive response of CLIFS to an OMUI shock over the 24-period ahead forecast horizon. The results are consistent with existing studies (e.g., Aye et al., 2014; Aye, 2015; Balcilar et al., 2020; Elder and Serletis, 2009; Jo, 2014; among others) that find evidence for the recessionary impacts of oil price uncertainty on both real and financial activity.

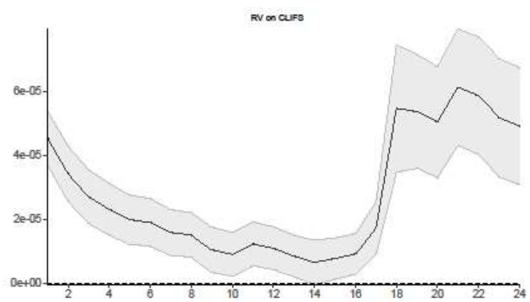
[8] See Figure A3. in Appendix for further details and the results.
[9] Data can be obtained from https://sites.google.com/site/nguyenhoaibao/oil-market-uncertainty.
[10] Data Source in SDW: https://sdw.ecb.europa.eu/browse.do?node=9693347. The CLIFS dataset includes 27 European Union (EU) countries (i.e., Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, and Slovakia).

Figure 5. Responses of CLIFS to an OMUI Shock



Notes: See Notes to Figure 1. OMUI represents oil price uncertainty as captured by the Oil Market Uncertainty Index (OMUI). CLIFS represents systemic financial stress as measured by the Country-Level Index of Financial Stress (CLIFS).

Figure 6. Responses of CLIFS to an RV Shock



Notes: See Notes to Figure 3 and Figure 5.

Given many studies use oil price volatility (e.g., realised volatility) as an indicator of oil price uncertainty (e.g., Alao and Payaslioglu, 2021; Chiweza and Aye, 2018; Maghyereh and Abdoh, 2020; Pinno and Serletis, 2013; among others), we also compute the impulse responses of CLIFS to an RV Shock. Our results show that RV also exerts a positive and statistically impact on CLIFS over the 24-period ahead forecast horizon. The results are as expected given a close association between oil price volatility and oil uncertainty.

4. Conclusion

This paper utilises both high frequency (daily) and monthly data and analyses the effect of oil price volatility on financial stress with various measures by comparing the Great Recession period and the COVID-19 recession period. Specifically, regarding oil price volatility, various measures such as daily OVX (forward-looking oil price volatility), daily realised volatility from historical data, and monthly oil market uncertainty index (OMUI) are used. To measure financial stress, we use the daily composite indicator of systemic stress (CISS) as well as the monthly country-level index of financial stress (CLIFS) from the ECB.

Using the local projection approach of Jordà (2005), the paper finds that oil price volatility has a positive and persistent effect on financial stress. However, the magnitude and the degree of persistency of oil price volatility impacts on financial stress is much greater for the Great Recession period than for the COVID-19 recession period. A possible explanation for this result would be that, as pointed out by Harvey (2020), the COVID-19 is better thought of as a "natural disaster" in which companies in stress were not being mismanaged. Another explanation would be that active intervention by the government through monetary and fiscal channels reduces the sensitivity of financial instability to oil price volatility during the COVID-19 period.

References

Ahmed, M.I., and Cassou, S.P. (2016). Does consumer confidence affect durable goods spending during bad and good economic times equally? Journal of Macroeconomics, 50, 86-97.

Apostolakis, G.N., Floros, C., Gkillas, K. and Wohar, M. (2021). Financial stress, economic policy uncertainty, and oil price uncertainty. Energy Economics, 104, 105686.

Aye, G. C., Dadam, V., Gupta, R., & Mamba, B. (2014). Oil price uncertainty and manufacturing production. Energy Economics, 43, 41-47.

Aye, G. C. (2015). Does oil price uncertainty matter for stock returns in South Africa?. Investment management and financial innovations, 12(1), 179-188.

Apergis, N. (2019). The role of oil price volatility in the real and financial economy: A survey review. In Routledge Handbook of Energy Economics (pp. 355-367). Routledge.

Alao, R. O., & Payaslioglu, C. (2021). Oil price uncertainty and industrial production in oil-exporting countries. Resources Policy, 70, 101957.

Balcilar, M., Gupta, R., Wang, S., & Wohar, M. E. (2020A). Oil price uncertainty and movements in the US government bond risk premia. The North American Journal of Economics and Finance, 52, 101147.

Balcilar, M., Ozdemir, Z. A., Ozdemir, H., & Wohar, M. E. (2020B). Spillover effects in oil-related CDS markets during and after the sub-prime crisis. The North American Journal of Economics and Finance, 54, 101249.

Belhassine, O. (2020). Volatility spillovers and hedging effectiveness between the oil market and Eurozone sectors: A tale of two crises. Research in International Business and Finance, 53, 101195.

Blair, B.J., Poon, S., Taylor, S.J. (2001). Forecasting S&P 100 volatility: the incrementalinformation content of implied volatilities and high-frequency index returns. Journal of Econometrics, 105, 5-26.

Bonato, M., Gkillas, K., Gupta, R., & Pierdzioch, C. (2020). Investor happiness and predictability of the realized volatility of oil price. Sustainability, 12(10), 4309.

Chiweza, J. T., & Aye, G. C. (2018). The effects of oil price uncertainty on economic activities in South Africa. Cogent Economics & Finance, 6(1), 1518117.

Diaz, E. M., Molero, J. C., & de Gracia, F. P. (2016). Oil price volatility and stock returns in the G7 economies. Energy Economics, 54, 417-430.

Duprey, T., Klaus, B., & Peltonen, T. (2017). Dating systemic financial stress episodes in the EU countries. Journal of Financial Stability, 32, 30-56.

Elder, J., & Serletis, A. (2009). Oil price uncertainty in Canada. Energy Economics, 31(6), 852-856.

Englama, A., Duke, O. O., Ogunleye, T. S., & Isma'il, F. U. (2010). Oil Prices and Exchange Rate Volatility in Nigeria: An Empirical Investigation. Economic and Financial Review.

Ferderer, J. P. (1996). Oil price volatility and the macroeconomy. Journal of macroeconomics, 18(1), 1-26.

Harvey, C. (2020).The Economic and Financial Implications of the COVID-19 Pandemic. Available online: https://www.darden.virginia.edu/sites/default/files/inline-files/COVID-19_Presentation_UVa_rev_1.pdf

Holló , D., Kremer, M., & Lo Duca, M. (2012). CISS- a composite indicator of systemic stress in the financial system, Working Paper Series No 1426, European Central Bank.

Huotari, J. (2015). Measuring Financial Stress - A Country Specific Stress Index for Finland. Available online: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2584378.

Ilesanmi K.D., Tewari D.D. (2020). Financial Stress Index and Economic Activity in South Africa: New Evidence. Economies. 8(4):110. https://doi.org/10.3390/economies8040110.

Ji, Q., & Fan, Y. (2012). How does oil price volatility affect non-energy commodity markets?. Applied Energy, 89(1), 273-280.

Jo, S. (2014). The effects of oil price uncertainty on global real economic activity. Journal of Money, Credit and Banking, 46(6), 1113-1135.

Jordà, O. (2005). Estimation and Inference of Impulse Responses by Local Projections. American Economic Review, 95(1), 161-182.

Kang, S. H., & Lee, J. W. (2019). The network connectedness of volatility spillovers across global futures markets. Physica A: Statistical Mechanics and its Applications, 526, 120756.

Karim, M. M., & Masih, M. (2021). Do the Islamic stock market returns respond differently to the realized and implied volatility of oil prices? Evidence from the time–frequency analysis. Emerging Markets Finance and Trade, 57(9), 2616-2631.

Malik, F., & Hammoudeh, S. (2007). Shock and volatility transmission in the oil, US and Gulf equity markets. International Review of Economics & Finance, 16(3), 357-368.

Malik, F., & Ewing, B. T. (2009). Volatility transmission between oil prices and equity sector returns. International Review of Financial Analysis, 3(18), 95-100.

Masih, R., Peters, S., & De Mello, L. (2011). Oil price volatility and stock price fluctuations in an emerging market: Evidence from South Korea. Energy Economics, 33(5), 975-986.

Maghyereh, A. I., Awartani, B., & Bouri, E. (2016). The directional volatility connectedness between crude oil and equity markets: New evidence from implied volatility indexes. Energy Economics, 57, 78-93.

Maghyereh, A., & Abdoh, H. (2020). Asymmetric effects of oil price uncertainty on corporate investment. Energy Economics, 86, 104622.

Nazlioglu, S., Soytas, U., & Gupta, R. (2015). Oil prices and financial stress: A volatility spillover analysis. Energy policy, 82, 278-288.

Nguyen, B., Okimoto, T., & Tran, T. D. (forthcoming). Uncertainty and sign-dependent effects of oil market shocks. Journal of Commodity Markets

Park, J., & Ratti, R. A. (2008). Oil price shocks and stock markets in the US and 13 European countries. Energy economics, 30(5), 2587-2608.

Pindyck, R.S. (1991). Irreversibility, uncertainty, and investment. Journal of Economic Literature, 29, 1110-1148.

Pinno, K., & Serletis, A. (2013). Oil price uncertainty and industrial production. The Energy Journal, 34(3).

Polat, O. (2018). The Interaction between Oil Price and Financial Stress: Evidence from the U.S. Data. Fiscaoeconomia, 2(2), 15-36.

Qin, X. (2020). Oil shocks and financial systemic stress: International evidence. Energy Economics, 92, 104945.

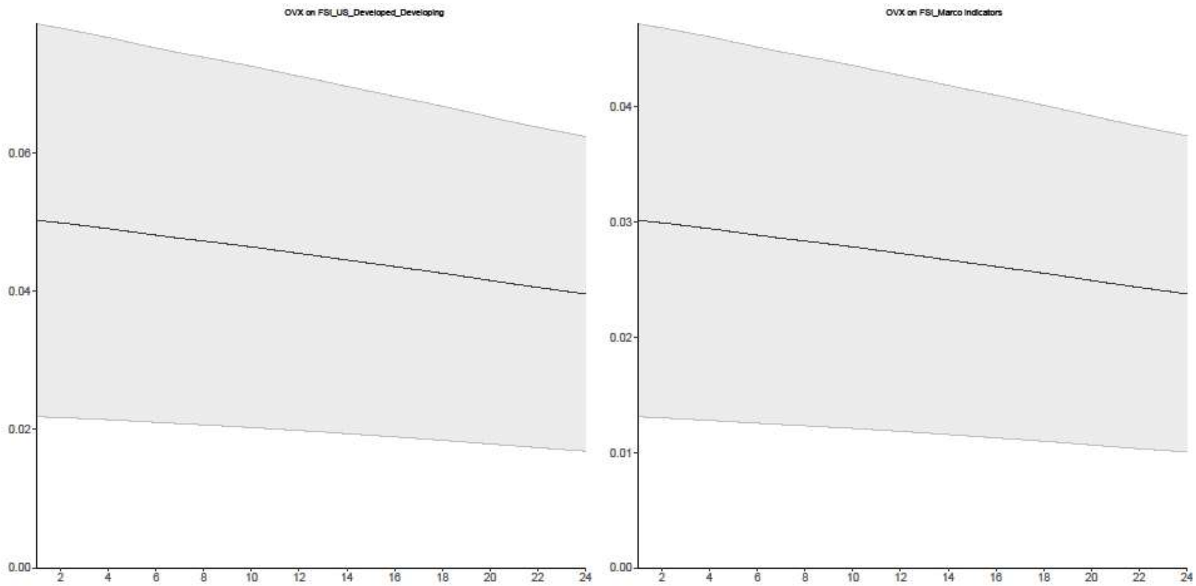
Rahman, S., & Serletis, A. (2012). Oil price uncertainty and the Canadian economy: Evidence from a VARMA, GARCH-in-Mean, asymmetric BEKK model. Energy Economics, 34(2), 603-610.

Van Eyden, R., Difeto, M., Gupta, R., & Wohar, M. E. (2019). Oil price volatility and economic growth: Evidence from advanced economies using more than a century's data. Applied energy, 233, 612-621.

Wen, D., Liu, L., Ma, C., & Wang, Y. (2020). Extreme risk spillovers between crude oil prices and the US exchange rate: Evidence from oil-exporting and oil-importing countries. Energy, 212, 118740.

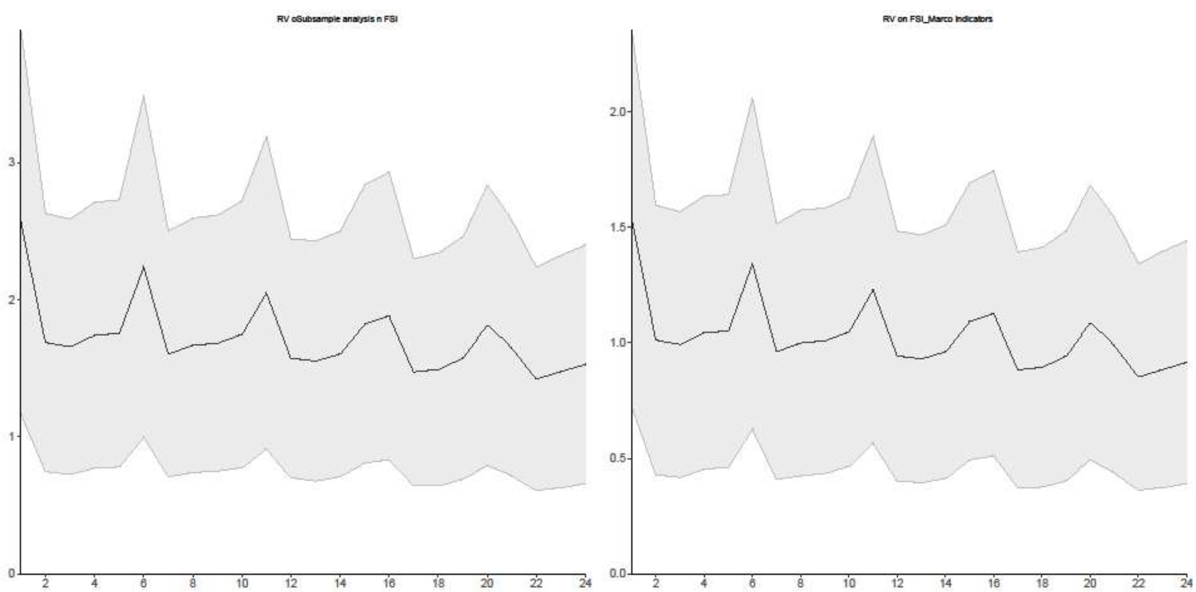
Appendix

Figure A1. Responses of FSI to an OVX Shock (Full sample analysis)



Notes: See Notes to Figure 1. FSI represents systemic financial stress as measured by the Financial Stress Index (FSI).

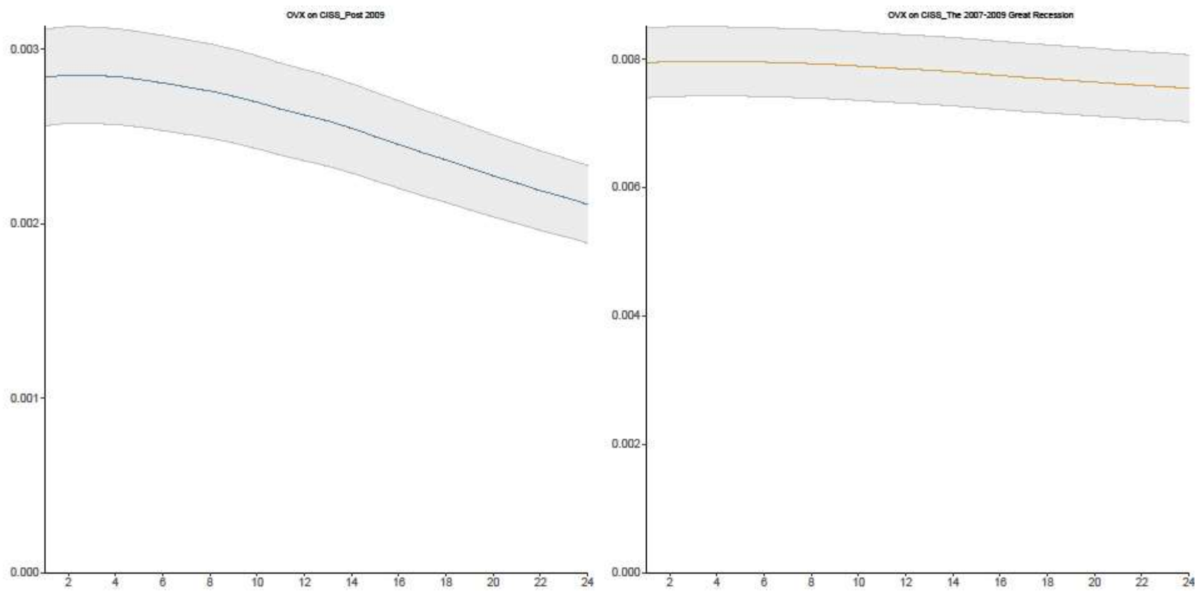
Figure A2. Responses of FSI to an RV Shock (Full sample analysis)



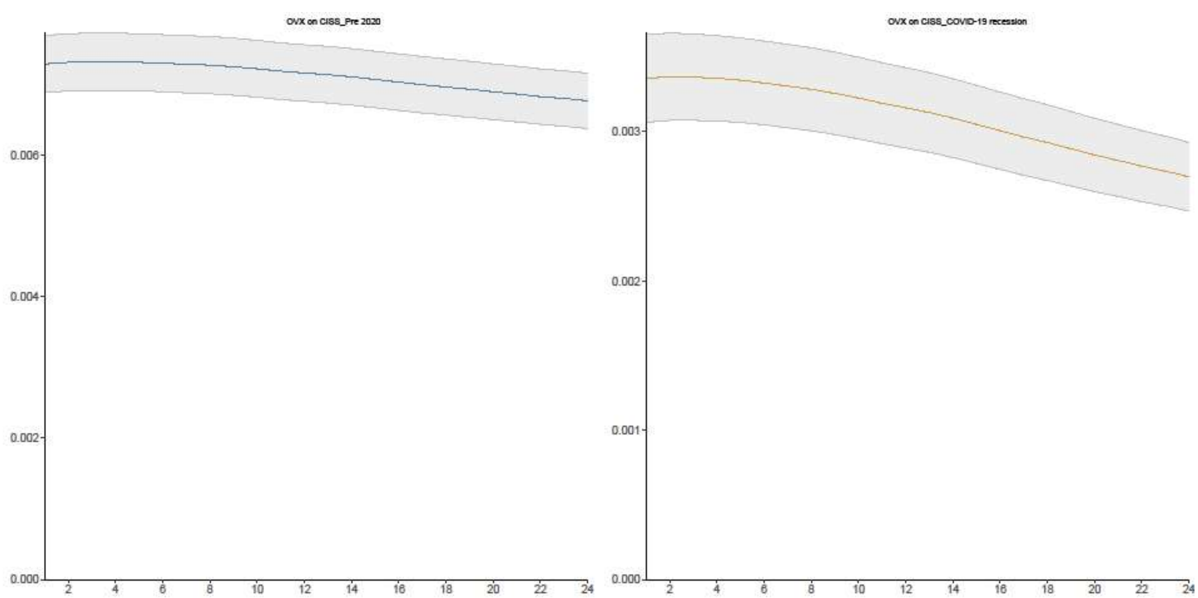
Notes: See Notes to Figure A1. and Figure 3.

Figure A3.

Panel A: Nonlinear Results: Responses of CISS to an OVX Shock (the Great Recession vs the Rest of the Sample)



Panel B: Nonlinear Results: Responses of CISS to an OVX Shock (the COVID-19 Recession vs the Rest of the Sample)



Notes: See Notes to Figure 1.