Open Journal of Business and Management, 2025, 13(3), 1955-1973
https://www.scirp.org/journal/ojbm
ISSN Online: 2329-3292
ISSN Print: 2329-3284

Unravelling Feedback Loop Effects in Oil-Macro-Financial Linkages: An Interdisciplinary Approach Using Econometrics, Network Analysis and SVAR

Maran Marimuthu[1]*, Hean Hoo Wong[1]*, Romana Bangash[2]

[1]Department of Management and Humanities, Universiti Teknologi Petronas (UTP), Seri Iskandar, Malaysia
[2]NUST Business School, Islamabad, Pakistan
Email: *maran.marimuthu@utp.edu.my, *hean_17007723@utp.edu.my, romana.bangash@nbs.nust.edu.pk

How to cite this paper: Marimuthu, M., Wong, H. H., & Bangash, R. (2025). Unravelling Feedback Loop Effects in Oil-Macro-Financial Linkages: An Interdisciplinary Approach Using Econometrics, Network Analysis and SVAR. *Open Journal of Business and Management, 13,* 1955-1973.
https://doi.org/10.4236/ojbm.2025.133102

Received: April 5, 2025
Accepted: May 18, 2025
Published: May 21, 2025

Abstract

This study examines feedback loop effects within oil-macro-financial linkages, focusing on how oil price shocks—particularly declines affect macroeconomic stability and financial sector performance. A comprehensive methodological framework integrates Structural Vector Autoregression (SVAR) with Impulse Response Functions and Variance Decomposition to trace the transmission of oil shocks to economic and banking variables, particularly non-performing loans. Granger causality analysis is used to establish lead-lag relationships, while degree centrality from network theory identifies the most influential variables within the system. The findings confirm the existence of significant feedback loops, with declining oil prices having a more profound and destabilizing impact than rising prices. Structural break analysis further reveals critical periods of instability, highlighting bidirectional causality between macroeconomic and financial indicators. The combination of network analysis and econometric modeling improves the identification of systemic risk channels and amplifiers. Policy implications emphasize the need for sector-specific analysis and dynamic scenario planning. Policymakers should strengthen macroprudential frameworks through adaptive capital buffers, targeted lending regulations, robust risk monitoring, and coordinated institutional responses. Transparent communication strategies are also vital for stabilizing market expectations during periods of oil price volatility. This study's originality lies in its interdisciplinary integration of econometrics, finance, and network theory. By combining SVAR, Granger causality, and degree centrality, it delivers a novel analytical approach that enhances understanding of complex feedback mechanisms, uncovers hidden systemic risks, and quantifies the disproportionate effects of oil price downturns. This contribution advances theoretical insight and supports evidence-based policymaking in the context of oil-induced macro-financial vulnerabilities.

Keywords

Degree Centrality, Feedback Loop Effects, Oil-Macro-Financial Linkages, SVAR

1. Introduction

1.1. Research Background

These oil prices experienced a sharp decline between 2014 and 2016, driven by a "perfect storm" of conditions that exerted significant downward pressure (Figure 1). Additionally, the COVID-19 pandemic in 2020 further exacerbated the situation, causing oil prices to plummet, with the West Texas Intermediate (WTI) futures price turning negative for the first time in history. Prolonged periods of low oil prices are likely to result in substantial revenue losses for oil-dependent economies, with potentially adverse cross-border spillover effects on economic and financial sectors. The accumulation of such spillover effects could create feedback loop effects within oil-macro-financial linkages, potentially triggering a severe economic downturn.

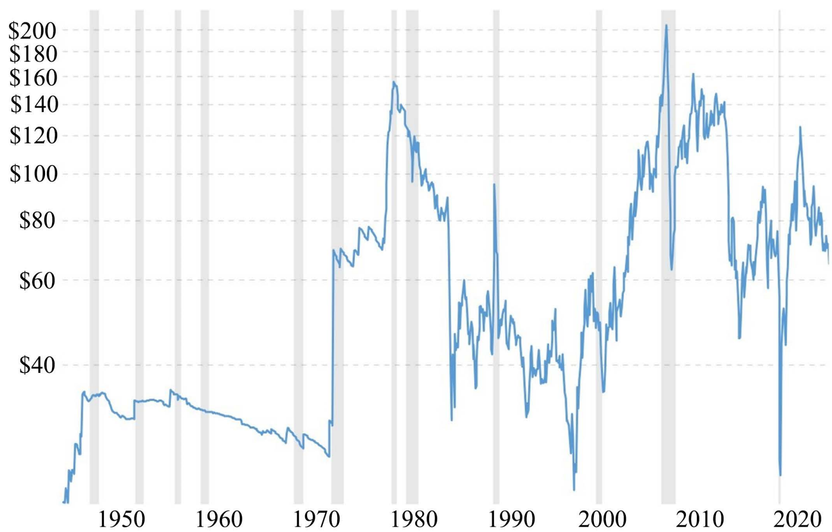

Figure 1. Oil prices, 1946-2020. Source: West Texas Intermediate Crude (WTI) Month-End Prices|Units: USD/Barrel|1946 - Present|Nominal and Real Data|Source: EIA, BLS.

Feedback loop effects within oil-macro-financial linkages refer to self-reinforcing mechanisms where oil price shocks amplify economic and financial instability.

A decline in oil prices weakens financial sectors, increasing non-performing loans and reducing financial investment, which further deteriorates financial stability due to pro-cyclicality (Gersl & Jakubik, 2010). This, in turn, exacerbates economic downturns, leading to rising fiscal deficits and reinforcing systemic vulnerabilities. Such interconnected dynamics illustrate how adverse oil price shocks trigger and sustain feedback loops, intensifying macro-financial instability.

A purely economic or financial perspective may overlook critical interdependencies within oil-macro-financial linkages. Therefore, an interdisciplinary approach is essential for examining feedback loop effects, as it integrates econometrics, finance, and network analysis to provide a comprehensive, data-driven understanding of these complex dynamics.

1.2. Problem Statement

Existing literature predominantly demonstrates that during periods of rising oil prices, key performance indicators of both the macroeconomy and financial system tend to strengthen (Zulfigarov & Neuenkirch, 2020; Chien et al., 2021; Aladwani, 2024). However, there remains a notable gap in literature concerning the potential for an oil price downturn to trigger a more pronounced feedback loop effect, potentially exacerbating financial system vulnerabilities and magnifying the impact of significant shocks on the real economy. These adverse effects tend to manifest within the banking system, posing a threat to banking stability if a series of precautionary measures are not implemented to safeguard against the next financial crisis. Thus, the study discusses the creation of feedback loop effects within the oil-macro-financial linkages and their impact on banking stability as well as the transmission of ripple effects to the real economy. To gain deeper insight into this issue, the failure to identify influential determinants within these linkages has led to insufficient evidence validation. This limitation hinders a clear understanding of feedback loop effects within oil-macro-financial linkages, which could potentially trigger economic and financial crises.

1.3. Research Objectives

This research activity intends to fulfill the following objectives:

1) To identify the presence of feedback loop effects within oil-macro-financial linkages.

2) To determine the key drivers influencing these feedback mechanisms.

3) To validate findings using an interdisciplinary approach combining network theory and econometric analysis.

1.4. Significance of Study

This study contributes to the literature by integrating macroeconomic, financial, and network analysis to advance theoretical and empirical understanding of feedback loop effects within oil-macro-financial linkages. It develops a cohesive framework that systematically examines the transmission mechanisms of oil price shocks, emphasizing their self-reinforcing dynamics and macro-financial implications. By synthesizing diverse theoretical perspectives, this study establishes a unified methodology that incorporates econometric and network-based approaches to identify and analyze these feedback loops.

Empirically, this study provides robust evidence of how oil price shocks propagate through financial and economic systems. Utilizing an extended SVAR framework alongside interdisciplinary tools such as Granger causality and degree centrality analysis, the study enhances the identification of influential determinants and structural interdependencies within oil-macro-financial linkages. The findings highlight the asymmetric effects of oil price fluctuations, particularly the greater impact of price declines on financial stability and economic performance.

From a policy perspective, this study supports the design of robust macro-financial stabilization policies. By uncovering key transmission channels and validating the presence of self-reinforcing feedback loops, the study equips policymakers with critical insights into mitigating systemic risks. The interdisciplinary framework combining econometric modeling with network theory offers a valuable tool for monitoring financial vulnerabilities and guiding policy interventions. Ultimately, this study bridges gaps in existing literature by integrating theoretical rigor with empirical validation, contributing to a more comprehensive understanding of oil-macro-financial dynamics.

2. Literature Review

Crude oil is a fundamental input in the production process, and price shocks in crude oil have long been recognized for their significant impact on the real economy (Kandil & Markovski, 2019). Beyond macroeconomic implications, oil price shocks play a crucial role in financial markets and banking stability (Espinoza & Prasad, 2010; Khandelwal, Miyajima, & Santos, 2017). While numerous studies have examined the effects of oil prices on macro- and microeconomic activities, there remains limited knowledge about the interactions between oil price fluctuations, banking sector stability, and real economic performance through oil-macro-financial linkages.

2.1. Macroeconomic Theories on Oil Price Shocks

Oil price shocks significantly influence economic stability, particularly in oil-exporting nations, through various macroeconomic channels. Existing literature predominantly highlights how rising oil prices bolster economic growth, while adverse oil price shocks can trigger financial instability. Boukhatem & Djelassi (2022) and Molick et al. (2024) emphasize that declining oil prices reduce export income in oil-dependent economies, weakening economic activity. This deterioration limits economic agents' ability to meet debt obligations, potentially destabilizing banking sectors.

Barsky & Kilian (2002) stress the importance of accounting for the endogenous nature of oil price fluctuations when analyzing their economic impact. Subsequent studies, such as Kilian (2009), have introduced structural decomposition methodologies that distinguish between supply-driven, demand-driven, and speculative oil price shocks. Bernanke et al. (2004) further demonstrate that the economic consequences of oil price shocks are contingent on prevailing macroeconomic conditions, which can either mitigate or amplify their impact.

2.2. Financial Stability and Banking Sector Effects

The transmission of oil price shocks occurs through multiple channels and banking channels play a crucial role in propagating oil price shocks. Albulescu (2020) examines publicly listed banks and finds that rising oil prices positively impact the long-term stability of Russian banks, while declining oil prices deteriorate financial conditions. Similarly, Osuma et al. (2019) show that the Nigerian banking sector suffered revenue shortfalls, increased nonperforming loans, and liquidity shortages due to declining oil prices. Kandil and Markovski (2019) highlight that lower oil prices lead to reduced government borrowing from banks, affecting lending capacity and financial sector stability.

Declining oil prices weaken the financial sectors, leading to higher nonperforming loans, which in turn reduces financial investment, further weakening the financial sectors due to their pro-cyclicality. In the event of a very strong decline in economic activity, Gersl and Jakubik (2010) find that procyclical behavior by financial intermediaries could lead to a feedback loop effect. This mechanism results in a drop in domestic output and an increase in government budget deficits. As far as both accelerators (financial and macroeconomic variables) are concerned, this self-reinforcing mechanism can be reinforced by adverse oil price shocks, where financial stability deteriorates and the real economy degenerates, vice versa. Such a self-reinforcing mechanism goes entirely under the name of feedback loop effects within the macro-financial linkages. Assuming that financial position is procyclical, meaning it increases during economic booms and declines during recessions, and leverage is countercyclical, meaning it declines during booms and increases during recessions, economic shocks will be amplified by the financial accelerator (Akinci & Queralto, 2023). Moreover, given that alterations in financial position or leverage are influenced by financial dynamics, these models provide financial markets with the capacity to impact the real economy.

2.3. Feedback Loop Effects on Oil-Macro-Financial Linkages

The heterogeneous impact of oil price shocks on banking sector stability and macroeconomic variables necessitates a nuanced analytical approach, reflecting the complex bidirectional causality highlighted by various theoretical frameworks. From a banking perspective, Chen and Zhang (2023), utilizing a structural vector autoregressive (SVAR) model, analyzing the spillover effects of oil price shocks on financial stress indices, distinguishing between supply, demand, and financial shocks. Their findings demonstrate that oil-specific demand and financial shocks exert the most significant stress on banking stability, aligning with the financial accelerator theory, which posits that adverse shocks amplify financial sector vulnerabilities. Conversely, from a broader macroeconomic perspective, Kilian and Park (2009), employing a structural decomposition approach, differentiates the varying effects of distinct oil price shock types on economic activity. Furthermore, Bernanke et al. (2004) emphasize the capacity of monetary policy responses—a key element of Keynesian and monetary economics—to either amplify or mitigate these effects, contingent upon prevailing economic conditions. This dual analytical framework underscores the imperative of integrating banking and macroeconomic variables, reflecting the interconnectedness emphasized by general equilibrium models, when assessing oil-macro-financial linkages. Notably, Hammersland and Traee (2011) provide a succinct exposition of a macroeconomic model that elucidates the fundamental attributes fostering interlinked fluctuations among credit, asset prices, and real economic activity, a phenomenon widely recognized as the financial accelerator within scholarly discourse, illustrating the pro-cyclical nature of financial markets and the feedback loops inherent in these systems.

2.4. Application of Network Theory in Economic Research

This study employs degree centrality to identify critical nodes within the economic and financial systems that either amplify or attenuate feedback loop effects, thereby offering a novel methodological contribution to the analysis of systemic risks. Furthermore, it introduces an interdisciplinary research framework that utilizes Granger causality analysis, to rigorously determine the directional interdependencies between variables, and synergistically integrates these findings with the degree centrality metric derived from network theory. This approach provides a refined understanding of the transmission mechanisms through which oil price fluctuations influence both financial stability and macroeconomic performance.

3. Methodology

3.1. Data Selection and Processing

This study utilizes a comprehensive time-series dataset spanning from January 2008:01 until June 2020:02, encompassing monthly observations of key macroeconomic and financial variables. Data on oil prices, represented by WTI Crude Oil Price. Macroeconomic indicators include Real Gross Domestic Product (RGDP), sourced from CEIC Global Database; Consumer Price Index (CPI) for inflation, obtained from CEIC Global Database; exchange rates (MR$/US$), derived from CEIC Global Database; and interest rates (Overnight Policy Rate), sourced from CEIC Global Database. Financial sector variables include Non-Performing Loans (NPLs), extracted from CEIC Global Database; and the rest of banking variables derived from BNM. Prior to analysis, all time-series data underwent rigorous processing, including stationarity testing using Augmented Dickey-Fuller unit root tests, with non-stationary variables subsequently transformed via logarithmic differences. Following this, a series of stability and diagnostic tests were conducted, confirming the homogeneity of the Structural Vector Autoregression (SVAR) model across the selected sample period. Specifically, the unit circle test demonstrated that all eigenvalues resided within the unit circle, thereby ensuring model stability. The Chow breakpoint test revealed significant structural breaks, indicating the consistency of relationships between oil price shocks, macroeconomic conditions, and financial stability over time. Furthermore, the VAR residual serial correlation Lagrange Multiplier (LM) test confirmed the absence of serial correlation, while the White heteroskedasticity test validated the homoscedasticity of the residuals. Collectively, these results substantiate the assumption of model homogeneity, thereby affirming its robustness in capturing the dynamic interactions within oil-macro-financial linkages. Consequently, this comprehensive data processing and model validation procedure ensures both data consistency and the suitability of the SVAR model for subsequent econometric analysis.

3.2. Econometric Modelling Approach

Identify impulse response functions and variance decomposition to assess oil price transmission mechanisms. Impulse Response Functions (IRFs) and Forecast Error Variance Decomposition (FEVD) are essential econometric tools for assessing oil price transmission mechanisms within macro-financial systems. IRFs trace the dynamic effects of an oil price shock on key macroeconomic and financial variables over time. This process begins with estimating a Structural Vector Autoregression (SVAR) model, incorporating oil prices, macroeconomic indicators, and financial variables. Structural shocks are then identified using methods such as Cholesky decomposition, sign restrictions, or external instruments. The IRFs illustrate the magnitude, direction, and persistence of responses, providing insights into the transmission dynamics of oil price shocks. In addition, FEVD quantifies the proportion of forecast error variance in each variable that can be attributed to oil price shocks compared to other disturbances in the system. This involves decomposing forecast errors at various time horizons to determine the extent to which oil price fluctuations drive macro-financial variability. A high proportion of variance explained by oil price shocks indicates strong transmission effects, while delayed responses suggest indirect or lagged mechanisms. Together, IRFs and FEVD provide a comprehensive framework for analyzing the propagation of oil price shocks through macroeconomic and financial linkages. These techniques enable researchers to identify the strength and persistence of feedback effects, evaluate structural interdependencies, and inform policy measures aimed at mitigating economic vulnerabilities associated with oil price fluctuations.

3.3. Granger Causality Analysis

Granger causality analysis is employed to establish lead-lag relationships among oil price shocks, macroeconomic variables, and financial indicators by testing whether past values of one variable can predict the future values of another. This is achieved through the estimation of a Vector Autoregression (VAR) or Structural VAR (SVAR) model, where lagged values of oil prices and macro-financial variables are included as explanatory factors. If oil prices shocked Granger-cause macroeconomic or financial indicators, it implies that oil prices lead to changes in these variables. Conversely, if macroeconomic or financial indicators Granger cause oil prices, it suggests a lagging response of oil prices to broader economic or financial conditions. The statistical significance of the Granger causality test results provides empirical evidence on the directional causality, helping to identify whether oil price shocks act as leading indicators or respond to macro-financial dynamics over time.

3.4. Degree Centrality Analysis

To identify the most influential variables shaping oil-macro-financial linkages, network graphs are constructed, incorporating degree centrality analysis from network theory. The process begins by compiling a dataset of oil price shocks, macroeconomic indicators, and financial variables. Econometric techniques of Granger Causality Analysis are then used to determine relationships among these variables. A directed network is then established, with nodes representing economic and financial variables and edges indicating causal or statistical relationships derived from empirical analysis. The directionality of these connections is determined based on lead-lag relationships identified in the Granger causality framework. Degree centrality metrics are subsequently computed to evaluate the relative influence of each variable within the network. A variable with high in-degree centrality is significantly impacted by other variables, whereas high out-degree centrality indicates a strong influence over the system. The degree centrality measure can be used to identify the most influential nodes or variables of interest. This process is often employed to validate the inferred relationship between two nodes in both directions. Degree centrality analysis confirms the accurate identification of causal influences and allows for the explicit assessment of feedback loop effects. The network is then visualized using centrality measures, highlighting the comparative analysis of degree and Eigenvector centrality for the nodes in question. UCINET 6.528 is used to obtain eigenvalues, which aid in identifying key nodes and systemic interdependencies. Further refinement through clustering and modularity analysis enhances the understanding of structural relationships within the oil-macro-financial system. The findings from this network analysis provide critical insights into systemic vulnerabilities and dominant transmission channels, informing policymakers in the design of targeted macro-financial stabilization strategies. By integrating network theory with econometric analysis, this approach strengthens the ability to detect key feedback loop effects and transmission mechanisms within oil-macro-financial linkages.

4. Results and Discussion

4.1. Empirical Evidence of Feedback Loop Effects

In Table 1, the results of the impulse response function reveal a feedback loop within the oil-macro-financial linkage. Oil price shocks significantly influence both macroeconomic factors (e.g., government debt and GDP) and banking factors (e.g., non-performing loan ratios and loans). Macroeconomic factors exhibit an immediate and notable response, while banking factors respond with a lag, though their impact becomes significant over time. Furthermore, the asymmetric effects of oil price shocks highlight the interconnectedness of macroeconomic and financial variables. Disruptions in one sector can propagate through the system, reinforcing the feedback loop between oil, macroeconomic performance, and financial stability.

Table 1. Summary of determining feedback loop effects—impulse response.

	Response of GDEBT_RGDP to:	Response of LOGRGDP to:	Response of LOGNPLR to:	Response of LOGLOAN to:

Source: Author's compilation using Eviews. Note: Shock 1: LOGNPLR, Shock 2: LOGLOAN, Shock 5: LOGRGDP, Shock 10: GDEBT_RGDP and Shock 11: LOGOIL. Note: NPLR: Nonperforming Loan, Loan: Total Loans, RGDP: Real GDP, GDEBT_RGDP: Government debt/Real GDP and OIL: Crude Oil Prices. Note: Response to Generalized One S.D. Innovations.

The forecast error variance decomposition in Table 2 reveals that while oil price shocks do impact Malaysia's government debt, national income, non-performing loans, and total loans, their overall influence is relatively weak, especially compared to other factors in Malaysia's open developing economy. Oil price shocks have a slightly stronger effect on macroeconomic variables than financial variables, possibly due to fiscal dominance. The analysis confirms the presence of feedback loops within the oil-macro-financial linkages, as oil price shocks influence both banking and macroeconomic variables to varying degrees.

Table 2. Summary of determining feedback loop effects—forecast error variance decomposing.

Influence in Short Run \ Influence in Long Run	Variance Decomposing of GDEBT_RGDP	Variance Decomposing of LOGRGDP	Variance Decomposing of LOGNPLR	Variance Decomposing of LOGLOAN
LOGOIL	No (0.0000) / Weak (4.7903)	No (0.0000) / Weak (6.1660)	No (0.0000) / Weak (3.2363)	No (0.0000) / Weak (3.9106)
GDEBT_RGDP	Weak (7.5543) / Weak (5.0571)	No (0.0000) / Weak (1.0934)	No (0.0000) / Weak (5.8871)	No (0.0000) / Weak (3.8018)
LOGRGDP	Moderate (71.9499) / Mild (39.7456)	Moderate (72.8304) / Mild (39.9467)	No (0.0000) / Weak (2.2801)	No (0.0000) / Weak (2.6803)
LOGNPLR	Weak (0.0504) / Weak (2.6058)	Weak (0.5708) / Weak (2.6918)	Strong (100.00) / Moderate (69.6246)	Weak (9.5534) / Weak (10.7823)
LOGLOAN	Mild (12.9026) / Mild (13.2904)	Mild (16.9567) / Mild (14.0594)	No (0.0000) / Weak (6.9791)	Strong (100.00) / Moderate (58.0656)

Source: Author's compilation using Eviews.

Bai-Perron multiple breakpoint tests were applied to identify multiple structural breaks in the univariate time series of the five major variables for oil-macro linkages: LOGNPLR, LOGLOAN, LOGRGDP, GDEBT_RGDP, and LOGOIL, as shown in Table 3. Notably, breakpoints were identified for LOGNPLR (2014M02 - 2017M12), LOGLOAN (2013M10 - 2015M09), and LOGRGDP (2014M09 - 2016M08), all closely aligned with the oil price shocks observed from 2014M12 to 2017M06. These oil price shocks were supply shocks caused by a surge in oil supply and a simultaneous reduction in global demand. The declining oil price shocks of 2014-2016 had direct effects on the real sector, which subsequently disseminated to the banking system. The structural break analysis in this study was conducted with the objective of identifying points in the time series where the underlying data-generating process experienced abrupt changes, particularly in response to significant oil price movements. The structural break identified during the 2014-2016 period aligns with a well-documented and sharp decline in global oil prices, largely driven by supply-side shocks such as increased U.S. shale production and OPEC's strategic decisions. This identification of breakpoints serves to highlight economically significant turning points in the oil-macro-financial linkages.

Table 3. Multiple breakpoint tests compare information criteria for 0 to M globally determined break.

Variable	Breaks	Schwarz Criterion	Estimated Break Dates
LOGNPLR	4	−6.3051	2009M12; 2012M03; **2014M02**; **2017M12**
LOGLOAN	5	−7.2979	2009M12; 2011M11; **2013M10**; **2015M09**; 2018M04
LOGRGDP	5	−6.8818	2010M10; 20112M10; **2014M09**; **2016M08**; 2018M07
GDEBT_RGDP	3	−6.1142	2009M12; **2016M07**; 2019M05
LOGOIL	4	−4.5612	2010M12; **2014M12**; **2017M06**; 2019M05

Note: Select the model with the lowest BIC and LWZ values as the best model. Source: Author's compilation using Eviews.

4.2. Identification of Key Drivers

A comprehensive overview of the Granger-causality test results for all variables incorporated in the VAR model. Figure 2, an innovative Granger Causality Diagram based on the test results, illustrates feedback loop effects within oil-macro-financial linkages, providing a novel framework for understanding these complex interactions. A feedback loop is a self-sustaining cause-and-effect system where outputs are continually fed back as inputs, creating ongoing cycles. Negative oil price shocks notably weaken the real sector and undermine financial stability, with more significant shocks causing more pronounced impacts. The interaction between financial development, inclusion, and the real sector creates macro-financial linkages that can influence macroeconomic stability bidirectionally. Given the pronounced impact of financial conditions on bank intermediary functions, a feedback effect from the banking sector to the overall economy reinforces these macro-financial connections. This interplay, recognized as the financial accelerator mechanism, establishes a feedback loop between the macroeconomy and bank credit, which, in turn, amplifies the effects of financial and aggregate disturbances. The five key variables, namely LOGNPLR, LOGLOAN, LOGRGDP, GDEBT_RGDP and LOGOIL, were observed to effectively exhibit a feedback loop effect. In this dynamic, the variables mutually reinforce each other, meaning a small change in one can led to a larger, cascading effect. Consequently, Granger causality confirms bidirectional relationships between oil prices, financial stability and macroeconomic activity.

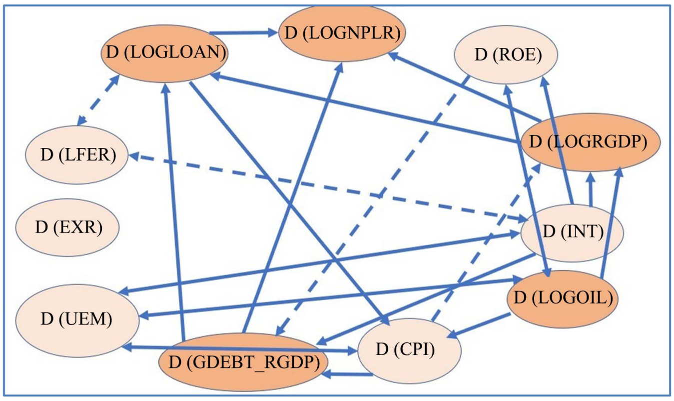

Figure 2. Granger causality diagram. Source: Author's compilation and modification from EViews. Dashed line <10% confidence level. Solid line <5% confidence level.

The results of Table 4 show that D (INT) has the highest number of nodes. D (LOGLOAN), D (UEM), D (CPI) and D (LOGOIL) have the second higher number of nodes. Finally, the two major macroeconomic factors such as D (RGDP) and D (GDEBT_RGDP) have the third higher number of nodes. Based on the highest nodes and determinant value, D (INT) demonstrated a strong direct impact on the other macroeconomic and banking variables with five nodes. Similarly, D (LOGOIL) showed the second strong direct impact on the other macroeconomic and banking variables with four nodes as well. The analysis has identified D (LOGOIL) and D (LOGLOAN) with six nodes and D (LOGRGDP) and D (GDEBT_RGDP) with five nodes as the major variables involved in the creation of the feedback loop.

Table 4. Determinants of directional and nodes.

Variable	Determinants of Directional	Nodes
D (LOGNPLR)	−2 − 2 − 2 = −6	3
D (LOGLOAN)	−1 − 2 − 2 + 2 + 2 + 1 = 0	6
D (LFER)	−1 − 1 + 1 = −1	3
D (ROE)	−2 − 2 + 2 + 1 = −1	4
D (LOGRGDP)	−2 − 2 − 2 + 2 + 2 = −2	5
D (EXR)	0	0
D (INT)	−2 − 1 + 2 + 2 + 2 + 2 + 1 = 6	7
D (UEM)	−2 − 2 − 2 + 2 + 2 + 2 = 0	6
D (CPI)	−2 − 2 − 2 + 2 + 2 + 1 = −1	6
D (GDEBT_RGDP)	−2 − 2 − 1 + 2 + 2 = −1	5
D (LOGOIL)	−2 − 2 + 2 + 2 + 2 + 2 = 4	6

Source: Author's compilation and values obtained from Granger Causality Diagram. ⟶ = +2, ⟵ = −2, means impacted to other (positive)/from other (negative) variable (< 5% confidence level), - - → = +1, ← - - = −1, means impacted to other (positive)/from other (negative) variable (<10% confidence level).

The Granger causality diagram (Table 2), when adapted into a network analysis framework, serves as a visual representation of the directional relationships and causal interactions among variables. This integration transforms the causality output into a node-based graph, where variables are depicted as nodes and causal links as edges. By mapping these connections, the network visualization not only illustrates the temporal dynamics but also highlights the structural properties of the system. This approach enables the identification of influential variables through centrality measures, uncovers key drivers of systemic interactions, and reveals the presence of potential feedback loops. Thus, integrating the Granger causality diagram with network analysis enhances interpretability, facilitates the detection of complex interdependencies, and provides a more comprehensive understanding of the transmission mechanisms within oil-macro-financial linkages.

While Granger causality identifies causal interactions, degree centrality analysis, visualized in Figure 3 (a node graph modified from the Granger Causality diagram), pinpoints the most influential variables within a system and validates the direction of causal relationships. This combined approach clarifies the structural dynamics, highlights key variables, and confirms feedback loops, improving the interpretation of Granger causality results and offering a clearer understanding of interdependence. Degree centrality analysis, applied to nodes from a Granger Causality diagram, identifies influential variables by counting direct connections, with the highest count indicating the most influential node. However, Eigenvector centrality offers a more nuanced measure by considering the significance of a node within the entire network. Table 5 presents both degree and Eigenvector centrality measures, and UCINET 6.528 is used to obtain eigenvalues for further analysis. Feedback loops, crucial for understanding system dynamics, are validated by combining degree centrality and Granger causality to identify key interacting nodes. In this study of Oil-Macro-Financial Linkages, feedback loops were found among LOGLOAN, LOGRGDP, INT, CPI, and GDEBT_RGDP, with LOGOIL as a highly influential node and NPLR interacting indirectly. This confirms that this interdisciplinary approach effectively identifies influential variables and constructs network graphs to analyze system dynamics.

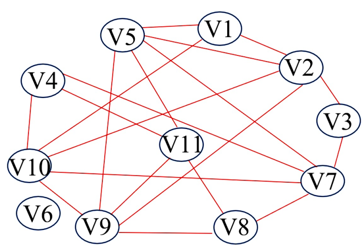

Figure 3. Node's graph (G). Source: Author's compilation for the study. Note: V1-LOGNPLR, V2-LOGLOAN, V3-LFER, V4-ROE, V5-LOGRGDP, V6-EXR, V7-INT, V8-UEM, V9-CPI, V10-GDEBT_RGDP, and V11-LOGOIL. Note: NPLR = Nonperforming Loans, LOAN = Total Loans of Banks, LFER = Loan to Fund and Equity Ratio, ROE = Return of Equity, RGDP = Real GDP, EXR = Exchange rate, INT = Interest, UEM = Unemployment, CPI = Consumer Price Index, GDEBT_RGDP = Government debt/RGDP, and OIL = Crude Oil Price.

Table 5. Multiple centrality measures.

Ranking	Nodes	Degree of Centrality	Eigenvalue
1	V9 (CPI)	5.000	0.394
2	V5 (LOGRGDP)	5.000	0.391
3	V10 (GDEBT_RGDP)	5.000	0.377
4	V2 (LOGLOAN)	5.000	0.375
5	V7 (INT)	5.000	0.331
6	V11 (LOGOIL)	4.000	0.296
7	V1 (LOGNPLR)	3.000	0.268
8	V8 (UEM)	3.000	0.240
9	V4 (ROE)	3.000	0.236
10	V3 (LEFR)	2.000	0.166
11	V6 (EXR)	0.000	0.000

Source: Author's compilation and Eigenvalue obtained from UCINET 6.528.

4.3. Implications for Economic Stability and Policy

Policymakers should recognize the uneven effects of oil price fluctuations on financial stability, necessitating thorough analysis of sector-specific impacts and comprehensive scenario planning. Clear communication is also essential to manage market expectations and prevent volatility.

To protect against oil price volatility's systemic risks, policymakers must enhance macroprudential measures, including dynamic buffers, targeted lending regulations, robust risk monitoring, and improved inter-agency and international coordination. Policies should be forward-looking, with ongoing refinements to stress testing and scenario planning.

5. Conclusion and Future Research

5.1. Summary of Findings

The study demonstrates that oil-macro-financial linkages are characterized by strong feedback loop effects, wherein changes in one sector significantly influence and reinforce changes in others. Notably, these feedback loop effects are particularly pronounced during periods of oil price downturns, indicating heightened systemic vulnerabilities during times of falling oil prices. This suggests that declining oil prices can trigger and amplify systemic risks across both macroeconomic and financial sectors, highlighting the interconnectedness of the system. Consequently, the analysis reveals that understanding and mitigating these feedback loops, especially during oil price downturns, is crucial for maintaining economic and financial stability. Therefore, policymakers should prioritize strategies that account for and address the amplified interactions within oil-macro-financial linkages during periods of declining oil prices.

The results of this analysis also indicate that an interdisciplinary approach, which combines techniques from different fields, significantly enhances the detection of structural interdependencies, leading to a more complete and nuanced understanding of the system's complexities. This study confirms that the implementation of an interdisciplinary methodology, by drawing on diverse analytical tools, enables the identification of intricate structural interdependencies, thereby providing a more accurate representation of the relationships between variables within the studied system.

5.2. Research Contributions

This study contributes to the field by introducing a novel and integrated methodological framework, combining SVAR, Granger causality, and degree centrality analysis, to provide a more nuanced understanding of the intricate feedback mechanisms within oil-macro-financial linkages, specifically revealing previously undetected relationships and quantifying systemic risks associated with oil price volatility, thereby offering valuable insights for policymakers to design targeted macro-financial stabilization strategies and establishing a robust approach for future research on complex interconnected systems, while also highlighting the increased impact of oil price downturns and the financial sector's role in shock transmission.

For the linkage between theory and findings, this study's empirical results reveal a dynamic, bidirectional interaction between oil price shocks, financial vulnerability, and macroeconomic performance, directly supporting the financial accelerator theory (Bernanke, 1998). This theory posits that adverse shocks, such as oil price declines, are amplified by deteriorating financial conditions, leading to constrained credit, reduced investment and consumption, and an intensified initial shock. The identified feedback loop, confirmed through SVAR, Granger causality, and degree centrality, validates this self-reinforcing mechanism. Financial instability transmits back to the real economy, further stressing the banking sector, illustrating the procyclical amplification described by Bernanke. This research extends the financial accelerator theory to the oil-macro-financial context, highlighting how oil price volatility can destabilize economic and financial systems through interconnected feedback loops, particularly during downturns like 2014-2017.

To manage these risks, policymakers can employ countercyclical capital buffers, targeted financial support, and enhanced monitoring using degree centrality. Fiscal policy, such as public investment, can support weak private demand. Clear communication between central banks and governments is also crucial. By combining econometric and network analysis, this study offers a practical approach to understanding and managing the impact of oil price shocks, supporting more effective and timely policy responses.

In summary, this study contributes to the literature on oil price shocks and macro-financial linkages by building upon the methodologies of Kilian and Park

(2009) and aligning with the empirical findings of Hammersland and Traee (2011). While Kilian and Park used SVAR to analyze oil price shock effects, this research extends their framework by incorporating Granger causality and degree centrality to capture feedback loops and systemic interdependencies. Consistent with Hammersland and Traee's findings on adverse oil price movements exacerbating financial vulnerabilities, this study further reveals that these feedback effects are more significant during supply-driven oil price downturns, particularly the 2014-2016 period, highlighting an asymmetry. Unlike earlier studies focusing on unidirectional transmission, this research uncovers robust bidirectional feedback loops between financial conditions and macroeconomic performance. This novel finding refines theories like the financial accelerator hypothesis by empirically demonstrating how financial fragility amplifies real-sector disturbances through feedback mechanisms, offering a more integrated and dynamic understanding of oil-macro-financial linkages.

5.3. Future Research and Limitation

While this study offers valuable insights into oil-macro-financial linkages within a single economy, future research should broaden the empirical scope to encompass a panel of economies. This comparative analysis would enable the identification of cross-country patterns, structural heterogeneities, and region-specific transmission mechanisms of oil price shocks, leading to a more generalizable understanding of systemic risks and resilience factors related to oil volatility. Moreover, acknowledging the potential for nonlinear and regime-dependent behavior, future studies could benefit from employing advanced econometric frameworks, including nonlinear models such as Threshold Vector Autoregression (TVAR) and Markov-Switching VAR (MS-VAR). These approaches allow for the capture of asymmetric responses and structural shifts across different economic regimes (e.g., boom vs. bust periods), thereby enhancing the explanatory power of the models. Integrating these methodologies would not only enrich theoretical and empirical analysis but also support a more nuanced understanding of how oil price shocks propagate through macroeconomic and financial systems across varying institutional contexts and stages of development.

While the timeframe of this study (2008-2020) indeed includes major global events such as the global financial crisis and the COVID-19 pandemic, the primary focus of the analysis is on exploring how declining oil prices, particularly those driven by supply-side factors—such as increased shale oil production, OPEC+ decisions not to cut supply, and the growing role of renewable energy—trigger feedback loop effects within oil-macro-financial linkages. These structural shifts in oil supply dynamics are central to the study, and the inclusion of major economic disruptions within the sample period adds empirical richness rather than undermining generalizability. The study does not aim to isolate the effects of unique crises, but rather to examine systemic responses to oil price declines, regardless of broader economic conditions. The presence of extraordinary shocks during the analysis period may influence the magnitude and dynamics of the estimated feedback effects. This limitation is acknowledged, and it opens avenues for future research to explore the behavior of these linkages during more stable periods or across different economic regimes.

This study employed structural break analysis to pinpoint abrupt changes in the data-generating process, particularly in response to significant oil price movements. A key structural break was identified during the 2014-2016 period, coinciding with a sharp global oil price decline driven by supply-side shocks. These breakpoints highlight economically significant turning points in oil-macro-financial linkages. The SVAR model assumes structural stability, but the identified breaks may indicate potential parameter instability, suggesting that the model's captured relationships might not be consistent across sub-periods. While this doesn't invalidate the analysis, caution is needed when interpreting the responses. Future research could enhance robustness by using time-varying or regime-switching SVAR models better suited for capturing dynamics with structural breaks. In this study, the structural break analysis provides contextual understanding of key oil-market shifts, rather than directly adjusting the SVAR estimation.

Author Contributions Statement

Formal analysis, Wong Hean Hoo; writing—original draft preparation, Wong Hean Hoo; writing—review and editing, Maran Marimuthu; supervision, Maran Marimuthu; review, Romana Bangash; and all authors have read and agreed to the published version of the manuscript.

Data Availability Statement

The authors confirm that the data supporting the findings, or this study is available within the article or its supplementary materials.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

Akinci, O., & Queralto, A. (2023). Exchange Rate Dynamics and Monetary Spillovers with Imperfect Financial Markets. *Review of Financial Studies, 37,* 1-47.

Aladwani, J. (2024). Oil Volatility Uncertainty: Impact on Fundamental Macroeconomics and the Stock Index. *Economies, 12,* Article 140. https://doi.org/10.3390/economies12060140

Albulescu, C. (2020). Bank Financial Stability, Bank Valuation and International Oil Prices: Evidence from Listed Russian Public Banks. *SSRN Electronic Journal.* https://doi.org/10.2139/ssrn.3325838

Barsky, R. B., & Kilian, L. (2002). Do We Really Know That Oil Caused the Great Stagflation? A Monetary Alternative. *NBER Macroeconomics Annual, 16,* 137-183. https://doi.org/10.1086/654439

Bernanke, B. S. (1998). The Financial Accelerator in a Quantitative Business Cycle Framework. *NBER Working Paper (6455).*

Bernanke, B., Reinhart, V., & Sack, B. (2004). Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment. *Brookings Papers on Economic Activity, 2004,* 1-100. https://doi.org/10.1353/eca.2005.0002

Boukhatem, J., & Djelassi, M. (2022). The Bank-Lending Channel of Monetary Policy Transmission in a Dual Banking System: Empirical Evidence from Panel VAR Modeling. *Cogent Economics & Finance, 10,* Article 2107765. https://doi.org/10.1080/23322039.2022.2107765

Chen, J., & Zhang, J. (2023). Crude Oil Price Shocks, Volatility Spillovers, and Global Systemic Financial Risk Transmission Mechanisms: Evidence from the Stock and Foreign Exchange Markets. *Resources Policy, 85,* 103875. https://doi.org/10.1016/j.resourpol.2023.103875

Chien, F., Chau, K. Y., Jalees, T., Zhang, Y., Nguyen, V. C., & Baloch, Z. A. (2021). Crude Oil Price Volatility and Economic Growth: Mediating Role of Macroeconomic Indicators. *The Singapore Economic Review, 12,* 1-25. https://doi.org/10.1142/s021759082150051x

Espinoza, R., & Prasad, A. (2010). Nonperforming Loans in the GCC Banking System and Their Macroeconomic Effects. *IMF Working Papers, 10,* 1-24. https://doi.org/10.5089/9781455208890.001

Gersl, A., & Jakubik, P. (2010). Adverse Feedback Loops in Bank-Based Financial Systems. *IES Working Paper, 14/2010*.

Hammersland, R., & Traee, C. B. (2011). The Financial Accelerator and the Real Economy Self-Reinforcing Feedback Loops in a Core Macro Econometric Model for Norway. *Statistics Norway, Research Department. Discussion Papers No. 668*.

Kandil, M. E., & Markovski, M. (2019). UAE Banks' Performance and the Oil Price Shock: Evidence across Conventional and Islamic Banks. *Review of Middle East Economics and Finance, 15,* 20190005. https://doi.org/10.1515/rmeef-2019-0005

Khandelwal, P., Miyajima, K., & Santos, A. (2017). The Impact of Oil Prices on the Banking System in the Gulf Cooperation Council. *Journal of Governance and Regulation, 6,* 32-47. https://doi.org/10.22495/jgr_v6_i2_p4

Kilian, L. (2009). Oil Price Shocks, Monetary Policy, and Stagnation. *CEPR Discussion Paper, No. DP7324.*

Kilian, L., & Park, C. (2009). The Impact of Oil Price Shocks on the U.S. Stock Market. *International Economic Review, 50,* 1267-1287. https://doi.org/10.1111/j.1468-2354.2009.00568.x

Molick, A. V., Killins, R. N., Egly, P. V., & Johnk, D. W. (2024). Bank Equity Returns and Oil Prices: The Story from U.S. Regional Banks during the "Shale Oil" Revolution. *Research in International Business and Finance, 70,* Article 102334. https://doi.org/10.1016/j.ribaf.2024.102334

Osuma, G. O., Babajide, A. A., Ikpefan, O. A., Nwuba, E. B., & Jegede, P. W. (2019). Effects of Global Decline in Oil Price on the Financial Performance of Selected Deposit Money Banks in Nigeria. *International Journal of Energy Economics and Policy, 9,* 187-195. https://doi.org/10.32479/ijeep.7514

Zulfigarov, F., & Neuenkirch, M. (2020). The Impact of Oil Price Changes on Selected Macroeconomic Indicators in Azerbaijan. *Economic Systems, 44,* Article 100814. https://doi.org/10.1016/j.ecosys.2020.100814

Glossary

Term	Definition
Degree Centrality	Degree centrality is a network theory metric that quantifies the number of direct connections (edges) a node has with other nodes within a network.
Granger Causality	Granger causality is a statistical hypothesis test used to determine whether one time series can predict another. It identifies lead-lag relationships and directionality in dynamic systems.
Impulse Response Function	Impulse response functions trace the dynamic effect of a one-time shock to an endogenous variable on the current and future values of other variables in a VAR or SVAR system.
Structural Break	A structural break refers to a point in a time series where the underlying data-generating process experiences a significant and abrupt change.
SVAR	SVAR is an extension of the Vector Autoregression (VAR) model that imposes theoretically grounded restrictions to identify structural shocks.
Variance Decomposition	Variance decomposition, also known as forecast error variance decomposition (FEVD), quantifies the proportion of the forecast error variance of each variable in a VAR or SVAR model that is attributable to each structural shock.