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Energy shocks and bank efficiency in emerging economies

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ABSTRACT

Geopolitical conflicts often result in commodity price increases and supply-chain disruptions to the global economy. A recent example of the Russia-Ukraine War caused a significant increase in energy prices, resulting in a prospect of recession in the European Union countries and slow economic growth worldwide. This paper examines how energy shocks affect banks, which are an important intermediary for financial stability and economic growth. We extend the existing literature, which used oil prices as the proxy for energy shocks. Given that oil accounts for decreasing share of global primary energy, we instead used energy prices, consisting of oil, natural gas, coal, nuclear energy, hydroelectricity, and renewables, as the proxy for energy shocks. We measure banks' operational and investment efficiency using data envelopment analysis (DEA) and applied fixed effect, random effect, dynamic OLS, fully modified OLS, and dynamic panel generalized method of moments (GMM) models. Based on the data of 48 banks in seven emerging economies from 2001 to 2020, we find that energy shocks decrease banks' operational and investment efficiency, even after controlling for macroeconomic factors. This paper provides evidence of the direct effect of energy shocks on bank efficiency, extending the previous knowledge that oil shocks affect bank performance only indirectly, making a theoretical contribution to our understanding of energy shocks and bank performance. The findings are also important for policymakers in emerging economies to achieve steady economic growth and financial stability. Countries can limit the impact of energy shocks on bank efficiency by using hedging and gradual adjustment of interest rates.

1. Introduction

Since the industrial revolution in the early 19th century, the world has observed two waves of globalization, where cross-border economic integration has been deepened. In between, from 1910 to 1945, however, there was a period of de-globalization, characterized by the two world wars, the Great Depression, and protectionism. The period of de-globalization, 1910–1945, canceled off the entire growth of global merchandise trade during the first globalization wave between 1820 and 1910 (Fouquin and Hugot, 2016). Considered the greatest threat to globalization, geo-political conflicts have a disruptive impact on politics, economies, and livelihoods, both domestically and globally (Wolf, 2022). A recent example of the Russia-Ukraine War affected the global economy via financial sanctions, commodity price increases, and supply-chain disruptions (Global economic impacts of the Russia-Ukraine war, 2022). Financial sanctions imposed by the United States and the European Union hindered trade with Russia, causing a significant energy shock to the world economy. Russia is the largest natural gas exporter and the second largest oil exporter in the world, after Saudi Arabia (The World Factbook: Explore all countries - Russia, 2022). The sanction on Russian primary energy increased the energy price globally, evidenced by an increase in natural gas price to $10/MMBtu on August 22, 2022, from $4.7/MMBtu on February 24, 2022, which was already more than twice the level of January 1, 2020 (source: Refinitiv database). Another recent example includes the COVID-19 pandemic. The advent of stringent lockdown measures and a consequent global economic downturn resulted in an abrupt contraction in energy demand. Industries came to a standstill and transportation systems ground to a halt, effecting a profound decline in oil and gas usage. This phenomenon brought about an unparalleled oversupply, inducing a precipitous plunge in oil prices (OECD, 2020). Such a drop significantly destabilized emerging economies reliant on oil exports for revenue generation and fiscal stability.

The change in energy prices has a wide-ranging effect on financial

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stability and economic growth (Degiannakis et al., 2014; Gaies et al., 2020; Nasir et al., 2020a,b,c; Nasir and Vo, 2020; Nasir, 2020). Energy price and food price constitute the two largest elements of consumer price, driving inflation in the economy. The International Monetary Fund estimates that global consumer price index inflation will rise to 8.8% in 2022 from 4.7% in 2021, followed by a decline to 6.5% in 2023 and 4.1% in 2024 (World economic outlook, 2022). In emerging economies, however, the figures will be 5.9% in 2021, followed by 9.9% in 2022, 8.1% in 2023, and 6.1% in 2024. The increase in interest rates by advanced economies to combat inflation adds difficulties for emerging economies to deal with increasing borrowing costs, inflation, capital outflows, commodity market volatility, and economic uncertainty. Emerging economies experienced more than $100 billion in outflows of local currency bonds in 2022 (Global financial stability report, 2022; Pham et al., 2023; Nasir, 2020).

Banks, on the other hand, play an important role in stabilizing the financial system and promoting economic growth (Goldsmith, 1969; McKinnon, 1973; Shaw, 1973; Chaudhry et al., 2021). De Gregorio and Guidotti (1995) argue that banks drive economic growth by improving the efficiency of investment, rather than the volume of investment. Therefore, banks improve capital allocation in the economy. Given the importance of banks, recent studies investigate the impact of energy shock on banks' performance in terms of stock returns (Broadstock and Filis, 2014; Elyasiani et al., 2011; Kilian and Park, 2009; Mohanty et al., 2011; Nandha and Faff, 2008; Narayan and Sharma, 2011; Scholtens and Yurtsever, 2012; Shaiban et al., 2021), volatility (Arouri et al., 2012), and profitability (Hesse and Poghosyan, 2016). Despite the extensive studies, papers found mixed results, ranging from a negative to non-significant impact of energy shock on banks' stock returns (Broadstock and Filis, 2014).

This paper extends the literature twofold by utilizing energy price as the proxy of energy shock and bank efficiency as the proxy of bank performance. Although oil still accounts for the largest share of global primary energy, its share has decreased from 40% to 30% between 2000 and 2021 (*BP Statistical Review of World Energy*, 2022). On the other hand, natural gas and renewables have taken up the shares. Therefore, using oil prices as the proxy for energy shock might be inadequate. As most economic activities by businesses and consumers are directly influenced by energy price, rather than oil price itself, we use energy price as the proxy of energy shock. For the proxy of bank performance, we use bank efficiency rather than bank stock returns. According to valuation theory, stock returns are determined by a firm's future cash flows (profitability or efficiency) and discount rates (Kim, 2019). Therefore, by studying the impact of energy shock on bank efficiency, we provide an explanation of the channel between energy shock and stock return, which is the dominant focus of the previous literature. We are aware that Hesse and Poghosyan (2016) examine the relationship between oil prices and bank profitability for countries in the Middle East and North Africa. Our paper differs from Hesse and Poghosyan (2016) by using energy price and bank efficiency as well as extending the sample coverage beyond the Middle East and North Africa. Efficiency measures the relative performance considering both input and output factors. As banks in different countries exhibit vastly different characteristics (Allen and Rai, 1996), we utilize efficiency to capture their different input and output natures. In addition, this paper extends the study of Nasim and Downing (2023), which investigates the impact of energy prices on banks' ROA and ROE in G7 countries. Our study instead focuses on emerging economies where the banking industry is relatively less established and, therefore, more susceptible to macro-economic shocks, such as energy shocks (Godspower-Akpomiemie and Ojah, 2021). Therefore, understanding the impact of energy prices on banks' health and efficiency is critical for emerging economies.

Emerging economies play an increasingly significant role in the global economic landscape. They represent expanding markets, serve as key nodes in global supply chains, and offer a dynamic environment for innovation and entrepreneurship (Dadush and Shaw, 2011). As burgeoning epicenters of economic activity, these countries, including the likes of India, China, Brazil, and others, have witnessed substantial growth rates and have collectively contributed a major share to global GDP growth in recent decades with the average GDP growth rate of 4.0% since 2014, while advanced economies observed 1.8% (International Monetary Fund, 2023). For instance, China, an emerging economy until recently, is now the world's second-largest economy and plays a pivotal role in global trade, investment, and technology markets (Lardy, 2019). Furthermore, according to a report by McKinsey Global Institute (2016), consumer spending in emerging markets is projected to reach $30 trillion by 2025, which would account for nearly half of global consumption. These developments underscore the increasing importance of emerging economies in the overall health and dynamics of the global economy. The banking industry plays a central role in emerging economies' economic growth and stability. As financial intermediaries, banks play an instrumental role in the efficient allocation of capital by channeling funds from savers to investors, thus promoting productivity and economic expansion (Levine, 1997). Banks are also pivotal in managing economic risks and financing large-scale infrastructure projects which are crucial for sustained development (Brei and Schclarek, 2013). Additionally, a solid banking system can attract foreign direct investment by assuring international investors about the financial stability of the country (Alfaro et al., 2004). Therefore, an understanding of the banking sector's efficiency and health is vital in shaping the economic trajectory of emerging economies.

Our sample includes 48 banks in seven emerging economies (Brazil, China, India, Indonesia, Mexico, Russia, and Turkey), accounting for >80% of the market shares in the respective countries. From 2001 to 2020, we examined the relationship between energy prices and banks' operational and investment efficiency. We utilized various models, including fixed and random effect, dynamic ordinary least squares (DOLS), fully modified OLS (FMOLS), and dynamic panel generalized method of moments (GMM), to estimate both static and dynamic relationships. The results show that energy price negatively affects banks' operational and investment efficiency. Among macroeconomic factors, GDP and exchange rate are positively related to bank efficiency, while inflation and uncertainty are negatively related. The impact of bank rate is inconclusive, possibly because bank rate works as both input and output factors.

In contributing to the existing body of literature, this study highlights the importance of analyzing efficiency as an alternative performance metric that complements profitability. While profitability primarily illustrates the current state of performance, efficiency measures the relative performance of firms against the efficient frontier line—indicating optimal industry performance. Prior research suggests that banks, on average, display 20% inefficiency in cost management and a remarkable 50% inefficiency concerning potential profits (Berger and Humphrey, 1997; Berger and Mester, 1997; Kweh et al., 2022). To our knowledge, this is the first study to investigate the relationship between energy shock and bank efficiency. Utilizing the X-efficiency theory, this study brings to the fore the contrast between current efficiency levels and the "best-practice" efficiency levels. In doing so, the paper delves into a relatively unexplored dimension of performance, thereby enriching the existing literature.

This study contributes to the existing literature by offering a novel examination of the direct effect of energy shocks on bank efficiency. According to valuation theory, a firm's stock returns are shaped by future cash flows (be it profitability or efficiency) and the discount rate (Gordon, 1959). As such, by investigating the impact of energy shocks on bank efficiency, we illuminate the channel between energy shocks and stock returns, a focal point of previous research that has thus far been under-explored.

In line with the guidelines laid out by the International Financial Reporting Standard (IFRS) 9 on Expected Credit Losses, banks are mandated to recognize expected credit losses as financial losses become more likely. Given that banks maintain expansive loan portfolios across diverse industries, a considerable surge in oil prices—which often negatively impacts many firms—increases expected loan losses, thereby reducing profits. Previous research, such as the study by Hesse and Poghosyan (2016), has explored the impact of oil prices on bank profitability. However, they did not identify a direct effect. Instead, they posited that oil prices influence bank profitability only indirectly through other macroeconomic factors, like interest rates or inflation. This study expands upon their work by furnishing evidence of a direct relationship between energy shocks and bank efficiency.

This study offers significant practical contributions, particularly in relation to policy implications. Previously, without a clear understanding of the mechanism linking energy shocks and banks' stock returns, policymakers were at a disadvantage in making informed decisions to promote financial stability and economic growth. This problem was especially pronounced for policymakers in emerging markets, given these economies' heightened vulnerability to macroeconomic shocks, including energy shocks. Such economies are influenced by not only their domestic macroeconomic fundamentals but also by policies implemented in advanced economies, like rising interest rates in the United States.

As financial intermediaries, banks play a pivotal role in moderating such impacts on the economy, emphasizing the necessity for policymakers to uphold banks' efficiency and performance. With evidence suggesting that banks' efficiency is negatively impacted by energy shocks, it becomes imperative for policymakers to implement strategies, such as hedging and gradual adjustments of macroeconomic variables like interest rates. These measures provide time and opportunities for banks to adjust their input and output factors. While banks typically adapt to energy shocks more swiftly than other industrial firms, their adaptation process should be gradual and flexible. Abrupt adjustments risk causing a misallocation of input and output factors, which can compromise banks' efficiency. This research thus provides valuable insights for policymakers, particularly in emerging economies, seeking to promote financial stability and economic growth in the face of energy shocks.

The layout of this paper unfolds as follows: Section 2 delves into the pertinent literature and formulates the research hypotheses. In Section 3, we expound upon the data collected and the methodology employed. The findings of the research are elucidated in Section 4. We discuss the implications of the findings in Section 5, followed by the concluding remarks presented in Section 6.

2. Literature review and hypothesis development

Since Adam Smith, economists have sought explanations for economic development. Several economic growth theories have been proposed over the centuries, including classical growth theory, neoclassical growth theory, and endogenous growth theory. Along with the theory development, several sources of growth have also been identified, including labor, capital, technology, human capital, trade, finance, institutions, and political economy. The division of labor and the accumulation of capital have been the main source of growth since the development of classical growth theory. Neo-classical growth theory argues that technological progress is another main source of growth, and the economy cannot continue to grow without technological advances. Endogenous growth theory emphasizes the importance of human capital accumulation, which drives technological progress (Becker et al., 1990; Lucas, 1988; Mankiw et al., 1992; Rebelo, 1991; Romer, 1986, 1990). Trade and finance have been also considered important sources of growth since Adam Smith and David Richardo (Darity Jr. and Davis, 2005). Trade promotes economic development via learning-by-doing (Lucas, 1988; Young, 1991), transfer of knowledge (Coe and Helpman, 1995; Grossman and Helpman, 1991), and a scale effect (Rivera-Batiz and Romer, 1991). Financial flow encourages labor mobility and knowledge and technology transfer (Moran, 1998; Moran et al., 2005; Romer, 1993). As financial intermediaries, banks play an important role in channeling financial flows in the economy. Linking financial flow with human capital accumulation, Abramovitz (1986) emphasizes the importance of 'absorptive capacity' or 'social capability' to fully realize the benefits of trade and financial flow.

Recent literature focuses on how oil price affects the economy, given that oil and its derivatives are used in a vast array of economic activities (Nandha and Faff, 2008). Specifically, most studies focus on the impact of oil price changes on stock returns. Hamilton (1983) first investigates the impact of oil price change on the aggregate US stock returns. He finds that oil price changes negatively affect the US economic activities and most US recessions since World War Two were driven by the oil price surge. Several studies have found a similar result that oil price changes negatively affect stock returns (Asteriou and Bashmakova, 2013; Ciner, 2013; Filis and Chatziantoniou, 2014; Ghosh and Kanjilal, 2016; Jones and Kaul, 1996; Laopodis, 2011; Lee and Chiou, 2011; Sadorsky, 1999). The negative effect is also observed in emerging markets, including Greece (Papapetrou, 2001) and Central and Eastern European countries (Asteriou and Bashmakova, 2013). On the other hand, some studies report that oil price changes do not impact stock returns (Al Janabi et al., 2010; Apergis and Miller, 2009; Cong et al., 2008; Henriques and Sadorsky, 2008; Jammazi and Aloui, 2010).

Studies on stock returns on the aggregate level, however, might not be able to show heterogeneous impacts of oil price changes in different industrial sectors. Depending on whether industrial sectors use oil as their input or output factors, different sectors may exhibit different responses to oil price changes. In the oil and gas sector, studies find that oil price changes positively affect stock returns (El-Sharif et al., 2005; Elyasiani et al., 2011; Nandha and Faff, 2008). However, in the non-oil and gas sector, oil price changes negatively affect stock returns (Elyasiani et al., 2011; Hammoudeh and Li, 2005; Narayan and Sharma, 2011). Similar findings are observed in the European stock markets (Arouri and Khuong Nguyen, 2010; Scholtens and Yurtsever, 2012). Scholtens and Yurtsever (2012) report negative stock returns for almost all sectors, except for the oil and gas and mining sectors. On the other hand, Arouri and Khuong Nguyen (2010) report a negative impact on the food and beverages, health care, and technology sectors, while the financial, oil and gas, industrials, basic materials, and personal and household goods sectors exhibit a positive effect. Overall, the studies of the sectoral stock returns show that the oil and gas sectors are positively affected by oil price changes, while the other sectors (including financials) are negatively affected (Degiannakis et al., 2018).

Although firm-level studies could potentially shed further light on the heterogeneous impact of oil price changes on stock returns, they have not received as much attention as sectoral studies. Studies of firm-level stock returns generally support the findings of sectoral studies (Boyer and Filion, 2007; Phan et al., 2015; Sadorsky, 2008). Boyer and Filion (2007) examine 105 Canadian oil and gas firms and find that oil price changes positively affect these firms' stock returns. Including non-oil and gas firms, Sadorsky (2008) find that S&P 1500 firms negatively react to oil price changes. Firm-level studies also find that firm size is an important moderator of the relationship between oil price changes and stock returns (Mohanty et al., 2013; Narayan and Sharma, 2011; Tsai, 2015). Some studies also investigate the asymmetric impact of oil price changes. They find that the stock market reacts more to oil price increases than decreases (Broadstock et al., 2016; Broadstock et al., 2014; Jiménez-Rodríguez, 2015; Narayan and Gupta, 2015; Park and Ratti, 2008; Phan et al., 2015; Tsai, 2015). Furthermore, studies also report a time-varying relationship between oil price changes and stock returns (Bouri et al., 2017; Broadstock et al., 2012; Degiannakis et al., 2013; Filis et al., 2011; Ftiti et al., 2016; Joo and Park, 2017; Miller and Ratti, 2009). Some studies investigate the linkage between oil price volatility and stock return volatility. Malik and Ewing (2009) and Arouri et al. (2011) find that oil price volatility is related to sectoral stock market volatilities. On the aggregate stock market level, Vo (2011), Mensi et al. (2013), and Ewing and Malik (2016) find that S&P 500 index and oil price volatilities are mutually dependent. Phan et al. (2016) observe a volatility linkage in the futures markets. Recently, studies on energy prices have extended to examine the impact of energy stock returns predictability on exchange rates (Tiwari et al., 2022), risk profiles of oil prices on the financial system (Ahmed et al., 2022; Chaudhry et al., 2022), and Bitcoin and US oil returns (Huynh et al., 2021).

The extensive literature on oil price changes and stock returns, however, implicitly assumes that oil price changes affect firms' performance directly or indirectly (Nasir et al., 2018; Nasir and Simpson, 2018; Nasir et al., 2019). So far, only limited attention has been paid to the mechanisms explicitly. Brown and Yücel (2002), Degiannakis et al. (2018), and Tang et al. (2010) explain that there are direct and indirect channels through which oil price changes can affect stock returns. According to valuation theory, a firm's value is the present value of the expected free cash flows, which are determined by the firm's profitability, and discounted by the future discount rate. For oil and gas firms, an increase in oil prices will increase their revenue and profitability, thereby increasing the firm value. On the other hand, for oil users, an increase in oil price will increase their input cost and reduce profitability. In addition to the direct channel, oil price changes can also affect firm value and stock returns indirectly through the monetary, fiscal, uncertainty, and consumer disposable income channels (see Degiannakis et al., 2018, for details). Although the above mechanisms are understandable for oil and gas and oil-user firms, it is not clear how oil price changes will impact banks' stock returns. As a non-oil-related industry, banks seem less susceptible to oil price changes. However, studies find that banks' stock returns are negatively related to oil price changes (Elyasiani et al., 2011; Faff and Brailsford, 1999). Hesse and Poghosyan (2016) argue that oil price change affects banks' profitability only through indirect channels.

In this paper, we argue that oil price changes can also affect banks' performance directly. According to the Recognition of Expected Credit Losses under IFRS 9, banks are required to recognize the expected credit losses when financial losses become expected. As banks hold an extensive portfolio of loans across firms and industries, a significant increase in oil prices, which affects most firms negatively, increases expected loan losses and decreases profits. This decrease in profits is expected before the negative indirect effects are materialized through macroeconomic factors, such as increases in inflation and interest rates and reduction in disposable income. Therefore, we hypothesize that energy shock will have a negative direct impact on banks' efficiency. For the potential channels, we hypothesize that energy prices will affect the operational and investment efficiency of banks. (See Fig. 1)

On the one hand, energy prices can significantly impact the operational efficiency of banks, particularly through their influence on overall operational costs. Banks, like any other businesses, are consumers of energy for a variety of their operational needs, from maintaining physical branches and offices to powering their massive data centers (Li et al., 2016). When energy prices rise, the costs associated with these activities inevitably increase, which can reduce operational efficiency by increasing the cost-income ratio, a commonly used measure of banking efficiency (Pampurini and Quaranta, 2018). According to the efficiency structure hypothesis, firms with lower costs, such as energy costs, will provide products at lower prices and hence have a higher market share (Berger, 1995). Therefore, higher energy prices can lead to reduced operational efficiency, potentially eroding market share and profits. Consequently, banks might face challenges maintaining their profitability and operational efficiency under high energy price conditions.

H1. *The efficiency of banks' operations will be adversely affected by the rise in energy prices.*

On the other hand, energy prices can have a substantial impact on the investment efficiency of banks, through their influence on the macroeconomic environment and business performance. According to the Fisher effect, rising energy prices can lead to increased inflation expectations, which could subsequently lead to higher nominal interest rates (Fisher, 1930). As interest rates rise, the cost of borrowing for businesses and consumers increases, which can lead to a decrease in investment and spending. This situation can lead to higher default rates on loans, thereby affecting the asset quality and investment efficiency of banks (Delis et al., 2014). Furthermore, banks' investment portfolios often include companies in energy-intensive sectors. When energy prices rise, these firms may experience decreased profitability due to higher operating costs, potentially devaluing the bank's investment portfolio (Borio et al., 2014). Consequently, fluctuations in energy prices could negatively impact the investment efficiency of banks.

H2. *The efficiency of banks' investments will be adversely affected by the rise in energy prices.*

3. Data and methodology

3.1. Data

The sample includes 48 banks in seven emerging economies (Brazil, China, India, Indonesia, Mexico, Russia, and Turkey), accounting for >80% of the market shares in the respective countries. The sample period spans from 2001 to 2020. The dataset utilized for this research was curated from a broad spectrum of repositories. Bank-specific variables, for instance, were procured from proprietary banking websites. Subsequently, macroeconomic indicators such as inflation, Gross Domestic Product (GDP) growth, and unemployment were amassed from authoritative sources like the World Bank's comprehensive database and the respective country's central bank archives. Finally, information on average annual energy prices, universally presented in the prevailing currency, the US dollar, was retrieved from the World Bank database.

Information on banking efficiency was extracted using Bank Scope as the primary tool. Annual reports from banks provided the necessary data to analyze the financial proficiency within the banking sector. This analysis was performed using two primary metrics. Operational efficiency, the first measure, was assessed by the ratio of net income to total assets. Simultaneously, investment efficiency was gauged by the ratio of net income to total equity. Several control variables were incorporated into the analysis, including the GDP growth rate, inflation rate (as

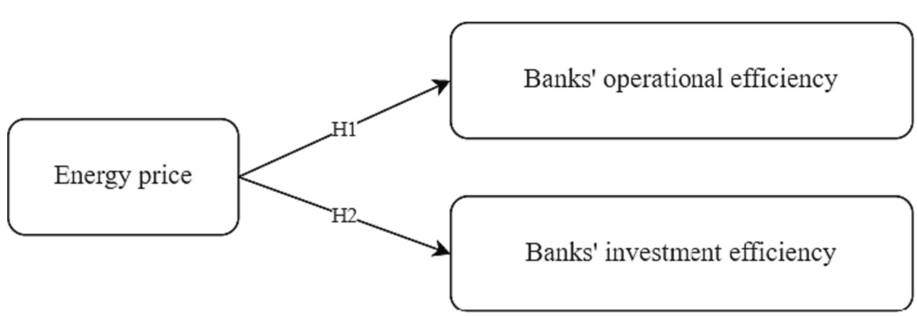

Fig. 1. Conceptual framework.

determined by the consumer price index), unemployment rate, leverage (represented as a debt-to-equity ratio), economic policy uncertainty, capital adequacy (required proportion of capital that banks must maintain against their risk-weighted assets, typically regulated by the authorities), annual average exchange rate, and bank rate.

3.2. Methodology

The paper utilizes four panel estimation regression techniques to examine the relationship between energy prices and banks' efficiency: fixed effect, random effect, dynamic OLS (DOLS), and fully modified OLS (FMOLS). The incorporation of these diverse analyses, as underscored by Ehigiamusoe and Lean (2018), was to generate robust and credible estimates. Muhammad et al. (2016) highlight two salient rationales for the use of fixed and random effects models: their proficiency in estimating the static form of the models and their capability to manage data heterogeneity. However, it should be noted that these methodologies do not explicitly resolve endogeneity issues, as stated by Muhammad et al. (2016). Conversely, DOLS, as elucidated by Botev et al. (2019), provides an advantage by tackling potential endogeneity problems associated with the independent variables. Moreover, the utility of DOLS and FMOLS in the context of cointegration was emphasized by Botev et al. (2019), along with Nasir et al. (2019). The methodologies employed address autocorrelation in the residuals using Newey-West adjustments, and they incorporate both preceding and succeeding values of explanatory variables in their initial differences, as suggested by Botev et al. (2019) and Nasir et al. (2019).

Currently, the data envelopment analysis (DEA) methodology is commonly used to evaluate relative efficiency. We acknowledge Charnes et al. (1978) for mathematically formalizing this concept, building on the groundwork laid by Farrell (1957) and other researchers. DEA facilitates relative efficiency evaluation in scenarios with multiple inputs and outputs, where a clear, objective method to consolidate either inputs or outputs into a productivity efficiency indicator is absent. This methodology has gained significant recognition in the management science literature (Charnes et al., 1978, 1981; Sexton et al., 1986) and has increasingly drawn scholarly attention, especially in addressing efficiency measurement complexities within the services sectors of the economy. In our analysis, we utilized the BCC model developed by Banker et al. (1984). This model, assuming a constant return to scale, applies an input-oriented approach, striving to minimize inputs while maintaining constant outputs for efficiency evaluation. Such an approach is apt for assessing banking efficiency as banks exhibit greater adaptability in adjusting inputs, such as operational expenses, compared to outputs like capitalization or revenue, often scrutinized by external entities. In this study, we employed assets and equity methods to determine input and output indicators. Specifically, return on assets, return on equity, leverage, capital adequacy, exchange rate, and bank rate were considered as the selected indicators for constructing the operational and investment efficiency variables.

$$Efficiency = E \equiv \frac{\sum_r v_i x_j}{\sum_b w_i y_j}$$

Subject to.

$$\frac{\sum_r v_i x_j}{\sum_b w_i y_j} \leq 1$$

$$V_I, W_I \geq \epsilon$$

where the w and v are input. The solution to the above equation gives us a value of E. If E is >1, it is an increasing return to scale. If E is less than l, it is a decreasing return to scale.

The relationship between banking efficiency, in terms of operational and investment efficiencies, and their determinants can be identified in the form of the following models:

$$\begin{aligned} Operational\ efficency_t = {} & \beta_o + \beta_1 Energy\ price_t + \beta_2 GDP_t + \beta_3 Inflation_t \\ & + \beta_4 Unemployment_t + \beta_5 Leverage_t + \beta_6 Uncertainty_t \\ & + \beta_7 Capital\ adequacy_t + \beta_8 Exchange\ rate_t \\ & + \beta_9 Bank\ rate_t + \varepsilon_t \end{aligned} \tag{1}$$

$$\begin{aligned} Investment\ efficiency_t = {} & \beta_o + \beta_1 Energy\ price_t + \beta_2 GDP_t + \beta_3 Inflation_t \\ & + \beta_4 Unemployment_t + \beta_5 Leverage_t + \beta_6 Uncertainty_t \\ & + \beta_7 Capital\ adequacy_t + \beta_8 Exchange\ rate_t \\ & + \beta_9 Bank\ rate_t + \varepsilon_t \end{aligned} \tag{2}$$

where *Operational efficency*$_t$ and *Investment efficiency*$_t$ are operational and investment efficiency, respectively; *Energy price* is the global energy price index; *GDP* is the annual GDP growth rate; *Inflation* is the inflation rate based on consumer price index; *Unemployment* is the unemployment rate; *Leverage* is the debt-to-equity ratio; *Uncertainty* is the economic policy uncertainty index; *Capital adequacy* is the required proportion of capital that banks must maintain against their risk-weighted assets; *Exchange rate* is the 12-month average exchange rate; *Bank rate* is the central bank's policy rate.

A spectrum of estimators was utilized to determine the parameters in Eqs. (1) and (2), integrating fixed effect, random effect, DOLS, and FMOLS. Therefore, our methodology endeavors to mitigate potential endogeneity complications, such as reverse causality. The DOLS approach takes into account the prior and subsequent values of the original differences in the explanatory variables, whereas the FMOLS approach employs the Newey-West technique to address biases stemming from serial correlation and endogeneity. FMOLS, an inherently non-parametric method, explores potential correlations among the first differences of the regressors, the error term, and the presence of a constant term, to handle serial correlation adjustments (Maeso-Fernandez et al., 2006). As a result, they are superior in mitigating issues of serial correlation and endogeneity in small datasets. Both DOLS and FMOLS methodologies produce credible standard deviation estimates, facilitating hypothesis testing. Following this, we implement the two-step system generalized method of moments (GMM) advocated by Windmeijer (2005) owing to its lower bias and standard errors (Saif-Alyousfi et al., 2020), and its higher robustness and efficacy in dealing with the issue of weak instruments, compared to the one-step estimator. The GMM approach capitalizes on the lags of both the dependent variable and exogenous regressors as prospective tools to address endogeneity concerns. While fixed effects and random effects are proficient static estimators that effectively tackle data heterogeneity (Muhammad et al., 2016), they do not operate as dynamic estimators, thus falling short of addressing endogeneity issues. This limitation makes alternative estimators like the GMM more desirable (Ullah et al., 2018). As emphasized by Mamatzakis and Remoundos (2003), Berger et al. (2000), and Goddard et al. (2004), dynamic models exploit more information, enabling more efficient estimation of the determining factors. Therefore, in this study, we implement a combination of static and dynamic models.

4. Results

4.1. Panel unit root tests

To derive reliable references, we incorporated three methodologies from the first and second generation of panel procedures. Breitung and Das (2005) propose a panel unit root test that eliminates the necessity for bias correlation factors. The resultant t-ratios display favorable power properties approaching one. The Breitung and Das (2005) method was selected due to its powerful and minimally biased nature among first-generation panel unit root tests, as evidenced by Narayan and Smyth (2009). Concurrently, the panel unit root test z-statistic proposed by Hadri (2000) recognizes that there are identical stationarity processes across different cross-sections. We employed the Hadri (2000) technique for its unique quality among panel unit root tests, in that it accepts the null hypothesis of stationarity. The Phillips and Perron (1988) test applies a non-parametric adjustment to the *t*-test statistic,

Table 1
Unit roots.

		Individual intercept		Individual intercept and trend		
	Test	Level	1st Difference	Level	1st Difference	Conclusion
Energy price	Breitung			(2.653) 0.996	(−9.122) 0.000***	Stationary after 1st difference
	PP	(98.921) 0.344	(459.260) 0.000***	(8.768) 1.000	(943.210) 0.000***	Stationary at level
	Hadri	(2.421) 0.007*	(6.674) 0.000***	(18.965) 0.000***	(55.910) 0.000***	Stationary at level
GDP	Breitung			(10.349) 1.000	(−1.259) 0.010*	Stationary at level.
	PP	(147.390) 0.000***	(1001.340) 0.000***	(154.292) 0.000***	(644.650) 0.000***	Stationary at level.
	Hadri	(9.080) 0.000***	(5.907) 0.000***	(9.167) 0.000***	(14.065) 0.000***	Stationary at level
Inflation	Breitung			(−1.757) 0.039	(−16.044) 0.000***	Stationary after 1st difference
	PP	(374.000) 0.000***	(3154.500) 0.000***	(475.140) 0.000***	(703.340) 0.000***	Stationary at level
	Hadri	(8.719) 0.000***	(−0.174) 0.569	(2.581) 0.004**	(13.026) 0.000***	Stationary at level
Unemployment	Breitung			(3.248) 0.999	(2.894) 0.000***	Stationary at level
	PP	(132.850) 0.005**	(299.530) 0.000***	(87.048) 0.681	(203.500) 0.000***	Stationary after 1st difference
	Hadri	(13.323) 0.000***	(7.468) 0.000***	(9.047) 0.000***	(14.042) 0.000***	Stationary at level
Leverage	Breitung			(−4.412) 0.000***	(−10.306) 0.000***	Stationary at level
	PP	(374.850) 0.000***	(1748.030) 0.000***	(255.750) 0.000***	(745.550) 0.000***	Stationary at level
	Hadri	(9.080) 0.000***	(2.333) 0.000***	(10.635) 0.000***	(9.203) 0.000***	Stationary at level
Uncertainty	Breitung			(4.635) 1.000	(−1.042) 0.000***	Stationary after 1st difference
	PP	(148.780) 0.000***	(626.770) 0.000***	(118.610) 0.043	(571.461) 0.000***	Stationary at level
	Hadri	(16.057) 0.000***	(11.360) 0.000***	(13.862) 0.000***	(41.927) 0.000***	Stationary at level
Capital adequacy	Breitung			(−0.336) 0.368	(−9.347) 0.000***	Stationary after 1st difference
	PP	(222.170) 0.000***	(1408.300) 0.000***	(266.390) 0.000***	(610.574) 0.000***	Stationary at level
	Hadri	(6.857) 0.000***	(2.983) 0.000***	(9.364) 0.000***	(9.912) 0.000***	Stationary at level
Exchange rate	Breitung			(10.956) 1.000	(−6.021) 0.000***	Stationary after 1st difference
	PP	(136.220) 0.002**	(539.480) 0.000***	(124.398) 0.019	(461.704) 0.000***	Stationary at level
	Hadri	(9.347) 0.000***	(8.800) 0.000***	(14.663) 0.000***	(6.368) 0.000***	Stationary at level
Bank rate	Breitung			(2.127) 0.983	(−4.873) 0.000***	Stationary at level
	PP	(282.330) 0.000***	(619.350) 0.000***	(218.370) 0.000***	(466.680) 0.000***	Stationary at level
	Hadri	(11.434) 0.000***	(14.146) 0.000***	(19.261) 0.000***	(10.011) 0.000***	Stationary at level
Investment efficiency	Breitung			(−2.925) 0.001***	(−3.975) 0.000***	Stationary at level
	PP	(1308.000) 0.000***	(5163.600) 0.000***	(529.950) 0.000***	(949.870) 0.000***	Stationary at level
	Hadri	(5.820) 0.000***	(5.408) 0.000***	(7.144) 0.000***	(13.038) 0.000***	Stationary at level
Operational efficiency	Breitung			(−4.258) 0.000***	(−6.026) 0.000***	Stationary at level
	PP	(1986.800) 0.000***	(6302.400) 0.000***	(542.810) 0.000***	(913.000) 0.000***	Stationary at level
	Hadri	(6.504) 0.000***	(7.718) 0.000***	(10.457) 0.000***	(13.581) 0.000***	Stationary at level

Statistics are in brackets; *, ** and *** denote the 10%, 5%, and 1% significance levels, respectively.

thereby remaining uninfluenced by unspecified autocorrelation. The test results in Table 1 demonstrate that all variables are stationary either at the level or first difference.

4.2. Panel cointegration tests

In accordance with Kao (1999), we deploy the panel cointegration test. This test recognizes a homogeneous cointegration relationship, permitting heterogeneity solely in the intercept while omitting the trend. Table 2 presents the results of the Kao panel cointegration test. The findings suggest that there is no enduring relationship between operational or investment efficiency and the independent variables.

4.3. Pedroni residual cointegration test for operational efficiency

We employ Pedroni (1999), Pedroni, 2004) cointegration test to scrutinize the cointegration relationship among the variables. Pedroni devised three tests anchored in the between-dimension (group-mean, ADF, and PP statistics) and four tests reliant on the within-dimension (panel variance ratio, ADF, and PP statistics). All seven tests, assessing the null hypothesis of no cointegration, exhibit an asymptotic distribution akin to the standard normal. Table 3 outlines the findings from the Pedroni cointegration test related to operational efficiency. The results show a long-term relationship between the factors.

4.4. Pedroni residual cointegration test for investment efficiency

Subsequently, Pedroni panel cointegration tests are applied to assess investment efficiency. The findings from this evaluation are depicted in Table 4. The outcomes of these tests reveal cointegration among variables in models, thereby establishing evidence of a long-term relationship between the factors.

4.5. Panel estimations for operational efficiency

In order to ascertain the interrelationship between energy prices and bank efficiency, a panel estimation test is executed. The employed models for this analysis include the fixed effect, random effect, DOLS, and FMOLS. The empirical outcomes derived from the regression analysis of operational efficiency are delineated in Table 5. The findings suggest that a shock in energy prices negatively impacts banks' operational efficiency, echoing the conclusion of Nasim and Downing (2023), who reported substantial detrimental effects of energy prices on bank performance. The result can be interpreted as an inevitable increase in the costs associated with operational activities such as the maintenance of physical branches and data centers when energy prices surge, subsequently reducing operational efficiency by amplifying the cost-income ratio, a frequently employed metric of banking efficiency (Pampurini and Quaranta, 2018). Moreover, the study corroborates the deleterious impact of inflation and unemployment on the operational efficiency of banks, insinuating that management struggles to align bank performance with inflationary forecasts. Capital adequacy and leverage exert a negative influence on the operational efficiency of banks. Conversely, the bank rate exerts a favorable influence on operational efficiency, consistent with the findings of Aburime (2008).

Table 2
Kao residual cointegration test for the dependent variables.

Operational efficiency −38.247	0.000***
Investment efficiency −31.737	0.000***

*** denotes the 1% significance level.

Table 3
Pedroni cointegration test for operational efficiency.

	Test statistics	I·I	I·I and I. T	No, I or T
Operational efficiency, GDP, Inflation, Unemployment, Bank rate, Leverage, Energy price	Panel v Statist	(−4.445) 1.000	(−5.415) 1.000	(−3.505) 1.000
	Panel rho Statistic	(3.762) 0.999	(5.234) 1.000	(1.295) 0.941
	Panel PP Statistic	(−13.348) 0.000***	(−14.887) 0.000***	(−19.773) 0.000***
	Panel ADF Statistic	(−11.865) 0.000***	(−11.945) 0.000***	(−20.724) 0.000***
Operational efficiency, GDP, Inflation, Unemployment, Capital adequacy, Leverage, Energy price	Panel v Statist	(−2.739) 1.000	(−4.670) 1.000	(−3.560) 1.000
	Panel rho Statistic	(3.496) 0.999	(5.305) 1.000	(1.329) 0.956
	Panel PP Statistic	(−14.086) 0.000***	(−14.000) 0.000***	(25.034) 0.000***
	Panel ADF Statistic	(0.720) 0.000***	(−13.617) 0.000***	(−24.618) 0.000***
Operational Efficiency, GDP, Inflation, Unemployment, Capital adequacy, Exchange rate, Energy price	Panel v Statist	(−3.164) 1.000	(−4.816) 1.000	(−3.173) 1.000
	Panel rho Statistic	(3.666) 1.000	(6.324) 1.000	(1.433) 0.984
	Panel PP Statistic	(−12.418) 0.000***	(−11.217) 0.000***	(−20.068) 0.000***
	Panel ADF Statistic	(−9.998) 0.000***	(−10.652) 0.000***	(−18.638) 0.000***
Operational Efficiency, GDP, Inflation, Unemployment, Capital adequacy, Uncertainty, Energy price	Panel v Statist	(−1.620) 1.000	(−3.860) 1.000	(−2.506) 1.000
	Panel rho Statistic	(2.942) 0.999	(5.351) 1.000	(0.376) 0.964
	Panel PP Statistic	(−17.433) 0.000***	(−13.866) 0.000***	(−23.884) 0.000***
	Panel ADF Statistic	(−16.903) 0.000***	(−12.286) 0.000***	(−23.583) 0.000***

Statistics are in brackets; *** denotes the 1% significance level; I·I. is Individual Intercept; I·I. and I.T. are Individual Intercept and Individual Trend; No, I or T is No Intercept or Trend.

4.6. Panel estimations for investment efficiency

Table 6 unveils the impact of energy prices on the investment efficiency of banks. The analysis reveals that energy prices negatively influence banks' investment efficiency. This is in agreement with the findings of Lee and Lee (2019), who concluded that escalated oil prices result in diminished profitability. The inference is that an upsurge in energy prices adversely affects the economy by reducing investment and the ability of borrowers to repay their debts, potentially destabilizing the balance sheets of banks and impairing their investment efficiency (Delis et al., 2014). GDP presents a positive, albeit insignificant, influence on investment efficiency, an outcome that aligns with Alper and Anbar (2011) findings. Conversely, the exchange rate exerts a positive influence on the investment efficiency of banks. In terms of bank-specific variables, this research shows an insignificant impact of capital adequacy on the investment efficiency of banks, which contradicts the findings of Athanasoglou et al. (2026) who observe that the capital ratio positively impacts bank efficiency.

4.7. GMM estimation

Finally, we apply a dynamic panel GMM estimator, a method conceived by Blundell and Bond (2000). The results from the system GMM analysis are outlined in Table 7. Mirroring the findings from the panel estimation, energy prices exhibit a negative correlation with both operational and investment efficiency at the 1% level. As for the control variables, GDP growth and unemployment significantly enhance bank

Table 4
Pedroni cointegration test for investment efficiency.

	Test statistics	I.I	I.I and I. T	No, I or T
Investment efficiency, GDP, Inflation, Capital adequacy, Unemployment, Energy price, Bank rate	Panel v	(−0.423)	(−0.449)	(0.349)
	Statist	1.000	1.000	1.000
	Panel rho	(2.009)	(4.768)	(0.391)
	Statistic	1.000	1.000	0.997
	Panel PP	(−17.464)	(−28.480)	(−19.746)
	Statistic	0.000***	0.000***	0.000***
	Panel	(−14.968)	(−19.137)	(−19.531)
	ADF	0.000***	0.000***	0.000***
	Statistic			
Investment efficiency, GDP, Inflation, Capital adequacy, Unemployment, Energy price, Uncertainty	Panel v	(−2.300)	(−3.203)	(−1.658)
	Statist	1.000	1.000	1.000
	Panel rho	(0.783)	(4.444)	(−0.440)
	Statistic	1.000	1.000	0.995
	Panel PP	(−21.335)	(−30.515)	(−22.282)
	Statistic	0.000***	0.000***	0.000***
	Panel	(−21.082)	(−21.675)	(−16.281)
	ADF	0.000***	0.000***	0.000***
	Statistic			
Investment efficiency, GDP, Inflation, Leverage, Unemployment, Energy price, Uncertainty	Panel v	(−2.302)	(−3.701)	(−2.183)
	Statist	1.000	1.000	1.000
	Panel rho	(2.266)	(4.017)	(−0.522)
	Statistic	1.000	1.000	0.987
	Panel PP	(−22.000)	(−22.539)	(−27.694)
	Statistic	0.000***	0.000***	0.000***
	Panel	(−16.429)	(−17.429)	(−26.074)
	ADF	0.000***	0.000***	0.000***
	Statistic			
Investment efficiency, GDP, Inflation, Exchange rate, Unemployment, Energy price, Uncertainty	Panel v	(−0.447)	(0.112)	(0.302)
	Statist	1.000	1.000	1.000
	Panel rho	(2.068)	(4.200)	(0.457)
	Statistic	1.000	1.000	0.998
	Panel PP	(−14.171)	(−26.076)	(−18.417)
	Statistic	0.000***	0.000***	0.000***
	Panel	(−12.022)	(−20.101)	(−16.710)
	ADF	0.000***	0.000***	0.000***
	Statistic			

Statistics are in brackets; *** denotes the 1% significance level; I.I. is Individual Intercept; I.I. and I.T. are Individual Intercept and Individual Trend; No I or T is No Intercept or Trend.

efficiency, which aligns with research undertaken in East Asian countries by Phan et al. (2019), whereas inflation adversely impacts bank efficiency. Interestingly, leverage exerts a substantial negative effect on operational efficiency, yet positively influences investment efficiency. At first glance, this might appear contradictory. When a bank augments its leverage, it inevitably exposes itself to elevated risk, thus demanding heightened risk management. The additional complexity may potentially detract from operational efficiency, as more resources are diverted towards risk management and mitigation. Conversely, banks can bolster investment efficiency through leverage. By leveraging borrowed funds for investment, banks can maintain a reduced level of equity capital and employ their assets in high-yield investments, thereby enhancing their return on equity and overall investment efficiency. Economic policy uncertainty detrimentally impacts both facets of bank efficiencies.

5. Discussion

This paper brings several noteworthy contributions to the literature. It extends the current understanding of energy shocks' impacts on banking efficiency, highlighting the crucial role energy prices play in determining bank performance. Being the first study to explore the correlation between energy prices and banks' efficiency in emerging markets, this research expands the range of previous studies that mainly concentrated on developed economies and restricted indicators such as stock returns and profitability. This paper also extends Hesse and Poghosyan (2016), who explore the impact of oil prices on bank profitability. They argue that oil prices only indirectly affect bank performance through macroeconomic factors, such as interest rates and inflation. Our study provides evidence of the direct effect between energy prices and bank performance, critically extending the previous knowledge.

The examination of the nexus between energy shocks and banking efficiency offers insights beyond traditional profit-based analyses. By adopting efficiency as a measure, we are better positioned to capture the complexities of bank performance and its interplay with energy shocks.

Table 5
Energy shocks and banking sector operational efficiency.

	Fixed effect	Random effect	DOLS	FMOLS
Energy price	(−0.0001)	(−0.0001)	(−0.0001)	(−0.0001)
	0.323	0.000***	0.000***	0.000***
GDP	(0.0226)	(−0.0185)	(−0.0210)	(−0.0310)
	0.002**	0.313	0.268	0.094
Inflation	(−0.0046)	(−0.0030)	(−0.0030)	(−0.0022)
	0.001**	0.023	0.032	0.109
Unemployment	(−0.0763)	(−0.0490)	(−0.0307)	(−0.0274)
	0.303	0.271	0.445	0.484
Leverage	(−0.0023)	(−0.0014)	(−0.0012)	(−0.0011)
	0.000***	0.003*	0.008*	0.018
Uncertainty	(−0.0000)	(−0.0000)	(−0.0000)	(−0.0000)
	0.228	0.151	0.115	0.123
Capital adequacy	(−0.0413)	(−0.0294)	(−0.0233)	(−0.0259)
	0.046	0.081	0.149	0.102
Exchange rate	(0.0003)	(0.0002)	(0.0003)	(0.0003)
	0.000***	0.000***	0.000***	0.000***
Bank rate	(0.0282)	(0.0457)	(0.0501)	(0.0460)
	0.063	0.001*	0.000***	0.001*
R-square	0.070	0.058	0.057	0.055
F statistic	2.233	6.072		
Prob	0.000***	0.000***		
D-W test	1.531	1.533		
H. test	5437.05	5608.04	5612.40	5600.00
	0.000***	0.000***	0.000***	0.000***

Coefficients are in brackets; ***, **, * denote significance at the 1%, 5%, and 10% levels; D—W statistic is Durbin-Watson statistic; H. test statistic is Heteroscedasticity test statistic, where Chi-square Distribution at 5% significance is 18.30.

Table 6
Energy shock and bank investment efficiency.

	Fixed effect	Random effect	DOLS	FMOLS
Energy price	(−0.0001)	(−0.0001)	(−0.0001)	(−0.0001)
	0.000***	0.000***	0.000***	0.000***
GDP	(0.0419)	(0.0120)	(0.0130)	(0.0137)
	0.110	0.571	0.547	0.521
Inflation	(−0.0027)	(−0.0020)	(−0.0021)	(−0.0021)
	0.100	0.189	0.547	0.172
Unemployment	(0.0190)	(0.0379)	(0.0056)	(0.0832)
	0.826	0.452	0.223	0.067
Leverage	(0.0003)	(−0.0000)	(0.0001)	(−0.0000)
	0.713	0.982	0.862	0.934
Uncertainty	(−0.0000)	(−0.0000)	(−0.0000)	(−0.0000)
	0.350	0.100	0.075	0.018
Capital adequacy	(−0.0274)	(−0.0229)	(−0.0174)	(−0.0193)
	0.255	0.237	0.343	0.290
Exchange rate	(0.0002)	(0.0002)	(0.0002)	(0.0002)
	0.009*	0.027	0.000***	0.000***
Bank rate	(−0.0007)	(0.0025)	(0.0053)	(0.0010)
	0.967	0.881	0.747	0.950)
R-square	0.071	0.026	0.053	0.055
F statistic	1.164	2.619		
Prob	0.198	0.005		
D-W test	1.703	1.628		
H. test	5876.73	6019.23	5970.63	5927.85
	0.000***	0.000***	0.000***	0.000***

Coefficients are in brackets; ***, **, * denote significance at the 1%, 5%, and 10% levels; D—W statistic is Durbin-Watson statistic; H. test statistic is Heteroscedasticity test statistic, where Chi-square Distribution at 5% significance is 18.30.

Table 7
Energy shock and banking sector performance: system GMM analysis.

	Operational Efficiency	Investment Efficiency
Energy price	(−0.0000)	(−0.0000)
	0.000***	0.000***
GDP	(0.0127)	(0.0309)
	0.000***	0.000***
Inflation	(−0.0018)	(−0.0015)
	0.000***	0.000***
Unemployment	(0.0295)	(0.1218)
	0.000***	0.000***
Leverage	(−0.0027)	(0.0019)
	0.000***	0.000***
Uncertainty	(−0.0000)	(−0.0000)
	0.000***	0.000***
Capital adequacy	(0.0284)	(−0.0279)
	0.000***	0.000***
Exchange rate	(0.0001)	(0.0001)
	0.000***	0.000***
Bank rate	(−0.0105)	(0.0572)
	0.022	0.000***
Hansen J-Stat.	38.595	38.253
Prob(J-Stat)	0.397	0.412
Instrument rank	47	47
AR (1)	−4.6599	(−1.9111)
	0.000***	0.005*
AR (2)	−0.8786	(0.5936)
	0.379	0.550
Observations	798	797

Coefficients are in brackets; ***, **, * denote significance at the 1%, 5%, and 10% levels.

Efficiency measures provide a more holistic view, encapsulating both input and output factors. This is particularly significant considering that banks across different nations exhibit vastly differing characteristics.

By illuminating the negative relationship between energy shocks and banking efficiency, this study reveals critical information for policymakers, particularly those in emerging economies. Policymakers can harness these insights to implement strategies that mitigate the adverse effects of energy shocks on banks' operational and investment efficiency, promoting greater financial stability and economic growth. In doing so, they can help safeguard their economies against the destabilizing effects of energy shocks, underpinning their broader growth and development aspirations.

6. Conclusion

This study brings new insights into the impact of energy shocks on bank efficiency, with a focus on emerging economies. Our empirical findings based on the data from 48 banks in seven emerging economies from 2001 to 2020, underscore the negative influence of energy shocks on banks' operational and investment efficiency. These results align with our theoretical understanding of how the increase in energy prices and subsequent macroeconomic disruptions can impact banks' input and output factors, thereby affecting their efficiency.

From a theoretical perspective, our work extends the existing literature on the relationship between energy shocks and bank performance by introducing bank efficiency as an alternative proxy for bank performance. We argue that efficiency, capturing both the input and output characteristics of banks, provides a more comprehensive understanding of a bank's operational capabilities than stock returns or profitability alone. By using energy prices as a proxy for energy shocks rather than the traditionally used oil prices, our study presents a more nuanced view of the varied energy landscape faced by contemporary economies.

The practical implications of our findings are multifold. For bank managers, the study provides insights into the dynamics of energy shocks and their effects on bank efficiency. Our research suggests that strategic planning in anticipation of energy shocks and implementing mechanisms to maintain efficiency could yield long-term benefits in terms of operational stability and financial performance. For policymakers, particularly in emerging economies, our findings highlight the need for well-designed strategies to combat the negative effects of energy shocks on banks. Our paper suggests that policies promoting hedging and gradual adjustments of macroeconomic variables, such as interest rates, may provide banks with better opportunities to manage their efficiency in the face of energy shocks.

In light of the implications of our findings, we propose several avenues for future research. Firstly, we encourage further exploration into the micro-mechanisms by which energy shocks influence banks' input and output factors. The nuances and intricacies of this relationship remain largely unexplored and would provide valuable insights into the resilience and adaptability of banking institutions in the face of significant external shocks. Additionally, our study opens the door for an investigation into the link between energy shocks and other dimensions of banks' performance, such as risk-taking and lending behaviors. Given the considerable influence of these factors on the overall financial stability of a country, understanding how they are affected by energy shocks is crucial. Future research could also delve into the potential variation in the impact of energy shocks across different types of banks, such as commercial banks, investment banks, and cooperative banks. Such comparative studies would elucidate whether certain banking sectors are more susceptible to energy shocks and why this might be the case. Moreover, it would be beneficial to extend the analysis to other forms of external shocks, including financial crises or geopolitical events, and their influence on bank efficiency. Such research could yield comprehensive insights into the ways in which banks can better prepare for and navigate these challenges. Finally, while our research focuses on the general relationship between energy prices and bank efficiencies, it would be instructive to explore the potential asymmetric impact of energy shocks. As our study and historical events like the Russia-Ukraine War and the Covid-19 pandemic demonstrate, energy shocks can occur due to both increases and decreases in energy prices. Unpacking the potential differential effects of these variations on bank efficiency could offer a critical understanding of future policy decisions and strategic planning within the banking industry.

Credit author statement

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Declaration of Competing Interest

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Appendix A. Supplementary data

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