KnE Social Sciences
ICESG
International Conference on Environmental, Social and Governance
Volume 2023

Conference Paper

Determining Oil-Macro-Financial Linkages and Feedback Loop Effects: Evidence from Malaysia

Wong Hean Hoo*, Maran Marimuthu

Department of Management and Humanities, Universiti Technologi PETRONAS, 32610 Seri Iskandar, Perak, Malaysia

ORCID
Wong Hean Hoo: https://orchid.org/0009-0006-1998-1189

Abstract.
The correlation between declined oil prices versus bank stability has widely drawn researchers' attention and has set the stage for vicious feedback loops. This paper further explores the oil-macro-financial linkages and its intensity of the feedback loop between declined oil prices and macroeconomic-financial development in Malaysia. To gain further insights into this issue, we discuss the development of oil-macro-financial linkages that can propagate through the domestic financial system and reverberate to the real economy. The empirical results reveal that oil price shocks have a significant impact on banking performance, channelling through microeconomic banking-specific and macroeconomic country-specific variables which influence Malaysia's banking stability and create a ripple effect onto its real economy. In addition, this paper applies Granger causality, impulse response, and variance decompositions evaluation to assess the existence of a feedback loop effect within the oil-macro-financial linkages by using the VAR setting. In conclusion, oil-macro-financial linkages were empirically evaluated and had a more adverse effect than macro-financial factors alone could have explained within the Malaysian economy. Hence, a comprehensive understanding and extensive knowledge of the potent form of oil price volatility are significantly crucial in guiding bank operators and government regulators to mitigate risks with increasing control measurement, particularly in terms of the heterogeneous impact across the banking system and real economy.

Keywords: Oil-Macro-Financial Linkages, Feedback Loop Effects, Oil Price Shocks

Corresponding Author: Wong Hean Hoo; email: hean_17007723@utp.edu.my

Published 7 December 2023

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICESG Conference Committee.

1. Introduction

The performance of key indicators of macroeconomy and financial system has been strengthened in the oil price upturn. In contrast, the oil price downturn has tended to set a vicious feedback loop to weaken the financial system, with a larger shock having more pronounced impacts in the real economy (Samman & Jamil, 2021). Years of 2014 – 2021,

How to cite this article: Wong Hean Hoo*, Maran Marimuthu, (2023), "Determining Oil-Macro-Financial Linkages and Feedback Loop Effects: Evidence from Malaysia " in *International Conference on Environmental, Social and Governance*, KnE Social Sciences, pages 745–758. DOI 10.18502/kss.v8i20.14635

declining oil price has placed a macroeconomic pressure on oil exporting dependent economies and their banking systems. With the coincidence of global macroeconomic conditions, international oil markets have entered a sustained period of low oil prices. Thus, this research established the interdependence of the banking sector and the real economy in the consequence of the oil price downturn.

This paper builds on the emerging literature using both macroeconomic and bank-level data to study oil-macro-financial linkages in Malaysia, which is considered moderately dependent on oil production country compared to heavily reliant on oil production countries in the existing literature. Firstly, key determinants of bank NPLs are identified using a multivariate model which is controlling for bank and macroeconomic specific effects. Secondly, a VAR framework which was developed by Love and Zicchino (2006) would be employed to assess feedback effects among macroeconomic and bank level balance sheet variables. This paper attempts to apply the VAR framework to explore the dynamic existing relationship between macroeconomic and bank level data for a modestly dependent oil production country, Malaysia.

In the formation of Macro-Financial Linkages, the theory of real and financial transmission channels between the real and financial sectors potentially operates in both directions. In the study of different models, complementary sets of linkages between the financial and the real sectors produce a wide array of predictions for the macroeconomic effects of a shortfall in capital (Morley, 2015). In turn, the capital shortfalls in the intermediation sector propagate to the rest of the economy (Guerrieri and et.al, 2019). The financial shocks have a significant adverse effect on economic outcomes.

In the forming of Oil-Macro-Financial Linkages, it is believed that financial and macroeconomic performance in oil exporting countries is interlinked to oil price movement. Oil price shocks have impact and asymmetric effects on the nonperforming loans of large banks as opposed to small banks (Al-Khazali & Mirzaei, 2017). This study has provided a confirmation that oil price declines have significant impacts on major aspects of bank performance in the GCC oil-exporting economies (Naimy & Kattan, 2020). The empirical results revealed favourable effects of positive oil price changes on bank profitability, credit growth and output growth and vice versa.

In the formation of the Feedback Loop Effect, it is a mutually reinforcing effect between growing risks in the financial/banking sector and in the real economy. An occurrence might be illustrated by spelling out the transmission mechanism of an external shock in the presence of self-reinforcing feedback loops between financial factors and real economic activities. In the event of a strong decline in economic activity, Gersl & Jakubik (2010) found that procyclical behaviour by financial intermediaries could lead to a feedback loop effect. The causality analysis has revealed the existence of bidirectional causalities between oil prices and the GCC banking sectors, and between the US banking sector and the GCC banking sectors (Alqahtani, Samrgandi & Kutan, 2020). The further development of Oil-Macro-Financial Linkages can propagate through the domestic financial system and reverberate to the real economy. Oil price shocks have a significant impact on banking performance, channelling through banking and macroeconomic factors, which have influenced banking stability and created a ripple effect on the real economy.

2. LITERATURE REVIEW

2.1. Theoretical Background

Crude oil is the most important required input in the production process, and its price shocks have been long noticeable due to their impact on the real economy (Kandil & Markovski, 2019). Oil price shocks are also recognized to be of significant importance in both economic activities and financial markets (Khandelwal, Miyajima & Santos, 2017). An oil price shock affects bank performance through its adverse effects on macroeconomic aggregate such as consumption and investment. The decreasing consumption expenditures are driven by the discretionary income effect, uncertain effect, precautionary savings effect, and operating cost effect that led to a deterioration of non-performing loans and lower off-balance sheet activities (Killian 2008).

Oil prices affect oil-exporting countries' economies through direct and indirect channels. Oil-macro-financial linkages in Saudi Arabia have been studied that the lower oil prices led to slower credit and deposit growth and higher non performing loan ratios, with feedback loops within bank balance sheets which in turn dampened economic activity (Miyajima, 2016). There is a volatility transmission between oil prices and financial stress that were dominated by long-run volatility.

The theoretical foundation of credit risk shocks and their implications on the real economy are well established in the literature by using financial acceleration (Bernanke, 1998). In the other study, Espinoza & Prasad (2010) noticed that the impact of macroeconomic risks on the banking system and their feedback effects increasing credit risks on the economy. Khandelwal, Miyajima & Santos (2017) found that the Gulf Cooperation Council (GCC) economies can be adversely affected by low oil prices due to their high dependence on oil and gas exports. While their macro-financial linkages can amplify the effects of oil price movements over the financial cycle. In the econometric models, it confirmed that oil prices and economic activity tended to significantly be affecting bank asset quality. Furthermore, declining in oil prices and slowing of GDP growth could lead to an increase in the NPL ratio. The conceptual framework of the study depicts in Figure 1.

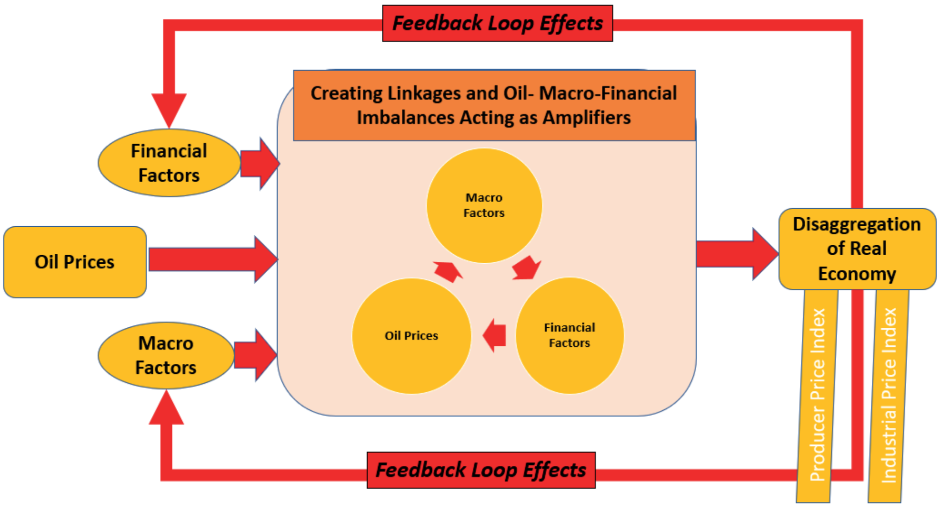

Figure 1: Proposed Conceptual framework.

2.2. Empirical Literature Review

In this paper, two related empirical models of oil-macro financial linkages are estimated for the Malaysia economy. Firstly, a brief review of the literature and discussion of data are followed by estimation of a multivariate model to assess the impact of oil price shocks on macroeconomic outcomes and bank asset quality, i.e., Non-performing Loans. Secondly, a VAR model to investigate oil-macro-financial linkages and Granger Causality method to identify feedback loop effects embedded in oil-macro-financial linkages.

Using a partial equilibrium analysis framework, Krugman (1983) studied the impact of oil price shocks on the key macroeconomic variables in the short run and long run. The study inferred that oil price has a major impact on the exchange rate and some other macroeconomic variables. In another study, Bernake et at (1997) explored the interaction between oil price and GDP from a monetary policy perspective.

The other standard practice of using the VAR model is performing the impulse response analysis and forecast error variance decomposition. To assess the feedback effect of disturbances in the banking system, this analysis focuses on the impulse responses to various structural shocks, particularly to oil prices shock, credit shock (influenced by the bank-specific factors) and macroeconomic shocks (influenced by the country-specific factors). Panel Vector AutoRegression (PVAR) model is proposed to assess the feedback effects among the oil price shocks, the banking system and the real economy (Zicchino, 2006). The Generalized Impulse Response is proposed to examine the impact of a shock to one variable on another, and to observe the period of existence of the impacts (Shin, 1998). Plotting the orthogonalized impulse response function is a practical way to visually represent how a variable responds to various shocks in the endogenous variables, and through the impulse response function, one can examine the direction, magnitude, and length of time that a variable is affected by a shock or in another variable within the system, ceteris paribus (Lutkepohl, 2005) . After analysing the behaviour of shocks through the impulse response, then the next step is to predict the contribution of each study variable to shocks or changes in certain variables to see the model through the Forecast Error Variance Decomposition (FEVD).

In the other study, Granger causality was employed to investigate the causalities among COVID-19 and stock market returns, as well as between pandemic measures and several commodities (Gherghina, Armeanu & Joldes, 2020). Furthermore, Lee & Li (2020) assessed the causal relation among oil price, geopolitical risk and green bond index that observed a significant bi-directional causality from oil price to green bond index for the lower quantiles. In this study, the Granger causality test determines whether a bidirectional or unidirectional link exists among oil price and macro-financial factors. Thus, the feedback loop effects are determined.

3. Data and Methodology

3.1. Multivariate Regression Model

Using a partial equilibrium analysis framework, Krugman (1983) studied the impact of oil price shocks on the key macroeconomic variables in the short run and long run. In this study, a multivariate model is used to empirically assess the determinants of NPLs in Malaysia. We adopt this econometric method as it allows this study to consider banking's performance and macroeconomic factors at the base level, treating these as endogenous variables. The empirical specification takes the following general form:

NPLs = □ + □1bank + □2country + □3OIL + □ (1)

Where NPLs is Nonperforming Loans; bank and country are vectors of bank-specific and country-specific factors of bank performance and stability; oil denotes a measure of oil price shock; σ is a constant variable; β is a vector of estimated parameters and □ is the error term.

To examine the bank-specific determinants of NPLs in Malaysia, the specified research model based on the earlier works will be used as follow by Roman & Bilan (2015):

$$\mathbf{NPLR} = \sigma + \beta\mathbf{1\Delta LOAN} + + \beta\mathbf{2LFER} + \beta\mathbf{3LFR} + \beta\mathbf{4ROA} + \beta\mathbf{5ROE} + \quad \mathbf{(2)}$$

Where NPLR is Nonperforming Loans; ΔLOAN is loan growth, LFER is total loan to fund and equity; LFR is total loan to fund; ROA is return on asset; ROE is return on equity; σ is a constant variable; β is a vector of estimated parameters and □ is the error term.

To examine the country-specific determinants of NPLs in Malaysia, the specified research model based on the earlier works will be used as follow by Roman & Bilan,(2015):

$$\mathbf{NPLR} = \sigma + \beta\mathbf{1NGDP} + \beta\mathbf{2EXR} + \beta\mathbf{3INT} + \beta\mathbf{4UEM} + \beta\mathbf{5CPI} + \beta\mathbf{6GDEBT} + \quad \mathbf{(3)}$$

Where NPLs is Nonperforming Loans; NGDP is Nominal GDP, EXR is Exchange rate; INT is Interest; UNE is Unemployment rate; CPI is Consumer Price Index; GDEBT is Government Debt; σ is a constant variable; β is a vector of estimated parameters and □ is the error term.

This study will use time series data from the year 2000 until the most recent 2020. In this period, Malaysia oil price has been constantly increasing since 2000 but has been significantly dropping after 2015 until at present sluggishness. The source of data will be taken from the Bank Negara Malaysia and CICE Global Database.

3.2. VAR model of Oil-Macro-Financial Linkages

There are some studies employing time series econometric techniques such as unit root, co-integration, Granger causality, impulse response function and forecast error variance decomposition within the vector autoregression (VAR) framework (Espinoza & Prasad, 2010). Vector AutoRegressions (VAR) model is implemented to assess the feedback effects between the banking systems and the real economy. To assess the feedback effect of disturbances in the banking system, the analysis focuses on the impulse responses to various structural shocks, particularly to oil prices shock and macroeconomic shocks. To assess the feedback loop effect of the oil-macro-financial linkages, the analysis focuses on the Granger causality to reveal the existence of unidirectional and bidirectional causalities between the variables. The analysis of three-stage-procedure is carried out in the following order to determine whether VAR satisfies the stability condition: i) unit root test, ii) cointegration test and iii) causality test.

3.3. Unit Root Test

Augmented Dickey-Fuller (ADF) Unit Root Test was used to test the stationary or the presence of unit root. Most of the time series data in economics exhibit a trend over time and usually are not stationary. The non-stationary implies the mean, variance and covariance are not constant over time. When the data contain unit root, the result accrue to such data will be spurious or nonsensical. Spurious regression implies that the relationship between variables may appear statistically significant, however, there is no meaningful relationship among the variables.

3.4. Cointegration Tests

For example, once the orders of integration of the variables are determined via unit tests and ensure that all the variables are integrated of order one, i.e., 1(I), this study can employ Johansen (1995) techniques to test for cointegration among variables within the model. The optimal lag length selections in the VAR must be satisfied to apply Johansen's approach, which is sensitive to lag lengths. In the second step, Johansen Cointegration Analysis will be carried out to analyse the long run relationship among the dependent variable and independent variables. The cointegration test on time series can avoid the errors that are carried forward to the next step.

3.5. Granger Causality Analysis

The third step would be to conduct a causality test. If there is existing a cointegrating vector between two variables, there is a possibility of either a bidirectional and/or a unidirectional Granger causality among the variables in the system (Granger, 1987). The VAR can be used for conducting causality tests to verify the usefulness of one variable to forecast another.

3.6. Impulse Response and Forecast Error Variance Decomposition

The other standard practice of using the VAR model is the impulse response analysis and forecast error variance decomposition. Panel Vector AutoRegression (PVAR) model is proposed to assess the feedback effects among the oil price shocks, the banking system and the real economy (Zicchino, 2006). To assess the feedback effect of disturbances in the banking system, this analysis focuses on the impulse responses to various structural shocks, particularly to oil prices shock, credit shock (influenced by the bank-specific factors) and macroeconomic shocks (influenced by the country-specific factors).

The Generalized Impulse Response is proposed to examine the impact of a shock to one variable on another, and to observe the period of existence of the impacts (Shin, 1998). Plotting the orthogonalized impulse response function is a practical way to visually represent how a variable responds to various shocks in the endogenous variables, and through the impulse response function, one can examine the direction, magnitude, and length of time that a variable is affected by a shock or in another variable within the system, ceteris paribus (Lutkepohl, 2005) . After analysing the behaviour of shocks through the impulse response, then the next step is to predict the contribution of each study variable to shocks or changes in certain variables to see the model through the Forecast Error Variance Decomposition (FEVD).

4. Empirical Findings

4.1. Findings of Least Square Regression

By using the multivariate regression model, the paper confirmed that oil prices and economic activities tended to significantly affect bank asset quality. Thus, the presence of oil-macro-financial linkages was determined. The existence of oil-macro-financial linkages in the Gulf Cooperation Council (GCC) countries has confirmed that oil prices and economic factors significantly affect banking factors (Khandelwal, Miyajima & Santos, 2017). The result of the Least Square Regression as follows:

4.2. Findings of Unit Root Test and Heteroskedasticity Test

VAR satisfies the stability condition based on the roots of the characteristic polynomial. If there is unstable VAR, the results of impulse response function and variance

Table 1: Determinants of Non-Performance Loans (Least Square Regression).

5

Dependent Variable: Non-Performing Loans Ratio (LOGNPLR)							
Explanatory Variables Coefficients (P-value)							
	Micro Variables						
CONSTANT 2.1226.*** (0.0000)	LOGNPLR(-1) 0.8059*** (0.0000)	LOGLOAN -0.7100*** (0.0000)	LFER -0.0039 (0.1569)	LFR 0.0026 (0.3321)	ROA 0.0384* (0.0759)	ROE - 0.0037* (0.0962)	
Macro Variables							
LOGNGDP 0.3363*** (0.0002)	EXR 0.0141* (0.0661)	INT 0.0083* (0.0599)	UEM 0.0087* (0.0825)	CPI 0.0014 (0.1272)	GDEBT_NGDP 0.0100** (0.0135)	LOGOIL -0.0279** (0.0420)	Dummy 0.0079* (0.0842)
R^2 = 0.9976 F-Statistic = 4422.735 Probability (F-Stat) = 0.0000 Durbin-Watson = 1.65 Breuch-Pagan-Godfrey = 0.5946							

Source: Author's compilation using Eviews

decomposition will be invalid. In this study, VAR satisfies the stability condition as the value of its AR roots is less than one and there is no root that lies outside the unit circle. Heteroskedasticity happens when the standard deviations of a predicted variable, monitor over different values of an independent variable or as related to prior periods, are non-constant. Since the p-value is 0.6511, the insignificance of the test indicating the data has no heteroskedasticity. To test whether there is an autocorrelation problem in the model, the Autocorrelation LM test has been implemented and the p-value for the Lag 2, Lag 3 and Lag 4 interval is more than 5%. Therefore, there is no autocorrelation problem in the model with the respective lag interval.

On the specification of VAR models, the determination of the lag order of the autoregressive Lag Polynomial is applied because all inferences in the VAR model depend on the correct model specification. According to the analysis, the most convenient lag length for VAR models has been found as Lag 5 and None/Intercept/No Trend.

4.3. Findings of Cointegration Test

Johansen Cointegration Test has been carried out to examine the long-term relationships between the series. Cointegration is measured with the help of eigen-values and the stationary must be ensured for all the series involved in the analysis. According to the results of Johansen Cointegration Test, to accept the existence of a cointegration equation, Trace and Max-Eigen Statistical values should be higher than the critical value at 5% significance level. Trace test and maximum eigenvalue test both indicate the existence of one and five cointegrating equations at 5% significance level. In this test, there are eleven and seven long-term stable relationships among these variables.

In other words, long run movements of the variables are determined by eleven and seven cointegrating relationships.

4.4. Findings of Granger Causality Test

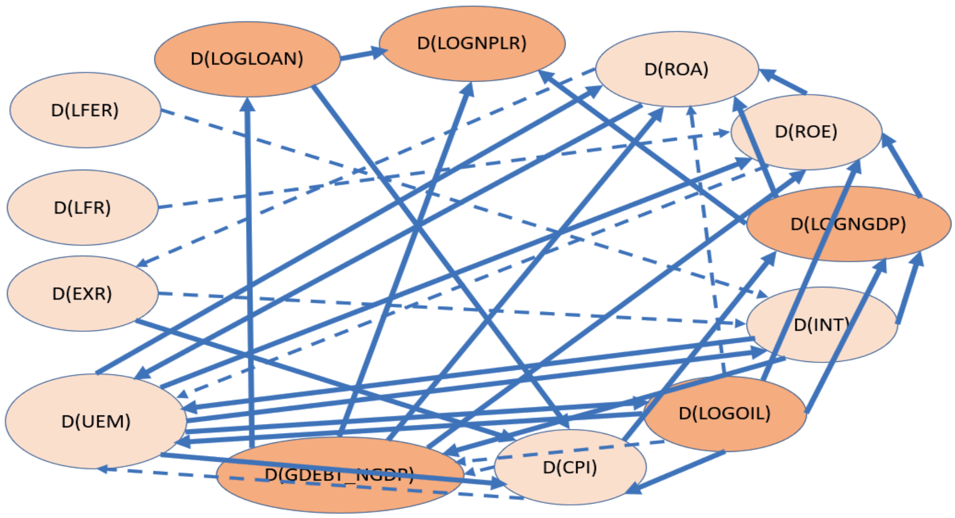

Figure 2: Granger Causality Diagram.

By using Granger-causality test, the results show that there are unidirectional causality running from D(LOGLOAN), D(GDEBT_NGDP) and D(LOGNGDP) to D(LOGNPL). There are unidirectional causality running from D(LOGOIL) to D(CPI), D(GDEBT_NGDP), D(LOGNGDP), D(ROE) and D(ROA) and there is bidirectional causality running from D(LOGOIL) to D(UEM). There are unidirectional causality running from D(GDEBT_NGDP) to D(LOGLOAN) and unidirectional causality running from D(LOGLOAN) to D(LOGNPLR) and D(CPI). There are unidirectional causality running from D(GDEBT_NGDP) to D(LOGLOAN), D(LOGNPLR), D(ROA), and D(ROE). There is uni-directional causality running from D(INT), D(LOGOIL) and D(CPI) to D(GDEBT_NGDP). Lastly, there are unidirectional causality running from D(LOGNGDP) to D(ROE), D(ROA), and D(LOGNPLR). There are unidirectional from D(CPI), D(LOGOIL) and D(INT) to D(LOGNGDP). Thus, the presence of Oil-Macro-Financial feedback loop effects was determined. Ray (2012) has conducted granger causality test to examine whether there are any causal linkages between stock prices and macroeconomic variables. The unidirectional and bidirectional causality have explored the impact of different macroeconomic variables on the stock prices in India from 1990 to 2010.

Source: Author's compilation and values obtained from Granger Causality Diagram +2 means impacted to other variable and -2 means impacted from other variable (<

TABLE 2: Summary of Determinants of Directional and Nodes.

Variable	Determinants of Directional	Nodes
D(LOGNPLR)	-2-2-2 = -6	3
D(LOGLOAN)	+2+2-2 = +2	3
D(LOGNGDP)	+2+2-2-2-2+2 = 0	6
D(GDEBT_NGDP)	+2+2+2+2-2-1-1 = +4	7
D(LOGOIL)	+2+1+2-2+1+2+2 = +8	7

5% confidence level) +1 means impacted to other variable and -1 means impacted from other variable (< 10% confidence level)

The results of the Table 2, LOGOIL has indicated the higher positive value of the determinants of directional and the second higher number of nodes. The two major macro-economic factors, LOGNGDP and GDEBT_NGDP have indicated the second higher value of the determinants of direction and the number of nodes. Lastly, the two major financial factors, LOGLOAN and LOGNPL have indicated the lower value of the determinants of directional and the number of nodes. LOGOIL changes have demonstrated largest impact variables (determinant of directional = +8) to others and followed by the Government Debt (determinant of directional = +4). Thus, the presence of Oil-Macro-Financial feedback loop effects was determined.

4.5. Findings of Impulse Response Function and Forecast Error Variance Decomposition

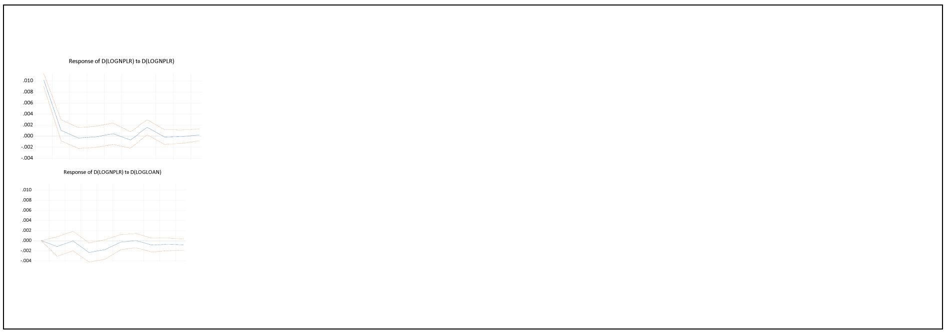

Figure 3: Impulse Response Function for D(LOGNPLR)- Response to Generalized 1 S.D Innovation.

Figure 3 above shows the response of D(LOGNPLR) to shocks in D(LOGOIL), D(GDEBT_NGDP), D(LOGNGDP), and D(LOGLOAN). The results for the IRF showing a response of D(LOGNPLR) to shocks in D(GDEBT_NGDP) and D(LOGNGDP), were insignificant. However, the response of D(LOGNPLR) to shocks in D(LOGOIL) and D(LOGLOAN), were significant. In the response of D(LOGNPLR) to shocks in D(LOGOIL), it has increased in the positive region at 4 periods and has started to decrease at

5^{th} period but short-lived and turned close to zero permanently. The IRF is found in the significance at 4, 5 and 7 periods. In the response of D(LOGNPLR) to shocks in D(LOGLOAN), it has stayed in the negative region till close to zero permanently. At 4 periods, it started to increase till the 6^{th} period and reached zero. The IRF is found in significance at 4 till 5 periods.

For the Forecast Error Variance Decomposition for D(LOGNPLR), a 100% of forecast error variance in LOGNPLR by explaining the variable itself in the short run. So, it has a strong endogenous effect impact, and it implies strong influence from its own variables. D(LOGOIL), D(GDEBT_NGDP), D(LOGNGDP) and D(LOGLOAN) have no strong influence on D(LOGNPLR) in the earlier periods. That means these four variables have a strong exogenous impact. The strong exogenous impact implies they have no impact on D(LOGNPLR) at all in the short run. In period 10, the 2.46%, 7.37% and 7.27% shows these three variables have strong exogeneity.

5. Conclusion and Recommendations

This paper examines the existence of oil-macro-financial linkages and intensity of feedback loop between declining oil price and macroeconomic and financial development in Malaysia. In general, the performance of key indicators of macroeconomy and financial system has been strengthened in the oil price upturn. In contrast, the oil price downturn has tended to set a vicious feedback loop to weaken the financial system, with a larger shock having more pronounced impacts in the real economy. In this paper, the empirical results show that macroeconomic variables, including Oil Prices, Nominal GDP and Government Debt are the major determinants of Non-Performing Loans. Therefore, this paper concluded a higher level of Non-Performing Loans restricts banks' credit growth and dampens economic recovery in the economy. Due to the persistence of low oil prices and the continued shrinking of government revenues, GCC countries must focus on subsidies' reforms and to increase non-oil revenues, to strengthen fiscal sustainability and macroeconomic stability (Mahmah &Kandil, 2018). In GCC countries, government expenditure is highly affected by changes in oil prices. Some governments must cut their expenditure because of declined oil prices and others maintain current expenditure levels, at least in the short run. Thus, this paper can be served as a recommendation for achieving financial stability, so policy makers need to monitor the development in international oil markets and smooth the potential effects to Malaysia's banking system. As a modestly dependent oil production country, Malaysia has to accumulate a large amount of oil stabilization buffers and have the fiscal space to limit any negative feedback to the real economy. Nevertheless, a comprehensive understanding and extensive knowledge of the potent form of oil price volatility are very crucial in guiding bank operators and government regulators to mitigate risks with increasing control measurement particularly impact heterogeneously across banks.

References

[1] Alqahtani F, Samargandi N, Kutan AM. The influence of oil prices on the banking sector in oil-exporting economies: is there a psychological barrier? International Review of Financial Analysis. 2020;69:1057–5219.

[2] Al-Khazali OM & Mirzaei A. The impact of oil price movements on bank non-performing loans: Global evidence from oil-exporting countries. Emerging Markets Review. 2017; S1566-0141(17)30178-4.

[3] Espinoza M, Prasad A. Nonperforming loans in the GCC banking system and their macroeconomic effects. Working Paper, IMF. 2010. WP/10/224.

[4] Gersl A, Jakubik P. Adverse feedback loop in the bank-based financial systems. IES Working Paper. 2010;14.

[5] Gherghina SC, Armeanu DS & Jolder CC. Stock market reactions to COVID-19 pandemic outbreak: Quantitative evidence from ARDL bounds tests and Granger causality analysis. International Journal of Environment Research and Public Health. 2020;17(18).

[6] Granger RF. Cointegration and error correction: Representation, estimation, and testing. Econometrica. 1987;55(2):251–76.

[7] Guerrieri, et al. Macroeconomic effects of banking-sector losses across structural models. International Journal of Central Banking. 2019.

[8] Johansen S. Likelihood-based inference in cointegrated vector auto-regressive models. Oxford University Press; 1995. https://doi.org/10.1093/0198774508.001.0001

[9] Johansen S, Juselius K. Maximum likelihood estimation and inference on cointegration - with applications to the demand for money. Oxford Bulletin of Economics and Statistics. 1990;52(2):169–210.

[10] Kalian L. The economic effects of energy price shocks. Journal of Economic Literature. 2008;46(4):871–909.

[11] Kandil M, Markovsiki M. UAE bank's performance and the oil price shock: Indicators for conventional and Islamic banks. Review of Middle East Economics and Finance. 2019;15(3). https://doi.org/10.1515/rmeef-2019-0005

[12] Khandelwal P, Miyajima K, Santos A. The impact of oil prices on the banking system in the Gulf Cooperation Council. Journal Of Governance and Regulation. 2017;6(2):32–47.

[13] Krugman P. Oil shocks and exchange rate dynamics. National Bureau of Economic Research; 1983. pp. 259–84.

[14] Lee CC & Li YL. Oil price shocks, geopolitical risks, and green bond market dynamics. The North American Journal of Economics and Finance. 2020;V(55).

[15] Lutkepohl H. New introduction to multiple time series analysis. Springer; 2005. https://doi.org/10.1007/978-3-540-27752-1

[16] Mahmah AE, Kandil M. Fiscal sustainability challenges in the new normal of low oil prices: Empirical evidence from GCC countries. International Journal of Development Issues. 2018:1446–8956.

[17] Miyajima K. An empirical investigation of oil-macro-financial linkage in Saudi Arabia. IMF Working Paper. 2016;16(22):1.

[18] Morley J. Macro-financial linkage. John Wiley & Sons Ltd. Journal of Economic Surveys. 2015;00(0):1–14.

[19] Naimy V, Kattan R. The impact of the recent oil price decline on the GCC banking system. Middle East Development Journal. 2020;10(2):1080.

[20] Ray S. Testing Granger causal relationship between macroeconomic variables and stock price behavior: Evidence from India. Advances in Applied Economics and Finance. 2012;3(1).

[21] Roman A, Bilan I. An empirical analysis of the macroeconomic determinants of non-performing loans in EU28 banking sector. Review of Economics. 2015;67(2).

[22] Samman HA, Jamil SA. Does falling oil prices impact industrial companies in the Gulf Cooperation Council countries? Journal of Asian Finance. Economics and Business. 2021;8(2):89–97.

[23] Shin MH. Generalized impulse response analysis in linear multivariate models. Economics Letters. 1998;58(1).

[24] Zicchino IL. Financial development and dynamic investment behavior: Evidence from panel VAR. Quarterly Review of Economics and Finance. 2006:46.