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Article

Impact of International Oil Price Shocks and Inflation on Bank Efficiency and Financial Stability: Evidence from Saudi Arabian Banking Sector

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Abstract: This study examines the short-run and long-run equilibrium relationship between the banking sector's efficiency and stability and its endogenous and exogenous determinants, such as inflation and international oil price shocks in Saudi Arabia from 2004 to 2022. This study differentiates between the direct and indirect effects of international oil price changes on bank efficiency and stability and investigates how these changes can affect the banking sector through inflation. The first stage uses a panel Autoregressive Distributive Lag (ARDL). The empirical result confirms a long/short-run relationship between oil price shocks and the stability and efficiency of banks. In the long run, the relationship is statistically significant and positive, and it is negative in the short run. On the other hand, this study finds that oil price shocks directly affect the stability and efficiency of banks. In the second stage, this study uses a nonlinear ARD (NARD) to examine the short- and long-run asymmetric impacts of oil price shocks on the stability and efficiency of banks by decomposing the oil price index into positive and negative changes. The findings confirm an asymmetric relationship between oil prices and the stability and efficiency of banks in Saudi Arabia. In addition, a positive change in oil price can affect the stability and efficiency of banks more than a negative one. Overall, the findings highlight the need for policymakers in Saudi Arabia to be vigilant in addressing potential risks arising from oil price fluctuations and to adopt appropriate policy measures to maintain stability and efficiency in the banking sector.

Keywords: Saudi Arabian banking sector; oil price shocks; inflation; bank efficiency; bank stability

JEL Classification: G20; G210; G28; D24

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1. Introduction

The Saudi banking sector has a principal economic position, given its crucial role in financing production, trade, and investment, especially following the liberalization of after-trade and foreign investment. It continues to play a critical role in supporting the broader Saudi economy and in ensuring the stability and resilience of the financial system.

Banking is an essential organ in the economy and in social development. Thanks to its financial resources, human resources, technological capabilities, and professional expertise, it has developed as an economic and ecosystem developer. This has been achieved through passing regulations that conform to international banking standards and transparency (Ramady 2021). In this context, determining the factors affecting the banks' efficiency and stability remains a major interest for regulators and policymakers.

Despite ongoing efforts to decrease oil use and explore alternative green energy sources, it remains a crucial component of world economic activities for both import/export countries. In recent decades, oil prices have been exposed to many shocks, which caused fluctuation in oil prices. These fluctuations affected the economy in general and the banking sector through different channels. Since Saudi Arabia is a significant player in the global energy market (Alghassab 2023) and owns a large oil reserve, it cannot be immune to any changes in oil prices.

Many studies have investigated the relationship between oil price shocks, bank profitability, and macroeconomic performance in Saudi Arabia; however, the literature on the relationship between oil price shocks and bank efficiency is limited (Alsmadi et al. 2022; Bin Amin 2022; Bin Amin and Rehman 2022; Medhioub and Makni 2020; Huybens and Smith 1999; Umar et al. 2014; Altaee et al. 2022).

Alsmadi et al. (2022) suggested that higher oil prices positively influence the profitability of Saudi Islamic banks as they rely on oil prices for their profitability. Additionally, Bin Bin Amin (2022) concludes that the volatility of the Saudi Arabian financial market is primarily driven by fluctuations in oil prices, and the country's oil production capacity directly affects its financial market performance. Bin Bin Amin and Rehman (2022) also suggested that higher oil prices positively influence Islamic banks' profitability, adversely affecting the stock prices of banks and the financial service sector. Medhioub and Makni (2020) suggested that the private sector in Saudi Arabia is also affected by oil price uncertainty, with the stock market index having a significant positive impact on private investment, particularly in the case of unexpected news from the oil sector.

The effect of inflation on the performance of banks has been primarily investigated in the empirical literature as a primary macroeconomic variable. Huybens and Smith (1999) examined the impact of inflation on financial sector performance. They suggested that an increase in inflation would lead to credit market friction, which, in turn, negatively impacts the financial sector's performance. The volume of bank lending and performance tend to decrease when the inflation rate rises. Umar et al. (2014) examined the effect of inflation on bank performance, and they suggested that inflation had an adverse effect on banking sector performance; the bank cannot absorb the shocks of an increase in the inflation rate. According to Azariadis and Smith (1996), it is crucial to consider a specific level of inflation when examining the link between inflation and the financial sector's performance. The detrimental impact of inflation on the efficiency of the financial sector only becomes significant after surpassing a certain threshold. Considering the mixed outcome, this study investigates the relationship between the banks' efficiency stability and inflation in Saudi Arabia.

The primary motivation behind conducting this research is to address the existing gap in the literature regarding the banks' efficiency and stability and oil price shocks. To achieve this goal, this study examines the short-run and the long-run equilibrium relationships between the banking sector's efficiency and stability and its internal and external determinants, such as inflation and international oil price shocks in Saudi Arabia. The study will differentiate between the direct and indirect effects of international oil price changes on bank efficiency and stability and investigate how these changes can affect the banking sector through macroeconomic variables in general and inflation in particular.

Many studies have investigated the determinants of profitability and bank efficiency. Altaee et al. (2022) and other scholars examined the relationship between the oil price shock and bank performance through the effects of oil price fluctuations on banking efficiency and stability. However, they did not investigate the role of inflation. Many external factors can affect international oil prices, including armed conflicts like the war in Ukraine. Such conflicts often impact current events.

Given the dependence of some countries on the production and export of oil in general and the Saudi economy in particular, the linkage between international oil price shocks and bank efficiency and stability is of great political significance not only during crises and recession periods but also during cycles of prosperity. This leads to questions such as: Do oil price shocks influence bank efficiency and stability? If so, is there a direct or indirect link between international oil price shocks and efficiency and stability if bank-specific factors and macroeconomic determinants are accounted for? Is there an asymmetric effect between positive and negative oil price shocks on bank efficiency and stability?

This study fills the gap in the literature by looking into the asymmetric effects of oil price shocks on the stability and efficiency of banks in Saudi Arabia. This emphasis on an oil-reliant economy with a transitioning banking sector, such as Saudi Arabia, is especially applicable due to the nation's economic change objectives in Vision 2030. By applying a nonlinear ARDL approach that distinguishes both the short and long-run impacts of oil price changes and captures the fact that positive opposite shocks may have different effects from negative ones (as is likely in contemporary settings), we show that such dynamics are important but often neglected in earlier research.

Such a study is important for policymakers who want to reduce the potential dangers of oil price volatility and maintain a stable banking industry during Saudi Arabia's transition to economic diversity. While oil price effects on banking efficiency are known from the current literature, the asymmetric response assessment restraints are not, and a more complex methodology is required.

This study is organized as follows. Section 2 overviews the relevant literature; Section 3 provides the data description, the methodology used, and how the oil price shock was measured; Section 4 explores and evaluates the findings; and Section 5 concludes and offers policy implications.

2. Literature Review

This makes oil the most essential energy source and a significant determinant and driver for global economic activities. Oil prices have very high volatility. Different direct and indirect channels can work through the economy with oil price-induced fluctuations. Hence, raising external price pressures or more loan risk, retarding activity increased the impulse to amplify this course of changes in bank profitability. Oil income prospects indirectly affect the allocation of fiscal spending, which impacts the profitability of corporations and banks through lending to the private sector. Higher oil prices could also boost demand for economic activities, leading to increased bank confidence, higher lending, and lower levels of non-performing loans. High oil prices can also push countries' growth rates by fueling new public and private investments.

Conversely, the decline in oil exports, government revenue, and fiscal balances due to the subsequent significant drop in oil prices in 2008/2009 in MENA countries led to a significant drop in GDP growth and equity/real estate prices, which has put a strain on both corporate and bank balance sheets (Hesse and Poghosyan 2016). Moreover, credit growth to the private sector has worsened considerably. In some countries, governments have had to step in to provide deposit guarantees, liquidity support, capital injections, or equity purchases through their government-owned entities, such as Sovereign Wealth Funds (SWFs), due to worsening financial sector indicators. Also, banks that heavily lent for real estate and equity purchases have suffered losses due to the collapse of these asset prices. So far, it should be clear that the volatility of the oil market has some influences on the performance of the banking system in the oil economy. This study aims to investigate the sensitivity level between the oil price fluctuations and the banks' efficiency and stability.

2.1. Empirical Background

In the literature, the impact of oil price volatility has been investigated from different perspectives. Many studies have examined the impact of oil price change on macroeconomic indicators (Hamilton 2003; Gisser and Goodwin 1986; Guo and Kliesen 2005; Mork et al. 1994; Berument et al. 2010; Cunado and De Gracia 2005; Cologni and Manera 2008; Chen and Chen 2007; Papapetrou 2001; Said 2015). Other studies have explored the significance of oil prices on the financial market (Jones and Kaul 1996; Sadorsky 1999; Park and Ratti 2008; Huang et al. 1996; Silvapulle et al. 2017; Sakurai and Kurosaki 2020; Yao et al. 2020; Ahmed and Huo 2021; Kelikume and Muritala 2019; Zhu et al. 2011; Alqahtani et al. 2019; Alsmadi et al. 2022; Alsubaiei et al. 2023). Further studies have considered the impact of oil price shocks on the banking sector (Hesse and Poghosyan 2016; Khandelwal et al. 2016; Kandil and Markovski 2019; Effendi 2019; Saif-Alyousfi et al. 2021;

Maghyereh and Abdoh 2021; Jin et al. 2022; Hamilton 2011; Alodayni 2016; Alqahtani and Mayes 2018; Mohammad et al. 2019; Said 2015; Lee and Lee 2019; Kaffash et al. 2020; Umar et al. 2021; Jreisat et al. 2022; Jreisat and Al-Mohamad 2022; Mohammad et al. 2019; Kandil and Markovski 2019; Said 2015).

This research paper explores the existing literature on oil prices on the macroeconomic indicators. Then, it explores how oil price shocks can affect the financial market. Finally, it investigates how oil price shocks affect the banking sector.

Oil price shocks have been a central topic in economics. A study by Hamilton (2003) using cross-section data from 1949 to 1999 in the US has demonstrated no linear correlation between oil price Altaee, H.H.A es, and economic growth. Contrary to this, Gisser and Goodwin (1986) and Guo and Kliesen (2005) have found a significant correlation between crude oil prices and economic growth in the US. Moreover, Mork et al. (1994) concluded a significant negative correlation between oil price increases and the GDP of these countries by using a database of seven OECD countries (Canada, France, Japan, Norway, Germany, the UK, and the US). They confirmed a positive correlation only in Norway because of its economy's dependence on oil income. Furthermore, using data from MENA countries, Berument et al. (2010) established a significant and positive effect of oil price shocks on the growth of net oil exporting countries.

On the other hand, Cunado and De Gracia (2005) and Cologni and Manera (2008) examined the impact of oil prices on inflation. They found a positive effect of oil price shocks on inflation. Furthermore, Chen and Chen (2007) examined the possible relationship between real exchange rates and oil prices. They analyzed a monthly panel database for G7 countries from 1972 to 2005; the study suggested a cointegrating relationship.

Papapetrou (2001) investigated the relationship between oil price shock and economic activities in Greece. He used a multivariate vector-autoregression (VAR) approach. The findings revealed that oil price shocks contribute to increased employment and economic activities (interest rates, industrial production, and real stock returns). Furthermore, Said (2015) highlighted a positive relationship between GDP and oil price change in oil-rich countries. These countries experienced a remarkable increase in GDP in the 1980s. However, when oil prices decreased in 2009, the GDP of these countries also decreased and adversely affected Islamic banking performance. This strong relationship between the oil price and the banking sector underlines the importance of understanding the oil price shocks on the country's financial landscape.

This research paper will now narrow the focus on the literature that discusses how oil price shocks affect the financial market (Jones and Kaul 1996; Sadorsky 1999; Park and Ratti 2008; Huang et al. 1996; Silvapulle et al. 2017; Sakurai and Kurosaki 2020; Yao et al. 2020; Ahmed and Huo 2021; Kelikume and Muritala 2019; Zhu et al. 2011; Moreover, Alqahtani et al. 2019; Alsmadi et al. 2022; Alsubaiei et al. 2023). Many studies examined the effect of oil price shocks on stock market returns. Jones and Kaul (1996) tested the reaction of international stock markets to oil price shocks. Using a cash-flow dividend valuation for four countries (Canada, the UK, Japan, and the US), they found a significant negative correlation between oil price volatility and stock returns in the US. In contrast to other countries, especially the UK and Japan, the reaction was not definitive. Moreover, Sadorsky (1999) conducted a study that utilized a vector autoregressive model (VAR) to examine the relationship between oil price shocks and US stock markets from 1974 to 1996. The results indicated that changes in oil prices can significantly influence stock prices, highlighting the importance of oil price volatility in the movement of stock prices. In 2008, Park and Ratti (2008) conducted a similar analysis of the impact of oil prices on US and 13 European stock markets, finding that oil price shocks hurt real stock returns in the short term. However, in contrast with these findings, Huang et al. (1996) indicated that oil futures had limited influence on stock returns and only affected the returns of certain oil companies.

In recent studies, Silvapulle et al. (2017) found a positive relationship between oil prices and stock indices, particularly after the global financial crisis of 2008. Furthermore, uncertainty in oil prices can also impact stock prices depending on the stock market conditions. After the eruption of the COVID-19 pandemic, Sakurai and Kurosaki (2020) examined how the relationship between the US stock market and oil has changed. Their findings revealed that changes in oil price shocks can influence performance. Thus, a decline in oil prices has been observed to have a more pronounced impact on US stocks than equivalent shocks experienced before the crisis. In contrast, positive oil shocks have yielded more favorable outcomes. Moreover, Yao et al. (2020) discovered, using multifractal methods, a strong cross-correlation between stocks and oil prices, with some symmetry in small and large-scale fluctuations. Furthermore, Ahmed and Huo (2021) used a tri-variate (VAR-BEKK-GARCH) model to study the effect of oil prices on the stock market in China. They found a significant unidirectional transmission of returns from the oil market to the Chinese stock market, emphasizing the strong dependence of the Chinese stock market on the oil market. Moreover, the inquiry was undertaken by Kelikume and Muritala (2019), who employed a dynamic panel analysis on a dataset from 2010 to 2018 from five African countries with a significant presence in the oil production industry. The findings revealed that the fluctuation in oil prices causes a detrimental impact on the stock market.

All the previously mentioned results are related to countries exporting oil. Having explored the global context, we will now focus on how oil prices can affect the financial market in Saudi Arabia. Zhu et al. (2011) explored the impact of the fluctuation of oil prices on the financial market of Saudi Arabia, UAE, Qatar, Oman, Kuwait, and Bahrain using a bootstrap panel cointegration. The empirical work provides further evidence for the positive correlation between oil prices and the UAE, Qatar, Oman, Kuwait, and Bahrain stock markets. However, it has not had a significant impact on the stock market in Saudi Arabia. Moreover, Alqahtani et al. (2019) investigated the interdependence of the Gulf Cooperation Council (GCC) stock markets and oil price uncertainty using a dynamic conditional correlation model. This study employed weekly stock and oil price data from 2007 to 2018 and utilized a GARCH model to represent oil price uncertainty. The findings show an inverse correlation between stock returns in the GCC and oil price volatility.

A recent study conducted by Alsmadi et al. (2022) on Saudi Arabia's financial market concluded that the increase in oil prices positively affects the value of the Saudi financial market. In addition, Saudi Arabia's financial market investors prioritize short-term gains from oil prices and fail to analyze the risk objectively. Alsubaiei et al. (2023) established monthly data on all equity Saudi funds from 2006 to 2017. They found that oil market volatility significantly negatively impacts mutual fund performance and reduces managers' stock selection ability.

As we have explored the influence of oil prices on financial markets, we will examine previous findings about the relationship between oil prices and banks' profitability, risk, efficiency, and stability. The existing literature has not thoroughly investigated the influence of oil prices on the banking industry. Additionally, the influence on bank efficiency remains constrained.

The pioneering study is referred to by Hesse and Poghosyan (2016), who investigated the relationship between oil price shocks and bank profitability in 11 oil-exporting MENA countries from 1994 to 2008 using data on 145 banks. The first finding was that the impact of oil price shocks on bank profitability is positive and is mainly channeled through investment banks. The second finding was that oil price shocks do not directly impact bank profitability, but their effects are transmitted through macroeconomic and institutional factors. Among these findings, the authors recognized that inflation and fiscal policies are the primary drivers that affect banks' profitability. The empirical work of Khandelwal et al. (2016) provides more evidence that confirms these results. Using macroeconomic and bank-level data covering the six GCC economies and span 1999–2014, the authors show that a decline in oil price and GDP growth could lead to an increase in the non-performing loans (NPL) ratio, adversely affecting the bank asset quality.

These results were confirmed by Kandil and Markovski (2019). The study investigated the impact of the fall in oil prices in mid-September 2014 on banks' performance in the UAE. It used panel data from 22 national banks (15 conventional and 7 Islamic) from 2013 to 2017. Their research indicated that the price fall has a negative impact on ROA, ROE, credit, and deposit growth. Conversely, the revenue of the Islamic banking sector is found to decrease more than that of conventional banks.

Furthermore, Effendi (2019) examined the impact of oil prices and macroeconomic variables on the performance of Islamic banks in seven OPEC member countries. The authors showed that oil price has a different impact on the performance of Islamic banks, as measured by ROA and ROE, depending on each country's characteristics and the share of the Islamic banks in this country. Thus, the performance of Islamic banking in Saudi Arabia is indirectly affected by changes in oil prices through macroeconomic variables (GDP, Inflation, and Unemployment). In addition, Saif-Alyousfi et al. (2021) investigated how the fluctuations in oil and gas prices affected the performance of banks in Gulf Cooperation Council (GCC) countries from 2000 to 2017. Their analysis revealed that increases in oil and gas prices positively impact bank performance by influencing deposits and lending for business activities. However, the negative impact on bank performance resulting from decreased oil and gas prices exceeds the positive effect of price increases.

As we explore the relationship between oil prices and bank performance, it becomes evident that fluctuations in oil prices impact banking performance differently through macroeconomic and institutional factors.

The literature explores a second perspective on the influence of oil price shocks and the banking sector: systemic risk. A study by Maghyereh and Abdoh (2021) examined the relationship between oil price shocks and systemic risk among the GCC countries' banks. They use data from banks from January 2006 to September 2020. Their findings suggest that oil price changes due to structural oil shocks caused by changes in the supply or demand of oil during the global financial crisis (2007–2009) and the ongoing COVID-19 pandemic have resulted in more significant effects on bank risk in the region. Jin et al. (2022) examine the impact of oil price shocks on bank risk measured by z score using data for 2217 banks from 39 countries from 2006 to 2017. The result suggests that oil shock has positive impacts on bank risk.

The literature has also examined the correlation between oil price shocks and the banking sector, using the stability factor. Hamilton (2011) and Killins and Mollick (2020) demonstrated that the fluctuations in the macroeconomic variables and oil prices have significantly influenced the banking sector's profitability. They concluded that an increase in oil prices has the potential to advance the stability of commercial banks by reducing the ratio of loan loss provisions to loans and supplying crucial financial resources for economic growth. Further, Alodayni (2016) examined the effect of the 2014–2015 oil price slump on the financial stability in the GCC region. Using panel data of GCC individual banks' balance sheets spanning 2000–2014, the obtained result shows that the decline in oil price contributes to a higher level of NPLs, adversely affecting banks' asset quality and banks' credit growth and, therefore, financial stability in the region that can dampen economic growth in these countries.

Moreover, Alqahtani and Mayes (2018) suggest that oil price adversely impacts banking stability. They used data from GCC banks, which spanned from 2000 to 2013; the study's results revealed a relationship between GDP and inflation on the stability of banks (conventional and Islamic). Additionally, Mohammad et al. (2019) used data from 49 conventional banks and 40 Islamic banks in 6 oil-rich countries, where the revenue generated from oil constituted the primary significance of their income during the period 2008–2018 to demonstrate that oil price change affected significantly the banking stability measured by the historical stability measurement (Z-score).

We will now investigating the literature that studied the impact of oil price shocks on the banking sector's efficiency. A study by Said (2015) used data from 32 Islamic banks operating in oil-producing countries in the MENA region during 2006–2009. The study analyzes the effect of the yearly oil price change on efficiency scores. The finding suggests that oil price has no direct influence on the efficiency score of Islamic banks.

Furthermore, Lee and Lee (2019) investigated the impacts of oil prices on bank management efficiency using the CAMELS system rate (Capital adequacy, Asset quality, Management, Earnings, Liquidity, and Sensitivity). They analyze data in China over the period 2000–2014. The primary discoveries of their study indicate that oil price shocks have a negative impact on banking efficiency, specifically in terms of capitalization, management efficiency, earning power, and liquidity. However, the negative consequences are lessened by the presence of a stable country, particularly in terms of economic and political stability. Moreover, Kaffash et al. (2020) have investigated the impact of oil price changes on the efficiency of banks in Middle East Oil Exporting (MEOE) countries using unbalanced panel data from 2001 to 2011. The results indicated that the change in oil prices has a significant impact not only through direct means but also indirectly on the efficiency of banks. Furthermore, it was observed that Islamic banks in the region exhibit less sensitivity to oil price fluctuations than commercial and investment bank counterparts. Furthermore, Umar et al. (2021) have assessed the impact of the resource curse on the banking sector of twelve countries significantly dependent on oil production (the percentage of oil rent of GDP is twenty percent and above) during periods of varying oil prices in 2001–2009. The results show that during episodes of the price boom, the banking efficiency declines, credit infection worsens, and the probability of default surges.

Further, Jreisat et al. (2022) examine the influence of oil price volatility on bank efficiency within the BRICS countries (Brazil, Russia, India, China, and South Africa) from 2003 to 2018. Using data from 112 banks, the authors have assessed the score of bank efficiency through Data Envelopment Analysis (DEA) in the first stage and evaluated the impact of volatility of oil prices on the efficiency of banks in the second stage. The findings indicate that oil price volatility affected bank efficiency in BRICS countries, and inflation and economic progress can serve as the primary indirect drivers. Additionally, Jreisat and Al-Mohamad (2022) investigated the impact of the oil price shock in 2014 on banks' efficiency in GCC countries. They used the data envelopment analysis (DEA) methodology to estimate the efficiency score. Their findings suggest that the global financial crisis (GFC) in 2008 and the oil price shock in 2014 significantly negatively impacted the efficiency scores of the GCC banks, implying that the efficiency of banks in the GCC region is sensitive to oil price change. They also show that domestic macroeconomic indicators have a more significant impact on bank efficiency than institutional or bank-specific variables.

The literature review concisely overviews the complex relationship between oil prices, economic factors, financial markets, and the banking sector. Changes in oil prices can significantly influence the stock market and the performance of banks directly or indirectly through economic factors. Although these studies provide valuable insight into many aspects of this correlation, there remain opportunities for further investigation to address the details of this interaction. The following sections of this study will examine the research methodology, data analysis, and findings to provide a comprehensive understanding of the impact of oil shocks on the efficiency of the banking sector in Saudi Arabia.

As mentioned above, there is no consensus about the impact of oil price change on the efficiency and stability of banks in countries rich in natural resources. This can be explained first by the characteristics of each country that allow the impact to differ from one country to another. Moreover, it may be due to the inappropriate model used to explain this impact. Jreisat et al. (2022), Mohammad et al. (2019), Kandil and Markovski (2019), and Said (2015) used a linear model, and they ignored the existence of short-run and the long-run relationship between an oil price change and performance of banks. Other authors have exploited the ARDL model to examine the relationship (Gökmenoğlu and Taspinar 2016; Katırcıoglu et al. 2020; Katircioglu 2009, 2010; Oskooee and Oyolola 2007).

However, they ignored the existence of the asymmetric impact of oil price shock, which can be positive or negative, and the impact intensity is different between the two facts. Also, many studies investigating this impact did not distinguish between direct and indirect effects (Jreisat et al. 2022; Mohammad et al. 2019; Kandil and Markovski 2019; Said 2015).

The nature of our two means requires choosing a model that can forecast their relationship and especially disentangle the short run from the long run relationship. The oil price shock may have two primary impacts on banks' efficiency and stability: a short-run impact and a long-run impact through a change in liquidity and new investment opportunities. In this study, to overcome the shortcomings in previous research and to contribute to the understanding of the intricate relationship between the stability and efficiency of banks in exporting oil countries in general and Saudi Arabia in particular, we use a nonlinear autoregressive distributed lag model (NARDL) developed by Shin et al. (2014). This model extends the ARDL framework within an Error-correction (EC) developed by Pesaran et al. (Pesaran and Shin 1999; Pesaran et al. 2001) to capture short-run price adjustments constrained by long-run equilibrium. The NARDL model allows us to estimate short- and long-run asymmetric effects of oil price shock within one regression framework. It fits well with our data, especially as we have an asymmetric effect due to the existence of positive shock and negative shock.

Table 1 serves as a summary, comparing the key aspects of previous pioneer research and what sets the study apart from others. These comparisons describe the methodology focus and results. This table aims to elucidate the approach and value addition from this study.

Table 1. Summary table comparing key past research with the unique contributions of the current study.

Study	Authors	Methodology	Focus	Key Findings	How This Study Differs
Impact of Oil Price on Stock Returns	Jones and Kaul (1996)	VAR Model	Effect of oil price shocks on U.S. stock returns	Oil price volatility has a significant negative impact on stock returns	This study focuses on bank efficiency, not stock returns, in an oil-dependent economy.
Oil Prices and Financial Markets	Sadorsky (1999)	VAR Model	Oil prices and U.S. stock markets	Oil price shocks influence stock prices, revealing a link to economic factors	Focuses on banking sector stability and efficiency rather than general financial markets.
Banking Sector and Oil Price Volatility	Park and Ratti (2008)	VAR Model	Relationship between oil prices and stock markets in the U.S. and Europe	Oil price shocks have negative effects on real stock returns across regions	Investigates asymmetric impacts on banking efficiency and stability, and short/long-run dynamics, with a focus on Vision 2030, using a nonlinear ARDL approach.
Bank Credit and Economic Diversification	Mukhtarov et al. (2019)	Cointegration and Causality Tests	Role of bank credit in non-oil GDP in Azerbaijan	Bank credits positively impact non-oil GDP, supporting economic diversification in oil-dependent countries	Examines the role of oil price shocks rather than bank credit in economic diversification in Saudi Arabia.

2.2. Theoretical Background

The selection of the variables for this study is based on theoretical and empirical literature. The paper discusses bank-specific and macroeconomic variables, which are well established in the literature and influence banking efficiency and stability in oil-exporting economies.

Institutional determinants: Size, credit risk, and financial intermediation are essential factors of bank stability to better substantiate the expected impacts, as supported by Bouzidi (2010) and Srairi (2010).

Macroeconomic determinants: Inflation and GDP growth are important standard macroeconomic variables that affect bank performance through profitability, asset quality, and overall risk environment (Singh 2010).

Oil price shock: Direct and indirect effects of oil prices on bank stability, as an area of focus of this research (The direct effect acts as the development for the oil-related business activities, while the indirect effect works through inflation and economic activity) (Kaffash et al. 2020).

The relationship between banks' efficiency and stability, the bank-specific determinants, and oil price stock can be presented through a direct functional form as follows:

$$SE_t = \beta_0 + \beta_1 X_t + \beta_2 OILP_t + \varepsilon_t \quad (1)$$

where SE_t, X_t, and ε_t indicate, respectively, the stability efficiency of banks, determinants of stability efficiency, and error disturbance. As presented at the outset, this study aims to examine the impact of oil price shocks on stability efficiency and whether their impact is direct or indirect. To this aim, the variable inflation and GDP are included in Equation (1). The oil price indirectly affects the stability efficiency through inflation (INF) and GDP if the coefficient γ_2 in Equation (2) is insignificant (Hesse and Poghosyan 2016; Katırcıoglu et al. 2020; Saif-Alyousfi et al. 2021). The indirect effect model can be presented as follows:

$$SE_t = \gamma_0 + \gamma_1 X_t + \gamma_2 OILP_t + \gamma_3 Macro_t + \varepsilon_t \quad (2)$$

Determinants of Bank Stability Efficiency

Table 2 presents all the variables used to examine the impact of oil price shocks on bank stability efficiency, its calculation method, and the expectation impact sign. SE, generated by using a translog function, is used as a proxy for bank stability efficiency. It indicates the ability of banks to use a good combination of inputs to produce the maximum output and ensure its stability.

Table 2. List of variables used.

Variables	Measurement	Expected Impact
SE: Stability efficiency of banks	Estimated through parametric model Stochastic frontier analysis (SFA)	
Bank-specific determinants:		
Size	Total Assets: converted to natural logarithm: Ln (TA)	+
Credit risk	Reserves for impaired loans/Gross loans	-
Financial intermediation	Loans to customers deposits ratio	+
Macroeconomic determinants:		
Inflation	Consumer price index (CPI)	+
GDP	Annual percentage growth rate of GDP	+
Oil price	Log Brent oil price	+

Two groups of variables are used to investigate the impact of the oil price shock on bank efficiency and stability. The first group contains three variables used to control for bank-specific factors largely exploited in the literature to investigate the determinants of bank efficiency and stability. The three factors considered are size, credit risk, and financial intermediation ratio.

The size of banks is used as a proxy for the total investment made by banks, which is expected to affect bank stability and efficiency positively. However, the literature does not offer a conclusive opinion about its impact. Some studies supported the positive impact

(Bouzidi 2010; Srairi 2010; Ariff and Can 2008), while others suggested a negative impact (Staub et al. 2010; Isik and Hassan 2002).

Credit risk is a proxy for asset quality and is expected to impact bank stability and efficiency negatively. The literature provides a conclusive opinion about its negative impact (Ariff and Can 2008).

The financial intermediation ratio shows the deposit lending rate and indicates the bank's ability to convert deposits into loans and master financial intermediation. It is expected to positively impact banks' efficiency and stability (Lutfi and Suyatno 2019).

The macroeconomic variables used in this study are Inflation and real GDP. These variables are not under the control of banks, and they can impact their stability and efficiency by affecting their profitability, asset quality, and ability to manage risk. The banks have to adapt well to refine their stability and efficiency. The existing literature reveals mixed results about its impact on general bank performance and efficiency and stability in particular.

Inflation (INF): This study uses the annual consumer prices index, which is expected to have a negative effect on bank stability efficiency. This can be explained by a mismatch between banks and businesses regarding the ability to predict inflation. Banks can adjust interest rates in advance to prevent additional inflation-related expenses (Hesse and Poghosyan 2016). A high inflation rate might lead to a higher level of uncertainty regarding economic agents' decisions and a lower level of technical efficiency. Many studies have supported the literature's positive relationship between inflation and bank efficiency. Garza-García (2012) showed that inflation should increase the value of bad credit and render banks inefficient because they are obliged to pay more to manage bad credit. Meanwhile, Sulaeman et al. (2019) and Said and Ali (2016) supported the positive effect of inflation on efficiency.

GDP: Bank stability and efficiency can be significantly affected by the economic activities in the country. In this study, the economic activities are proxied by the logarithm of real GDP. In case of expansion (recession) in the economy, banks can generate more (less) income because of the increase (decrease) of favorable opportunities for firms to invest. Therefore, the activities in the stock market can increase (or decrease). In case of expansion (recession) in the economy, the NPL ratio decreases (increases), and this can affect positively (negatively) the stability efficiency of banks. For this reason, the expected impact of GDP on the stability efficiency of banks is positive (Said and Ali 2016).

Oil price shock: The oil price variation might affect bank stability and efficiency via direct and indirect channels. Through direct effect, the variation of the oil price might impact oil-related lending and business activities, which can affect the efficiency and stability of banks. In addition, efficiency and stability can be indirectly affected by macroeconomic channels like changes in inflation and economic activities (Kaffash et al. 2020).

3. Data and Methodology

3.1. Data

The dataset used in this study is the annual and quarterly covering period from 2004 to 2022. This period is very appropriate and might answer this study's central question. In this period, many of the oil-exporting countries in the Middle East and North Africa (MENA) region, particularly Saudi Arabia, have been severely impacted by the global crisis of 2008/2009 and the subsequent significant drop in oil prices. Further, there was a significant decrease in oil prices from June to December 2014, ending four years of relatively stable prices.

The data used to estimate the Z-score are quarterly and are available only from 2004 to 2022. It was obtained from the Tadawul website. The annual dataset regarding bank-specific variables is obtained from the Bankscope database. The macroeconomic variables (CPI and GDP) are obtained from the World Development Indicators. The total number of banks selected is ten (10); four (4) are Islamic banks due to their Islamic banking activities: Alrajhi Bank, Bank Aljazira, Bank Albilad, and Bank Alimna. The six other banks are considered mainly conventional banks by the nature of their business activities. The dataset is unbalanced because the data items for four years for Saudi National Bank are unavailable, especially for Alinma Bank, formed during the period under investigation (2006). Albilad Bank was established in late 2004.

3.2. Modeling and Methodology

3.2.1. Estimation of Stability and Efficiency

In the literature, the efficiency of banks and stability have been measured separately. The efficiency score has been measured using a variety of methods. Some studies have employed the ratio method, and others have exploited the parametric and non-parametric methods to estimate banks' efficiency scores. Furthermore, the stability of banks has been measured by many tools. Z-score[1] and Altman scores have been commonly used. In our study, we follow Md Safiullah (2021) and combine many methods to estimate one variable that can reflect stability and efficiency simultaneously, called stability efficiency probability. Following Md Safiullah (2021) and Fang et al. (2014), we estimate bank-specific stability SE using the stochastic stability efficiency frontier, and we use Z-score as a proxy of risk-adjusted profit and the alternative profit function developed by Berger and Mester (2003) to estimate financial stability efficiency score through Z-score frontier.

The specific stochastic stability model and the translog specification for the stochastic stability frontier model for each bank "*b*" at the time "*t*" can be formulated as follows:

$$\begin{gathered} Z - score_{bt} = f(X_{bt};\varphi)e^{v_{bt}+u_{bt}} \\ b = 1,2,3,\ldots\ldots\ldots N;\ t = 1,2,\ldots\ldots\ldots T \end{gathered} \tag{3}$$

where Z-score$_{\mathrm{bt}}$ is the Z-score for bank *b* in year *t*.

X_{bt} is the vector of output and input prices.

φ is the vector of unknown parameters to be estimated.

V_{bt} is the usual error term that follows the normal distribution N (0, $\sigma^2 v$), independent of U_{bt}. It is white noise used to control for measurement errors and determinants of Z-score beyond the control of managers. The term also captures the good luck (bad luck) of the bank having experienced a favorable (unfavorable) exogenous shock that increases (decreases) the Z-score.

U_{bt} is the deviation of the Z-score of the bank of parameter b compared to the stability efficiency frontier. It is a non-negative random variable that follows the normal distribution truncated at zero and is assumed to be independent of V_{bt}, representing stability inefficiency. Higher bank stability inefficiency is associated with a lower Z-score than the best bank.

To facilitate Equation (3), it can be formulated as follows:

$$Z - score_{bt} = e^{X_{bt}\varphi + v_{bt}} \tag{4}$$

The functional form of the profit function adopted for the calculation of the level of stability efficiency is the type of translog profit function; it is as follows:

$$\begin{gathered} \log\frac{z-score_{bt}}{w_3} = \alpha + \sum_{k=1}^{2}\rho_k \log\frac{w_{kbt}}{w_3} + \sum_{m=1}^{3}\beta_m \log y_{mbt} + \\ \frac{1}{2}\sum_{k=1}^{2}\sum_{l=1}^{2}\lambda_{kl}\log\frac{w_{kbt}}{w_3}\log\frac{w_{lbt}}{w_3} + \frac{1}{2}\sum_{m=1}^{3}\sum_{m=1}^{3}\theta \log y_{mbt}\log y_{nbt} + \\ \sum_{k=1}^{2}\sum_{m=1}^{3}\Psi_{km}\log\frac{w_{kbt}}{w_3}\log y_{mbt} + v_{bt} + u_{bt} \\ b = 1,2,3,\ \ldots\ldots\ldots 11;\ t = 1,2,\ldots\ldots\ldots 2021 \end{gathered} \tag{5}$$

where the Log Z-score is the natural logarithm of the Z-score of the bth bank in the period *t*, ($\log w_{kbt}$) is the natural logarithm of its kth input prices, (Log y_m) represents the natural logarithm of its mth output,

The stability inefficiency, due to the excessive use of inputs to produce a given output volume, which results from the choice of the wrong combination of inputs given their relative prices in the market, would be captured by the stability inefficiency term U_{bt}. The term V_{bt} is used to control measurement errors and determinants of costs beyond the control of managers. This term also captures the (bad) luck of the banks having experienced an (unfavorable) favorable exogenous shock that (increases) decreases the Z-score of the bank.

To be consistent with economic theory, following Berger and Mester (2003), the standard symmetric restrictions are applied to the translog portion of the model as $\lambda_{kl} = \lambda_{lk}$ and $\theta_{mn} = \theta_{nm}$. Furthermore, following Md Safiullah (2021) and Fang et al. (2014), the Z-score, price of deposits (w1), and price of physical capital (w2) are normalized by the price of labor (w3).

In this study, we refer to the intermediation approach to define the inputs and outputs bank. It is the most widely used banking literature (Kwan 2006; Berger and Humphrey 1997). The independent variables included in the model reflect the characteristics of the banks and the environment in which they operate. We select variables that can be measured for all banks (Islamic and conventional).

The stability efficiency for each bank is estimated using the conditional expectation developed by Jondrow et al. (1982) to determine a reliable estimator of individual stability efficiency. Thus, the stability efficiency would be the following:

$$SE_{bt} = e^{-E(\frac{u_{bt}}{\varepsilon_{bt}})} \tag{6}$$

where $\varepsilon_{bt} = v_{bt} + u_{bt}$.

To ensure greater flexibility and exploit the information content of our panel, this study uses the model of Battese and Coelli (1992). It allows for considering the variability of stability inefficiency term in time for the case of an unbalanced panel. This is particularly important for this study since it is possible to explore the trend of the stability efficiency of banks over time and thereby assess the impact of oil price change on the stability and efficiency of banks.

3.2.2. Second Stage: Regression Analysis

The second stage of this study consists of estimating the impact of the oil price shock on the stability and efficiency score estimated in stage 1. For this aim, two stages are essential: (i) A preliminary test, a panel cointegration test; (ii) The specification of the NARDL/EC bounds model.

Preliminary Test

This study conducts a preliminary data analysis that tests the presence of cross-sectional dependence. The panel data estimation supposes that the disturbances are cross-sectionally independent; however, given that the dataset covers approximately 19 years, the presence of banks in similar geographical areas, regulation, and economic inducement, considering the potential influence of various significant events on Saudi Arabia's economy, the dependence may arise. It would be more appropriate to examine whether the series has been subject to structural shifts from their usual trends. For this purpose, the diagnostic test developed by Pesaran (2021) would be used to compute the cross-section dependence statistic (CD) and, therefore, to choose the appropriate panel unit root test. Several Unit root tests are performed: Im et al. (2003) test (IPS), Levin et al. (2002) test (LLC), and the second generation of the IPS test (CIPS) of Pesaran (2007)[2].

Panel Cointegration Test

Based on the result of the preliminary test of the presence of a unit root, a panel cointegration test would be performed. If the variables are non-stationary, this study would examine for cointegration through the cointegration test of Pedroni (1996, 2001, 2004). The cointegration test is expected to prove the existence or absence of a long-term relationship.

NARDL/EC Bounds Model

Our study examines the short-run and long-run relationship among variables by using a nonlinear autoregressive distributed lag model (NARDL) developed by (Shin et al. (2014).

This model, as noted above, is the extension of the ARDL model developed by Pesaran et al. (Pesaran and Shin 1999; Pesaran et al. 2001) that can allow the independent variable to be purely I(0), purely I(1), or mutually co-integrated (Gökmenoğlu and Taspinar 2016; Katircioglu 2009, 2010; Oskooee and Oyolola 2007), and can take large numbers of lagged components that are captured in the data of McCann et al. (2010).

The stability-efficiency equilibrium relationship is presented as follows:

$$SE_{bt} = f(X,\ \epsilon_{bt}) \tag{7}$$

where b = 1, 2, . . . N, indicates the number of banks, t = 1, 2, . . . T indicates the number of periods, SE_{bt} is the stability efficiency of banks, X is the vector of independent variables, and ε_t is a stochastic error term. This stability efficiency model can be written as a standard ARDL equation as follows:

$$\Delta SE_{b,t} = \sum_{j=1}^{U} \gamma_{bj} \Delta SE_{b,t-j} + \sum_{j=0}^{V} x_{bj} \Delta X_{b,t-j} + \varepsilon_{b,t} \tag{8}$$

where $bSE_{b,t}$ is the stability efficiency score, and $X_{b,t-j}$ is the vector of independent variables. γ_{bj} is a scalar, χ_{bj} are coefficients of explanatory variables, and ε_{bt} is a random term that gathers all other factors not included in the model and behaves well in statistical rules.

Pesaran and Shin (1999) rewrite Equation (8) in error-correction form as follows:

$$\Delta SE_{b,t} = \theta_b(SE_{b,t-1} - \eta_b X_{b,t-1}) + \sum_{j=1}^{U} \gamma_{bj} \Delta SE_{b,t-j} + \sum_{j=0}^{V} x_{bj} \Delta X_{b,t-j} + \varepsilon_{b,t} \tag{9}$$

Equation (9) fits our empirical study well. It allows for the investigation of the long-run equilibrium (cointegration) even if the independent variables are purely I(0), purely I(1), or mutually co-integrated. In addition, the equation specifies the short-run (χ, γ) and long-run (η) parameters. The parameter θ specifies the speed of adjustment, indicating the speed at which the dependent variable will return to long-run equilibrium after a shock hits the other variables, and belongs to the interval $-1 \leq \theta \leq 0$, the closer to -1; the more rapid the recovery from short-run shocks. The regression of Equation (9) determines the relationship between the independent and dependent variables and allows examining the potential symmetric cointegration relationship between the variables. However, since the price of oil shock can be positive or negative, using an asymmetric ARDL (NARDL) is more appropriate and allows for capturing long-run and short-run nonlinearities. By this model, the price oil shock OILP can be decomposed into its positive (+) and negative ($-$) partial sum of increase and decrease as follows:

$$OILP_t = OILP_0 + OILP_t^+ + OILP_t^- \tag{10}$$

where

$$OILP_t^+ = \sum_{j=1}^{t} \Delta OILP_j^+ = \sum_{j=1}^{t} max\left(\Delta OILP_j, 0\right)$$

$$OILP_t^- = \sum_{j=1}^{t} \Delta OILP_j^- = \sum_{j=1}^{t} min\left(\Delta OILP_j, 0\right)$$

The nonlinear cointegration regression is specified as follows:

$$SE_t = \Psi^+ OILP_t^+ + \Psi^- OILP_t^- + \mu_t$$

where Ψ^+ and Ψ^- are long-term parameters.

Including the asymmetric impact of oil price shock on the stability efficiency of banks, Equation (9) can be extended to obtain the NARD model, which is presented as follows:

$$\Delta SE_{b,t} = \sum_{j=1}^{U} \delta_{bj} \Delta SE_{b,t-j} + \sum_{j=0}^{V} o_{bj} \Delta X_{b,t-j} + \sum_{j=0}^{V} \left(\varphi_{bj}^{+} \Delta OILP_{b,t-j}^{+} + \varphi_{bj}^{-} \Delta OILP_{b,t-j}^{-} \right) + \varepsilon_{b,t} \quad (11)$$

where δ_{bj} is the autoregressive parameter and φ_j^{+} and φ_j^{-} correspond to the asymmetric distributed-lag parameters.

Integrating the asymmetric form of the exogenous variable (OILP), the error correction form of the nonlinear ARDL (NARDL) is presented as follows:

$$\begin{aligned} \Delta SE_{b,t} = k_b \left(SE_{b,t-1} - \beta_b X_{b,t-1} - \tau_j^{+} \Delta OILP_{b,t-1}^{+} - \tau_j^{-} \Delta OILP_{b,t-1}^{-} \right) + \sum_{j=1}^{U-1} \vartheta_{bj} \Delta SE_{b,t-j} \\ + \sum_{j=0}^{V} \upsilon_{bj} \Delta X_{b,t-j} + \sum_{j=0}^{V} \left(\xi_{bj}^{+} \Delta OILP_{b,t-j}^{+} + \xi_{bj}^{-} \Delta OILP_{b,t-j}^{-} \right) + \varepsilon_{b,t} \end{aligned} \quad (12)$$

where $\tau^{+} = -\frac{\varphi^{+}}{k}$, $\tau^{-} = -\frac{\varphi^{-}}{k}$, $\beta = -\frac{\eta}{k}$ and $\varepsilon_{b,t}$ is the error term

Equation (12) shows the asymmetric long-run and short-run effects on the stability efficiency of banks. The only exogenous variable showing an asymmetric form is OILP, while the others are presented linearly. U and V indicate the lag orders. The first part of the equation suggests the long-run level relationship and the second part suggests the error correction dynamic. $\sum \xi_{bj}^{+}$ and $\sum \xi_{bj}^{-}$ indicate, respectively, the short-run effect of *OILP* on the increase and decrease in the stability and efficiency of banks.

As mentioned earlier, our study aims to investigate the nonlinear relationship among variables and the direct and indirect effect of oil price shocks on the stability efficiency of banks through the NARDL approach developed by Shin et al. (2014). For this, Equation (12) will be modified, and two different models can be used for estimating the impact of oil price shock on the stability efficiency of banks:

Direct effects model:

$$\begin{aligned} \Delta SE_{b,t} = k_b \left(SE_{b,t-1} - \beta_b X_{b,t-1} - \tau_j^{+} OILP_{b,t-1}^{+} - \tau_j^{-} OILP_{b,t-1}^{-} \right) \\ + \sum_{j=1}^{U-1} \vartheta_{bj} \Delta SE_{b,t-j} + \sum_{j=0}^{V} \upsilon_{bj} \Delta X_{b,t-j} + \sum_{j=0}^{V} \left(\xi_{bj}^{+} \Delta OILP_{b,t-j}^{+} + \xi_{bj}^{-} \Delta OILP_{b,t-j}^{-} \right) + \varepsilon_{b,t} \end{aligned} \quad (13)$$

Indirect effects model:

$$\begin{aligned} \Delta SE_{b,t} = \; & k_b \left(SE_{b,t-1} - \beta_b X_{b,t-1} - \tau_j^{+} \Delta OILP_{b,t-1}^{+} - \tau_j^{-} \Delta OILP_{b,t-1}^{-} - \delta CPI_{b,t-1} - \alpha GPD_{b,t-1} \right) \\ & + \sum_{j=1}^{U-1} \vartheta_{bj} \Delta SE_{b,t-j} + \sum_{j=0}^{V} \upsilon_{bj} \Delta X_{b,t-j} \\ & + \sum_{j=0}^{V} \left(\xi_{bj}^{+} \Delta OILP_{b,t-j}^{+} + \xi_{bj}^{-} \Delta OILP_{b,t-j}^{-} \right) + \sum_{j=0}^{v-1} \pi_{b,j} \Delta CPI_{b,t-1} \\ & + \sum_{j=0}^{v-1} \Phi_{b,j} \Delta GPD_{b,t-1} + \varepsilon_{b,t} \end{aligned} \quad (14)$$

Equations (13) and (14) are estimated using the mean group (MG), pooled mean group (PMG), and dynamic fixed effects (DFE) techniques developed by (Pesaran and Smith 1995; Pesaran and Shin 1999)[3]. The Hausman test was used to select the most appropriate estimator.[4]

4. Results and Discussion

4.1. Results of Primary Tests

For analysis, the study begins to examine the impact of oil prices on bank stability and efficiency. In model 1, only bank-specific factors are introduced. If the impact of oil price changes is not significant, this means that the oil price changes are not associated with bank stability and efficiency. In other cases, if the impact of oil price changes is significant, the second step that would be taken is to explore the nature of this impact, direct or indirect, on bank stability and efficiency by including macroeconomic variables in model 2. Suppose the impacts of oil price changes remain significant when macroeconomic factors are added to the models. In that case, we can suggest that oil price changes directly impact bank stability and efficiency. Otherwise, we can conclude that oil prices indirectly impact bank stability and efficiency through macro variables.

First, this study explores the test of Pesaran (2004) to verify the existence of Cross-sectional Dependence (CD). This step is essential; the presence of correlation between units in the same cross-section due to the effect of unobserved common factors can provide biased results and inconsistent empirical results. To overcome this limit, the cross-section test can guide which generation units root test will be more appropriate for empirical results. Table 3 presents the result of this test:

Table 3. Results of cross-sectional dependence test.

Variables	Test Statistic	*p*-Value
SE	27.73	0.000 *
Size	27.37	0.000 *
Credit Risk	5.22	0.000 *
Financial Intermediation	8.44	0.000 *
Inflation	29.24	0.000 *
GDP	29.24	0.000 *
Oil price	29.24	0.000 *

Notes: The null hypothesis indicates cross-sectional independence. The CD statistic follows the N (0, 1) distribution. * indicates that the tests are significant at 1% confidence level.

As shown in Table 3 above, all the variables are significant at the 1% level. This indicates that the null hypothesis of cross-sectional independence is rejected. Moreover, according to this result, the second-generation panel unit root test is more appropriate. It must be noted that variables such as inflation, GDP growth, and oil price vary in time but not in cross-section since they have the same value for all units each year and change only from year to year. These variables can also be included in panel data without including time-period fixed effects to avoid multicollinearity.

To test whether or not unit roots exist, we use a second-generation panel unit root test for the variables specific to banks. Table 4 presents the result of the PCADF test (Pesaran 2007).

Table 4. Results of panel unit root test.

	PCADF Test			
	CIPS 1	CIPS 2	CIPS 3	Integration
SE	−13.324 (0.00) ***	−12.363 (0.00) ***	−7.945 (0.00) ***	I(0)
Size	−3.041 (0.001) ***	−2.64 (0.004) ***	−1.806 (0.035) **	I(0)
Credit Risk	−0.301 (0.382)	1.970 (0.976)	1.262 (0.897)	I(1)
Financial Intermediation	−0.536 (0.296)	−0.188 (0.425)	−0.160 (0.437)	I(1)
Inflation				
GDP				
Oil price				

Notes: *** and ** indicate the statistical confidence levels at 1% and 5%, respectively. *p*-values are in parentheses. The test has the null hypothesis of the presence of a unit root. Optimal lags are introduced to allow for serial correlation in the errors.

As the macroeconomic variables vary in time but not in cross-section, it is more appropriate to use another unit root test. Table 5 below presents the result of the Levin-Lin-Chu unit root test (LLC) (2002) to test the existence or not of unit roots for the macroeconomic variables:

Table 5. Result of panel unit root test for macroeconomic variables.

	LLC Test		
	Level	**First Difference**	**Integration**
Inflation	−2.5642 (0.0052) ***		I(0)
GDPG	−5.5153 (0.000) ***		I(0)
Oil price	−0.1966 (0.4221)	−8.9054 (0.000) ***	I(1)

Notes: *** indicates the statistic at a confidence level of 1%, respectively. *p*-values are in parentheses. The test has the null hypothesis of the presence of a unit root. Optimal lags are introduced to allow for serial correlation in the errors.

As shown in Tables 4 and 5 above, the variables Stability efficiency (SE) size (LnTA), Inflation (INF), and GDP growth (GDPG) were found to be integrated of order zero I(0), and the variables Credit Risk, financial intermediation, and oil price (OILP) were found to be integrated of order 1, denoted I(1). As all the variables are not integrated in the same order, the use of the ARDL bound test of Pesaran for exploring the existence of one or more cointegration relationships between variables is very appropriate[5].

As the variables of the study are not integrated in the same order, we perform a second-generation cointegration test, the Pedroni test (Pedroni 1996, 2001, 2004)[6], to verify the existence of cointegration relationships among variables. Table 5 presents the result of the test:

As shown in Table 6, the results illustrated reject the null hypothesis of no cointegration relationship among variables.

Table 6. Results of Pedroni's (2004) panel integration test.

Test Statistics	Panel	Group
Panel variance: ν	−3.123	
Panel rho statistic: ρ	4.29	5.666
Panel pp statistic: t	4.127	5.522
Panel ADF statistic: ADF	6.85	9.547

Notes: All test statistics are distributed N (0, 1), under a null of no cointegration, and diverge to negative infinity.

4.2. Results of ARDL Estimation

The result of the model (1) can support the short- and long-term relationship between the stability and efficiency of banks and the change in oil prices. Table 7 illustrates the results of the linear ARDL model (Equation (8)). Different techniques are used for this estimation, and to decide which is the appropriate one, we perform the Hausman test. The result of this test (*p*-value = 1) confirms that the PMG is the best estimation technique. The interpretation of the estimated coefficient for each variable will be based on the result of DFE estimation (Column 3 of Table 7).

The sign of the error-correction coefficient is negative and significant at 1%. This confirms the existence of an error correction mechanism, and the model converges to a long-run relationship. It also indicates that the stability and efficiency of banks are, over the long term, associated with their determinants (growth, inflation, and oil prices). The speed of adjustment of any disequilibrium toward a long-run equilibrium state, by the contribution of bank-specific determinants and oil price, is below 1.3% per annum, confirming the limited ability to recover.

We use the ARDL approach to estimate the long-term and short-term coefficients in Equations (13) and (14). Table 7 presents the long-term and short-term estimated coefficients of the direct effects model (Equation (9)) with the effects of bank-specific determinants and oil price on bank stability and efficiency estimated. Under the DFE estimation of the ARDL model in the case of the direct effects model, the long-term coefficient of stability and efficiency determinants: size, credit risk, financial intermediation, and oil price have statistically significant and positive effects on SE, confirming the prediction, indicate the successful policy actions of banks to manage their investments, processes of selecting customers and credits, the process of intermediation that transform the deposits into loans. The stability and efficiency of banks can be improved by the good quality of investments made by banks. The better the size and quality of credit, the better the banks' efficiency and stability. Moreover, the long-term coefficient of oil price is statistically significant and positive, suggesting that an increase of 1% in oil price can increase the stability and efficiency of banks in Saudi Arabia by 1.9% in the long term.

Table 7. Results of ARDL estimations for model 1.

Variables	MG	PMG	DFE
Long-run estimates			
Size	0.016	0.0006	0.132
	(0.251)	(0.265)	(0.000) ***
Credit Risk	0.158	0.0068	1.418
	(069)	(0.002) *	(0.000) ***
Financial Intermediation	−0.0117	0.0014	0.134
	(0.748)	(0.000) *	(0.000) ***
OILP	0.0074	−0.00004	0.019
	(0.346)	(0.265)	(0.027) **
Short-run estimates			
Error correction term	−0.0156	−0.016	−0.013
	(0.000) ***	(0.000) ***	(0.000) ***
ΔSE	0.846	0.862	0.94
	(0.000) **	(0.000) ***	(0.000) ***
ΔSize	0.00005	0.0003	−0.0004
	(0.660)	(0.254)	(0.337)
ΔCredit Risk	−0.0024	0.0008	−0.012
	(0.366)	(0.656)	(0.011) **
ΔFinancial Intermediation	0.0001	0.0004	0.0000
	(0.116)	(0.056) *	(0.886)
ΔOILP	−0.00004	0.00006	−0.0004
	(0.278)	(0.065) *	(0.008) ***
Constant	0.0079	0.0125	−0.023
	(0.116)	(0.000) *	(0.000) ***
Hausman test	0.001		
	(1.000)		

Note: ***, **, and * indicate the statistical significance level at 1%, 5%, and 1%, respectively. *p*-values are in parentheses.

For the short-term result of the estimation of the ARDL model (Equation (9)), the credit risk is a short-term significant determinant of the stability and efficiency of banks. The main important result is that oil prices illustrate statistically significant and negative effects on bank stability and efficiency in the short run. An increase in oil prices would lead to a decrease (increase) in the stability and efficiency of banks in the short run (long) run, a result confirmed by Umar et al. (2021).

According to the study, the long-term impact of oil prices on the banking system is positive, as it enhances the system's stability and efficiency. This outcome is expected, as higher oil prices lead to more foreign currency entering the economy.

A significant boost in economic growth due to government spending will lead to a more stable economy, resulting in a sustainable cash flow into the local banks. However, the impact of high oil prices on the local bank's stability and efficiency may differ in the short run. Higher oil prices could lead to less rational behavior in the banking system, which could encourage the banking system to create more risky credit. This could impact the stability and efficiency of the banking system.

Higher oil prices generally help steady the local banks' liquidity by sustaining government spending and economic growth. In the short term, the bankers may feel more optimistic, which could lead them to take on riskier loans. Therefore, during the boom, the Saudi central bank might implement a ban to minimize the excessive cash flow in the system and ensure the efficiency and stability of the banking system.

Table 8 presents the second estimation in which the macroeconomic factors inflation (INF) and GDP growth (GDPW) are added to the model (Equation (2)) to examine the indirect effect of oil prices on the stability and efficiency of banks in Saudi Arabia. As mentioned above, if the estimated coefficients of oil prices remain significant in the indirect model, the effects of oil prices will be called direct; in the opposite case, if the estimated coefficients of oil prices are significant, the effect will be called indirect through the channel of inflation and GDP growth (Hesse and Poghosyan 2016).

Table 8. Results of ARDL estimations for model 2.

Variables	MG	PMG	DFE
Long-run estimates			
Size	0.029	−0.0004	0.117
	(0.081)	(0.001)	(0.000)
Credit Risk	0.174	−0.011	1.533
	(0.107)	(0.000)	(0.000)
Financial Intermediation	0.0174	0.004	0.144
	(0.484)	(0.000)	(0.000)
Inflation	0.0009	1.96×10^{-6}	−0.007
	(0.03)	(0.735)	(0.000)
GDP	0.003	−0.006	−0.169
	(0.941)	(0.000)	(0.208)
OILP	0.0006	−0.0007	0.0328
	(0.9)	0.000	(0.000)
Short-run estimates			
Error correction term	−0.024	−0.015	−0.014
	(0.003) ***	(0.000) ***	(0.000)
ΔSE	0.771	0.872	0.944
	(0.000) ***	(0.000) ***	(0.000)
ΔSize	−0.00005	0.0002	−0.0006
	(0.417)	(0.223)	(0.881)
ΔCredit Risk	−0.001	0.0006	−0.012
	(0.267)	(0.769)	(0.01)
ΔFinancial Intermediation	−0.00009	0.0003	−0.00003
	(0.629)	(0.095) *	(0.917)
ΔOILP	−0.00002	0.00009	−0.0003
	(0.584)	(0.046) **	(0.046)
ΔInflation	-7.56×10^{-6}	-3.62×10^{-6}	0.00004
	(0.008) ***	(0.289)	(0.005)
ΔGDP	−0.0003	0.0006	0.001
	(0.582)	(0.034) **	(0.377)
Constant	0.012	0.011	−0.022
	(0.295)	(0.000) ***	(0.000)
Hausman test	0.01		
	(1.000)		

Note: ***, **, and * indicate the statistical values at 1%, 5%, and 1% confidence levels, respectively. *p*-values are in parentheses.

The size, credit risk, and financial intermediation have statistically significant and positive coefficients and are confirmed as long-term determinants of banks' performance. Moreover, the long-term coefficient of oil price remains statistically significant and positive even after adding macroeconomic factors. This result confirms that oil prices directly impact banks' stability and efficiency through oil-related business lending. Inflation has statistically significant and negative effects on the stability and efficiency of banks, as predicted in Table 2, and the long-run coefficient of GDP growth is statistically insignificant.

The error-correction term of the indirect effects model is statistically significant and negative, suggesting that the model also converges to a long-run relationship. The banks' stability and efficiency react to their long-run equilibrium path significantly by 2.4%, 1.5%, and 1.4% speeds of adjustment per annum.

The short-term coefficients of oil prices remain statistically significant and negative for stability and efficiency, suggesting the direct effect of oil prices on bank performance, as proxied by SE in the short term.

In the light of all results, oil prices directly affect the stability and efficiency of banks. Over the short term, oil prices exert a negative impact; over the long term, it exerts a positive impact. Stability and efficiency could be influenced by fluctuations in oil through improved oil-related cash flow to business activities or excess liquidity in the market. Additionally, a significant portion of government and external income comes from oil revenues. Consequently, the prospect of oil income affects fiscal spending, which affects the flow of deposits to banks. Moreover, higher oil prices can lead to expanded government spending limits and the consumption habits of economic entities. These factors can further stimulate local demand and, ultimately, restore increased bank deposits. In this case, an increase in the value of available deposits to banks may render them willing to grant more loans to applicants. This may affect the quality of loans granted through higher credit risk and increased loan default, which affects the banks' stability and efficiency in the short term. Banks cannot return to their level of stability and efficiency and benefit from higher deposits except over the long term because the speed of return is slow, according to the estimation result of the error correction term (1.4%). This result suggests that the banks in the short term cannot absorb oil price shock and become statistically significant and positive in the long term.

The results of the ARDL estimations support the fact that higher oil prices increase credit risk over the short term due to the lending expansion supported by liquidity from oil revenue, which leads to higher defaults on corporate loans. This causes a short-term decline in banking efficiency and stability. But in the long term, the oil price rise improves banks as increased government spending and situation creates stable liquidity inflows which strengthens bank stability and efficiency.

The combined impact of both highs and lows re-emphasizes the importance of banks managing their credit risk, not only by preventing losses but also by preparing themselves to leverage these opportunities resulting from shorter periods.

Through proper risk management strategies, such as strict lending standards and strong oversight of the borrowers, banks can reduce bank earnings susceptibility to temporary fluctuations while taking advantage of the long-run benefits from ongoing economic growth.

4.3. Result of NARD Estimations

The second part of this study investigates the existence of an asymmetric impact between positive and negative oil price shocks on bank efficiency and stability. To this end, we use the standard Wald test (Shin et al. 2014) to check for the joint significance of the coefficients of long-run and short-run asymmetric effects. In this study, the Wald test uses the null hypothesis that the two coefficients of positive and negative oil price shocks are equal to zero. For the long-run asymmetry, the null hypothesis is as follows:

H0: $\breve{C}^{+} = \breve{C}^{-} = 0.$

Furthermore, for the short-run asymmetry, the null hypothesis is as follows:

H0: $\xi^{+} = \xi^{-} = 0.$

The result illustrated in Table 8 rejects the null hypothesis of symmetry because the *p*-value is less than 5%, and the asymmetry is confirmed. The result reveals that positive and negative oil price shocks may impact the banks' stability and efficiency differently.

After confirming the existence of an asymmetrical effect of shocks to oil prices, the next step is to interpret the coefficients of short and long-run estimation. Table 9 illustrates the estimation results of nonlinear model 1[7] and model 2[8] We used only the DFE technique because it fits well with the database used (the result was confirmed for linear mode).

Table 9. Results of nonlinear ARDL estimations model 1 and model 2.

	Model 1	**Model 2**
Variables	**DFE**	**DFE**
Long-run estimates		
Size	0.010	0.022
	(0.032) **	(0.071) *
Credit Risk	0.77	1.081
	(0.002) ***	(0.002) ***
Financial Intermediation	0.015	0.054
	(0.013) **	(0.073) *
OILP increases.	0.081	0.078
	(0.000) ***	(0.000) ***
OILP decreases.	−0.051	−0.033
	(0.000) ***	(0.002) ***
GDPG		−0.103
		(0.270)
INF		−0.004
		(0.001) ***
Long run symmetry		
test ωLR		
Chi-Square	67.22	55.26
p-value	(0.000) ***	(0.000) ***
Short-run estimates		
Error correction term	−0.015	−0.015
	(0.000) ***	(0.000) ***
ΔSE	0.971	0.970
	(0.000) ***	(0.000) ***
ΔSize	0.0001	0.0004
	(0.788)	(0.262)
ΔCredit Risk	−0.006	−0.008
	(0.055) *	(0.059) *
ΔFinancial Intermediation	0.0004	0.0002
	(0.162)	(0.423)
ΔOILP increases.	−0.0012	−0.0016
	(0.001) ***	(0.000) ***
ΔOILP decreases.	0.0003	0.0002
	(0.116)	(0.305)
ΔGDPG		0.0001
		(0.883)
ΔINF		0.00002
		(0.072) *
Constant	0.0044	0.0012
	(0.325)	(0.770)
Short run symmetry		
test ωSR		
Chi-Square	8.74	18.47
p-value	(0.0031) ***	(0.0001) ***

Note: ***, **, and * indicate the statistical values at 1%, 5%, and 1% confidence levels, respectively. *p*-values are in parentheses.

From the result illustrated in Table 8 for model 1, the sign of the error correction coefficient is negative and statistically significant at 1%. The same result was attained when the linear ARDL model was estimated, which confirmed the existence of an error correction mechanism. The stability and efficiency of banks are in long-term association with its determinants. The speed of adjustment is as in the linear model, low 1.5%, confirming the limited ability to cover.

The long-run coefficient of stability and efficiency determinants have statistically significant and positive effects on SE. This result confirms what was illustrated when the linear ARDL model was estimated and proved that increasing stability and efficiency of banks can be attained by a good selection of credits and a good process of financial intermediation. The main important result is relative to the coefficient of positive oil price shocks ($Ꞇ^{+}$) and negative oil price shocks ($Ꞇ^{-}$). Oil price increases and decreases significantly impact bank stability and efficiency. A decrease in oil prices can decrease a bank's deposits and oblige it to select well-rated credits, improving its stability and efficiency.

For the short-run estimation, the bank-specific variables illustrate the same sign and statistic significatively of their coefficients as attained when the linear model is estimated. The coefficients of oil price increase and decrease prove that any change in oil price may lead to an adverse reaction from banks. An increase in oil prices would increase banks' deposits, which can rapidly increase the volume of credits, leading to an increase in the volume of bad loans and negatively affecting the efficiency and stability of banks. A decrease in oil price may decrease the volume of deposits, leading to a decrease in stability and efficiency through the decrease in the volume of credits granted without any change in the structure of total costs. In the short run, any change in oil price has adverse effects on stability and efficiency, and this reaction would be positive in the long term due to the return to equilibrium.

For model 2, the estimation of NARDL shows the same results as that of model 1, which confirms the advanced conclusions. The coefficient of increased oil price remains statistically significant and confirms that oil price directly affects the stability and efficiency of banks. In the long run, the increase and decrease in oil prices can positively affect the stability and efficiency of banks. Moreover, in the short run, the change in oil prices adversely affects the stability and efficiency of banks. Also, the result confirms that a positive change in oil price can affect the stability and efficiency of banks more than that of a negative one.

The finding that there exists an asymmetric relationship between oil prices and the stability and efficiency of banks in Saudi Arabia has significant implications for policymakers.

Firstly, it suggests that policymakers need to be aware of the impact of oil price fluctuations on the banking sector in Saudi Arabia. As oil prices play a crucial role in the country's economy, any significant change in oil prices can directly affect the stability and efficiency of banks. Therefore, policymakers need to monitor and anticipate oil price movements to manage potential risks to the banking sector effectively.

Secondly, the findings indicate that a positive change in oil prices has a more substantial impact on the banks' stability and efficiency than a negative change. This implies that policymakers should prioritize strategies to mitigate the risks associated with a sudden increase in oil prices. Such strategies may include implementing measures to prevent the financial sector from overheating, managing inflationary pressures, and enhancing banks' risk management frameworks.

Furthermore, policymakers should also consider the implications of this asymmetric relationship on the country's overall economic stability. A sharp increase in oil prices could lead to increased lending and investment activities by banks, potentially fueling economic growth. However, it also risks creating bubbles or excesses in certain sectors, which may eventually lead to financial instability. Hence, policymakers need to balance promoting economic growth and ensuring financial stability by closely monitoring the banking sector's response to positive changes in oil prices.

Overall, the findings highlight the need for Saudi Arabian policymakers to be vigilant in addressing the potential risks arising from oil price fluctuations and adopt appropriate policy measures to maintain stability and efficiency in the banking sector.

Table 9 reports the asymmetric effects of positive and negative oil price shocks on bank stability and efficiency and the NARDL estimation results. It is worth noting that the positive sign of oil price confirms that in the long run, higher oil prices will upturn liquidity and thus lead to better bank soundness. Alternatively, a negative coefficient for short-run oil price shocks indicates immediate instability, possibly due to rapid credit responsiveness to liquidity. The result is in line with the theoretical predictions of more significant and persistent effects of positive oil price shocks on bank performance than adverse shocks extending over a longer time horizon.

According to the NARDL model results, bank stability and efficiency are much more sensitive to long-term positive oil price shocks than negative ones. This asymmetry implies that Saudi banks are potentially better positioned to benefit from the economic upswing during periods of increasing oil prices thanks to improving liquidity and credit provision. In falling oil price environments, this effect of lower liquidity is weaker (ă although negative) for stability and efficiency.

Given the asymmetric effects of oil price shocks, these results reveal the necessity for adaptive approaches. Nonetheless, elevated oil prices put banks and policymakers in a position to mitigate the risk-taking that leads to asset bubbles by stockpiling reserves or restricting lending ex-ante.

In order to avert the adverse oil price shocks that threaten the stability of the banking system, policymakers need to expand the availability of liquidity beyond oil revenues. Banks are able to adjust to liquidity shocks because they increase credit risk assessments.

5. Conclusions and Policy Implications

This study aims to investigate the three main issues of oil price shocks and the stability and efficiency of banks in Saudi Arabia. The first issue examined the short and long-run relation between bank stability, efficiency, and oil price shocks. Moreover, to examine whether the relationship was positive, negative, or neutral, the second issue investigated the impact of oil price shocks on bank stability and efficiency, whether direct or indirect. The third issue of this study was to reject or accept the hypothesis of an asymmetric or symmetric relationship between oil price shocks and the stability and efficiency of banks.

This study used a nonlinear ARDL approach to investigate these issues for 2004–2022. The data relating to banks were obtained from the Tadawul site and Bankscope data, and macroeconomic data were obtained from the World Bank Database Indicator. The empirical results proved a significant relationship between oil price shocks and bank stability and efficiency. In the long run, the relationship was statistically significant and positive, and it was negative in the short run. On the other hand, the short-run relationship is negative, which implies that unexpected oil price hikes cause instability in banks in the short run by expanding credit rapidly and raising risk credit at each step.

The banks do not behave better when the volume of deposits increases through the new flow of deposits to banks. However, in the long run, the banks change their behavior and can take advantage of the increase in deposits to increase their stability and efficiency. On the other hand, this study finds that oil price shocks directly impact the stability and efficiency of banks and the existence of an asymmetric relationship between oil prices and the stability and efficiency of banks in Saudi Arabia. The result also confirmed that a positive change in oil price can affect the stability and efficiency of banks more than a negative one. In particular, positive oil price shocks are significantly stronger in effect than negative shocks on bank stability, suggesting that banks ought to hedge their risks during periods of high oil prices against potential asset bubbles and risky credit expansion woes.

The stability of the Saudi Arabian banking system in the face of any external shock, particularly those related to oil prices, is primarily attributed to the role of the Saudi central bank. The central bank ensures that all local banks adopt macroprudential policies based on the BASEL III measures, making them more resilient to any potential shock. The local banks in Saudi Arabia have a strong position in terms of their capital and liquidity, and they have limited exposure to foreign investments, which represent only 2.83% of their total assets by the end of March 2023, according to the SAMA stability report 2023. In addition, SAMA is committed to adopting new international regulatory reforms and implementing the best supervisory practices.

These results indicate the critical policy implications of this study. One, counter-cyclical capital buffers would better protect Saudi banks against the cycle of boom and bust, which is associated with oil price movements. In addition, this successful diversification away from oil revenue will reduce the risks associated with separation and align with Saudi Arabia's Vision 2030 goal, which aims to create a more sustainable and diversified economy.

The impact of inflation on the stability and efficiency of banks is different between the short run and long run. In the two models used in this study, inflation is statistically significant in the short run and long run, but its impacts are different. In the short run, an increase in inflation positively affects the stability and efficiency of banks, but in the long run, the impact is negative because investors will want to invest money in real investments rather than deposit their money in the banks; this can decrease deposits and, therefore, loans may decrease accordingly. Therefore, any increase in the rate of inflation can lead to a corresponding decrease in the banks' efficiency and stability.

Such suggestions reveal the way dynamic credit and investment concepts are aligned with the pressure of inflation for sustainable banking efficiency within an economic transitional state.

The Saudi Arabian economy has recently been transitioning toward increased emphasis on non-oil activities. Therefore, the Saudi Arabian economy will become more attractive to the global commodities market beyond oil. Various financial sector shocks are expected, particularly those associated with the banking system. Local banks are expected to be more active in financing these new activities. Additionally, local banks should adjust their portfolios to accommodate high-risk ventures. It is critical to implement SAMA macroprudential policies to withstand new external shocks continuously. This should motivate researchers to conduct more studies analyzing the expected effects of these shocks on the efficiency and stability of local banks.

Economic diversification is an elemental part of Saudi Arabia's Vision 2030, which aims to lessen dependence on oil revenues and concentrate growth on non-oil sectors. Lessons from Mukhtarov et al. from a study in 2019 on Azerbaijan can offer an appropriate context to interpret this relationship: likewise, the positive effect of bank credits on non-oil GDP has been found to be statistically significant in their analysis since they concluded that more bank loans facilitate economic growth in non-oil sectors, which are essential for diversification away from the oil sector. More specifically, a one percentage point increase in bank credit is associated with a 0.51% increase in non-oil GDP, highlighting the importance of financial intermediation in promoting growth outside of the oil sector. Likewise, Seyfullayev (2023) provides empirical insights into Azerbaijan showing that the development of finance is essential for non-resource economic growth, further claiming that there is a critical relationship between financial intermediation and economic diversification. This could impact the entire economy and not just oil and gas-sector. This have implications for building stronger financial institutions that allocate resources more effectively and develop different parts of the economy.

In addition, evidence shows that a large expansion of bank credit benefits productivity and employment as an important aspect of economic development is needed for sustainable non-oil growth (Zeynalova 2023). Secondly, there is a positive link between the amount of lending and economic activity: The rapid rise of credit inflows to non-oil sectors appears to have produced gains in growth, with Safiullah 2023 identifying one-way direction from loans in the short-run toward growth. This trend is particularly pertinent to Saudi banks, which are increasingly tasked with providing funding for the nascent non-oil sectors (per Vision 2030).

This is a positive side for the economic development via non-oil sectors, but some literature is dual-natured. For instance, Safiullah (2023) show that although financial development promotes economic growth, it is not a certain path toward sustainable growth in the long term; for oil-endowed countries, the rapid growth of the financial sector usually does not entail good outcomes in both the short and long run.

Saudi Arabia will also require more credit policies that do not depend on oil but must still ensure sustainable non-oil (e.g., private) growth and simultaneously prevent risk to stability over the longer term. This approach will further protect the banking sector from the shocks of oil price volatility while also aligning with Vision 2030 aspirations and presenting a stable economic future structure.

The implication of this study calls for more attention to the stability effects of oil price variability and economic diversification on financial stability. Hence, bank practices must be aligned with the nature of an ever-changing economy. SAMA should remain vigilant on the matter and enforce and further develop macroprudential policies to ensure that banks can withstand any risks of diversification into new local sectors or global markets. This will ensure the sustainability stability, and efficiency of the Saudi banking system over the long run.

Although this study provides important information, limitations exist. This research is in the framework of the Saudi banking sector; thus, it may generalize constraints on other oil-dependent economies. Moreover, nonlinear ARDL is also an asymmetric approach. It can only reflectasymmetries while assuming that the derived effects from slacks/booms are not affected by other economic shocks/interventions. These shortcomings could be addressed in future research through the investigation of other models or an expansion into a multi-country model; however, these limitations remained within our analysis.

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Notes

1 Z-score is a financial analysis method that involves synthesizing a set of ratios to obtain a single indicator that distinguishes healthy (banks) from failing banks in advance (Goyeau and Tarazi 1992). This tool, commonly used to predict the probability of bank failure, was initially proposed by Altman (1968). It uses accounting data as a basis and allows for measuring the probability that a bank's losses exceed its equity. A high Z-score implies a low probability of failure, and vice versa. Formally, the Z-score (z-score) can be presented by the following formula:

$$\text{Z-score} = (\text{ROA} + \text{EQTA})/\sigma(\text{ROA})$$

where: ROA: Return on assets
EQTA: Total equity to total assets
σ(ROA): Standard deviation of ROA

2 LLC test is based on the assumption of non-heterogeneity of the autoregressive parameter. IPS test allows for heterogeneity. The CIPS unit root test relaxes the assumption of cross-sectional independence of the contemporaneous correlation.

3 MG estimator allows for short-term and long-term relationship heterogeneity and is appropriate for many units (banks). The PMG estimator allows heterogeneity only for short-run relationships and restricts long-run equilibrium to be homogenous across units (banks). DFE estimator restricts the speed of adjustment, slope coefficient, and short-run coefficient to exhibit non-heterogeneity across units (Asteriou et al. 2021).

4 First, a Hausman test was conducted to choose between MG and PMG estimators. If the test is not significant, PMG is the appropriate estimator. However, if the null hypothesis is rejected, we conduct a second test to choose between MG and DFE with

the null hypothesis that DFE restriction is valid. Therefore, rejecting the null hypothesis implies that MG is more appropriate than DFE. Otherwise, if the test is not significant, we have the option to choose DFE.

5 The use of sEngle, Grange, and Johansen's counter is inefficient because they require the same order of integration.

6 These tests are based on the FM-OLS method, which gives more robust results than the usual OLS method when the samples are small. These tests allow for heterogeneity in the autoregressive term (Nealm 2014; Kirikkaleli 2016).

7 Only the specific bank variables are taken.

8 Bank-specific variables and macroeconomic variables are jointly taken.

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