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Empirical evidence of the relationship between regulatory efficiency, market openness, and bank productivity in economies at different income levels: Evidence from selected Asian and MENA countries

JEL Classification: *D24; G21; G28*

Keywords: *bank productivity; economic freedom; regulatory efficiency; market openness; income levels*

Abstract

Research background: Economic freedom plays a pivotal role in ensuring the progressive productivity of banks. It fosters a favorable economic climate and acts as a catalyst for the generation of innovative ideas. In addition, economic freedom allows new domestic and foreign entrants in the banking sector which leads to increased competition as well as wider range of product offerings and thus potentially affect bank efficiency.
Purpose of the article: This study aims to identify the effects of regulatory efficiency and market openness in terms of economic freedom on the bank's productivity at three income levels: lower-middle, upper-middle, and high-income economies.
Methods: A sample of 15 countries are included in the study from differing income levels. The study uses the data envelopment analysis (DEA) based Malmquist productivity index (MPI) approach to measure banks' productivity. This non-parametric approach measures the relative efficiency of banks by considering the production change while taking into account technical efficiency change and technological change in order to capture a comprehensive view over time. Then, regression analysis was performed utilizing the ordinary least squares (OLS) approach, fixed effect (FE), and random effect (RE) panel multiple regression estimation methods are utilized to measure economic freedoms and other determinants' effect on banks' productivity change over time.
Findings & value added: The results show that banks in high-income economies are more productive and have higher growth rates than those in upper- and lower-income economies. Furthermore, starting, obtaining permits, and closing businesses under business freedom have a detrimental effect on banks' output, whereas the effects of labor freedom on employing, managing, and supervising staff members have a substantial favorable impact on banks' productivity. Moreover, financial freedom and investment freedom under the market openness dimension negatively influence banks' productivity. Government intervention is required to introduce regulations that allow foreign countries to provide labor at lower wages, introduce tax allowances, and control inflation rates. Thus, the empirical results of this study will benefit regulators and policymakers in developing a system and plan to increase banks' productivity based on indicators of business, labor, financial, and investment freedom.

Introduction

Banks are vital to the financial system of individuals, businesses, and the economy as a whole. Banks efficiently allocate funds from savers to creditors, serving as an essential moderator in the financial system (Diamond, 2023). Savers and investors delegate the function of monitoring of these loans to banks who provide contracts as banks can monitor firms and their cash flows and thus ensuring repayment of these loans i.e. reduction of information asymmetry (Gorton & Winton, 2003). Borrowers on the other hand reduce risk taking behavior to ensure the ability to repay the loans given that bank monitoring resolves this conflict (a potential agency problem) (Allen *et al*., 2019). They provide advanced financial services that reduce the cost of accessing knowledge about saving and borrowing options. Banks increasingly recognize that no institution can excel at providing all financial products and services to cater to every customer's needs. Each bank strategically evaluates market entry, development, and competitive positioning in this context as key considerations. Therefore, as the world's competition grows, service companies like banks are forced to look for ways to improve productivity and ensure optimal profitability.

Productivity refers to efficiently converting inputs or resources into outputs or products without any waste, often by comparing performance across different periods. Economists summarize the technological link between inputs and outputs as a production function (Jubilee *et al.,* 2022; Kamarudin *et al*., 2022; Llorens *et al*., 2020). The two major categories of productivity are partial and total factor productivity (TFP). The gross or net production ratio to single-factor input measures total productivity. For the same amount of resources, the increase in the TFP means generating more and higher profits.

The productivity and profitability of banks are not constant, and they can drastically decline if they cannot maintain a good position in the market. Banks can attempt to reduce their weaknesses and improve their productivity levels to maintain their sustainable competitiveness in the financial market by identifying possible internal and external factors like bank-specific characteristics, macroeconomic conditions, regulation, and economic freedom. Additionally, this approach can help banks maximize shareholder wealth and profitability, ensuring that their financial performance remains robust and aligned with stakeholders' interests. Bank productivity diverges significantly between countries, a discrepancy often

attributed to variations in economic environments. A body of literature consistently demonstrates that heightened productivity can substantially augment a bank's performance and profitability (e.g., Llorens *et al*., 2020; Kamarudin *et al*., 2022). This finding underscores the critical link between productivity and financial success, prompting banks to strategize and optimize productivity levels to enhance their competitive position and ensure sustained profitability, particularly in diverse economic contexts.

The disparities in the profitability of banks and other financial institutions around the world motivated global researchers to investigate the main factors responsible for those consequences because they influence the performance that can be measured using efficiency and productivity (Doan *et al*., 2018; Addai *et al*., 2022; Najam *et al*., 2022). The literature documents substantial heterogeneity of profitability among the banking sector in low-, middle-, and high-income countries, where deterioration in profitability occurs with the increase in the country's income (Dietrich & Wanzenried, 2014; Hassan, 2020). Overall, the studies document that banks in middle income countries tend to have the highest level of capitalization, followed by low-income countries due to higher proportion of equity over total asset volume.

The lower cost-to-income ratio can benefit banks in low-income economies that are advantaged on the income side because of the ability to charge a higher interest rate. Meanwhile, the middle-income economies enjoy a lower tax burden due to the lowest effective tax rate. However, banks in high-income economies enjoy a better credit portfolio quality and benefit from the advantage of allocation efficiency in the credit market than banks in low- and middle-income countries. Furthermore, considering the macroeconomic indicators, the GDP growth rates are higher on average in low- and middle-income countries, which suffer from higher inflation rates than high-income countries. Overall, the banking sector's profitability worldwide has wide variation and among the reasons for the variations arise can be due to commercial banks work under different macroeconomic conditions (Bos & Kool, 2006; Akdeniz *et al*., 2023; Kallel & Triki, 2024), institutional realities (Hasan *et al*., 2009; Adem, 2023) and tax policies (Albertazzi & Gambacorta, 2010; Horváth, 2020; Borsuk *et al*., 2023).

Several studies have shown that economic freedom could significantly influence banks' profitability, stability, efficiency and performance in general (Abbas & Ali, 2022; Al-Gasaymeh, 2020; Asteriou *et al*., 2021; Defung & Yudaruddin, 2022; Masrizal *et al*., 2021; Qayyum *et al*., 2018; Gropper *et al*.,

2015). Generally, all the dimensions of the rule of law, size of the government, efficiency of regulations, and economic openness under economic freedom are significant factors that improve banks' performance. In addition, the findings are mixed in the different regions, countries, ownership, and sizes. Most of the prior studies have focused on internal and external determinants like bank-specific characteristics, ownership, globalization, regulations, supervisions, and macroeconomic conditions, but they have not yet narrowed their focus on economic freedom, specifically regulatory efficiency, and market openness dimensions, to the banks' productivity levels.

The Heritage Foundation (2021) indicates an individual's fundamental right to manage their property and labor under economic freedom. People in an economically free society can consume, spend, work, and create according to their preferences. In addition, governments in economically free societies facilitate the free movement of labor, capital, and commodities without coercion or restriction of liberty beyond what is required to ensure liberty. The economic freedom index acts as a guide for assessing and taking a holistic view of economic freedom, and every sub-indicator plays an important role in fostering and maintaining personal and national prosperity. Economic freedom is measured using 12 quantitative and qualitative factors classified under four broad dimensions: rule of law, government size, regulatory system and the open markets.

Economic freedom is crucial to the banking system because it promotes a positive economic environment and encourages the development of new ideas. According to Chortareas *et al.* (2013), the greater the economic freedom, the better results are obtained in the economic environment and, as a result, better economic growth and banking efficiency. Institutions and government policies are closely linked to economic freedom because they protect people's property and rights and empower them to do the right things. A higher level of economic freedom occurs when the government has an adequate legal structure and a robust legal compliance mechanism to safeguard people's properties and rights.

Asteriou *et al.* (2021) argued that there are various grounds for believing that economic freedom can enhance bank profitability. Claessens and Laeven (2004) suggested that increased economic freedom in terms of facilitating the entrance of new local and foreign entrants can increase efficiency and allow for a broader selection of products, hence improving banking profitability. In addition, economic freedom provides more oppor-

tunities for banks to offer their lending services and products to foreign financial institutions and other firms, providing better risk-return trade-offs for the banking industry and increased portfolio diversification for bank loans. The stronger economy and superior business conditions brought on by greater economic freedom enable banks to better perform in terms of profitability and stability. Holmes *et al.* (2008) posit that the greater banking service demand in countries with high real incomes, due to higher economic freedom levels, led to high bank performance.

Meanwhile, according to Gropper *et al.* (2015), political ties and state economic independence positively correlate with US bank performance. They also contend that tight bank regulations limit economic freedom and reduce opportunities. Blau (2017) suggested that economic freedom minimizes the uncertainty of regulations and encourages free trade, which, when accompanied by stronger emphasis on property rights, lessens the chance of market shocks. This indicates the benefits of economic freedom for banks' profitability and stability. More economic freedom should result in increased competition, thereby reducing inflation rates and a stable macroeconomic environment.

One of the key categories of economic freedom is regulatory efficiency, consisting of business freedom and labor freedom indices (Heritage Foundation, 2021). Business freedom measures the degree of efficiency of government control over business. It is one of the most basic measures of economic freedom of an individual's ability to initiate, run, and end a business activity without government intervention. The quantitative business freedom score is based on various factors that identify how difficult it is to initiate, run, and end a business activity. The higher the score (100), the more freedom there is in business. For instance, procedure, time, and cost of obtaining a license are all three sub-variables that are equally weighted in the business freedom component, which emphasizes closing, starting, and operating a business.

Labor freedom is a quantitative indicator that considers different aspects, including the legal and regulatory system of the labor market like laws of the minimum wage, laws prohibiting layoffs, severance provisions, and observable regulatory limits on hiring and hours worked. Market openness is composed of investment freedom and financial freedom indices. Investment freedom is an open and free investment climate that promotes increased economic growth, productivity, and job development by providing full entrepreneurship opportunities and incentives, and there

will be no restrictions on investment capital flow. Meanwhile, financial freedom is both a measure of banking performance and a measure of the independence of the financial sector from government control and intervention. The closer the score to 100, the higher the level of financial freedom in a business environment.

The existing literature indicates research gaps that are discussed as follows. First, most of the previous studies have predominantly concentrated on bank profitability, stability, and efficiency for banks' performance, and few focused on bank productivity. Second, numerous researchers have broadly explored economic freedom's impact in the broader economy, but limited studies have been conducted on the banking sectors (e.g., Bergh & Karlsson, 2010; Altman, 2008; Heckelman & Knack, 2009; Sufian & Habibullah, 2010a; 2010b). Recently, several studies have taken the initiative to investigate the impact of economic freedom on bank performance (e.g., Abbas & Ali, 2022; Al-Gasaymeh, 2020; Asteriou *et al.*, 2021; Defung & Yudaruddin, 2022; Gropper *et al.*, 2015; Masrizal *et al.*, 2022). Third, most prior scholars have investigated the overall economic freedom on the performance of banks. Finally, the impact of the specific dimensions of economic freedom on bank productivity is conspicuously absent in the literature. Accordingly, this study provides novel empirical evidence on the effects of regulatory efficiency and market openness under the dimensions of economic freedom on bank productivity at three levels of income economies: lower-middle, upper-middle, and high-income economies.

In summary, this study investigates the different levels of bank productivity and the impact of regulatory efficiency and market openness under economic freedom on bank productivity in lower-middle, upper-middle, and high-income economies. Our study provides a comparison between these countries' determinants of bank productivity changes between the observed period from the perspective of economic freedom which captures the impact of liberty and free markets on the ability banks to increase productivity. This is based on the notion that economic progress is often seen to have a positive correlation to economic freedom and banking institutions play a key role in promoting and enabling economic progress. The method employed allows the capturing of the effect over time and thus provides a comprehensive view of the banking sectors performance over time.

The findings provide the opportunity to understand potential opportunities as well as challenges arising from economic freedom in the ad-

vancement of economic progress. The current study utilizes two components of the regulatory efficiency measure, namely the business freedom and labor freedom. Business freedom captures the degree of state intervention in business as well as barriers arising from regulations which impede the success of entrepreneurial activities. Labor freedom, on the other hand, captures the ability to contract freely which influences productivity leading to sustainability of banking institutions in the context of our study. Furthermore, the current study employs two components of market openness which are financial freedom and investment freedom. Financial freedom promotes the openness of the banking system which in turn encourages competition among banks in their role as financial intermediaries and leads to productivity. Investment freedom measures the potential returns for risk taking which is supported by transparency as well as equity and thus leads to potential innovation arising from competition. It captures on the ease of capital movement within and across borders which leads to increased efficiency in resource allocation and thus heightened productivity. Thus, these four measures contribute by providing an understanding on the impact of both aspects of economic freedom on bank productivity and contributes to the literature given the gaps above. From the regulatory perspective our study aims to highlight potential gains for countries with homogenous economic characteristics as discussed above by enhancing economic freedom to encourage entrepreneurial activity as well as ensure the ability of the banking sector to promote sustainable economic growth.

Fifteen countries from Asia and the MENA region (Iran, Oman, Qatar, Bahrain, Egypt, Bangladesh, Jordan, Indonesia, Lebanon, Kuwait, Pakistan, Malaysia, Singapore, Saudi Arabia, and the United Arab Emirates) have been selected over the years 2011–2021. Given the period selected and the potential bias arising from the pandemic, we account for such impact in the methodology whilst discussing the implications in the results section. The selection of these three tiers is guided by the potential homogeneity in the development of regulatory and financial infrastructure as well as markets, which affects the productivity measures across the tiers. Low-income countries are excluded given that productivity changes over time would be potentially skewed due to lower cost-to-income ratio and marginal increments in any input variable may lead to outsized gains in productivity changes over time due to the marginal effect. The data envelopment analysis (DEA) is used in conjunction with the Malmquist Productivity Index (MPI) approach was used to measure the bank productivity level under the

first stage. Meanwhile, ordinary least squares (OLS), fixed effect (FE), and random effect (RE) panel multiple regression estimation methods are utilized to analyze the effect of economic freedom dimensions and other determinants on banks' productivity in each and overall levels income economies.

The following is the format of the rest of the paper: The literature review provides the variables of the investigation. The methodology section delves into the study's techniques and factors. Results and discussion sections provides the empirical results, explores the findings whilst discussing the implications. .Finally, the conclusion section encapsulates the main findings whilst discussing the contributions, policy ramifications as well as highlighting limitations which lead to potential future research avenues arising from the findings.

Literature review

Recent studies have examined the different levels of bank profitability, stability, and efficiency for the banks' performance across countries by investigating several issues like bank characteristics, macroeconomics, regulatory capital, trade openness, income diversification, and country income levels.

Najam *et al.* (2022) examined the impact of income diversification on ASEAN banks' financial sustainability in 2008–2019. The results uncover that income diversification increases the bank's financial stability, which is measured by return on assets in the overall countries. The results are similar to those by Addai *et al.* (2022), who found that income diversification has a significant positive impact on the performance of banks and are consistent with the studies on EU banks and emerging markets.

The role of regulatory efficiency

Basel capital requirements increase bank risk protection, which enhances the banks' efficiency (Bitar *et al.*, 2016; Haque & Brown, 2017; Veeramoothoo & Hammoudeh, 2022). In contrast, according to Mateev and Bachvarov (2021), the private interest view contributes to the stringent capital requirements and supervision that affect banks' productivity, since the private interest view could refer to endorsing bank regulations to maximize

a specific group of investors' interest. However, Hassan (2020) discovered mixed findings on capital requirements for North and Latin American bank performance, implying high capital's potential contribution to positive results, because banks operating in these nations have reputational and confidence gains that balance capital reserve losses.

According to Hassan (2020), Nayak (2021), and Rahman *et al.* (2021), bank regulatory and trade openness of banks could significantly influence banks' profitability. Hassan (2020) also suggested that regulations can be measured using four components: capital requirements, power of supervision, monitoring by private and market discipline, and restrictions on activity. All the regulatory components significantly influence the bank's productivity growth, but the impact is mixed with different countries' income levels. Nayak (2021) suggested that strict supervision and permissibility of activities will contribute to the enhanced banks' financial performance. However, the banks should not too stringently stick to regulations on capital requirements and external monitoring, because this will lead to low performance of the banks. Country income levels differently impacted banks' profitability because of competitiveness and capital allocation; banks in low-income countries enjoyed higher profitability and net interest margins due to low competition, but banks operating in high-income countries indicated an opposite finding because of the pressure of high competition and capital allocation (Dietrich & Wanzenried, 2014). Meanwhile, Doan *et al.* (2018) suggested that ownership of state-owned and foreign-owned banks may affect the banks' income diversification efficiency due to the fewer volatile income sources (Mateev & Bachvarov, 2021). Thus, our study aims to address the contention arising from the literature by investigating the impact of regulatory efficiency on bank performance across different income levels via efficiency gains over time based on the two stage methodological approach employed and discussed in the methodology section below.

Economic freedom and bank performance

The findings of this rigorous analysis have revealed that incorporating greater trade openness lowers financial intermediation costs and improves bank performance (Rahman *et al*., 2021). Increased trade openness can give banks more diverse investment opportunities, ultimately providing borrowers with various portfolio investment options. This matter leads to an

increase in net operating income and improved profitability. Furthermore, trade liberalization measures could stimulate fierce competition in the banking industry, thus cutting the cost of financial facilitation.

Several researchers evaluated banks' performance using the banking sectors' productivity and investigate the possible determinants that can influence the banks' productivity (Kamarudin *et al.*, 2022; Jubilee *et al.*, 2022; Llorens *et al.*, 2020). The productivity levels of the banking sectors in Spain are different due to the Great Recession (Llorens *et al.*, 2020). The empirical results exhibited that banks with regressive productivity are likelier to exit than progressive productive banks, and target banks need to be acquired by the surviving banks to ensure their branch network grows in the local markets where they operate suggesting that ease of entry and exit plays an important role in the banking sector. This would be of particular interest given the approach employed in this study which measures productivity changes over time rather than shifts in the production frontier which involves the traditional DEA approach alone.

Jubilee *et al.* (2022) examined the progressive and regressive nature of the bank's productivity in conventional and Islamic banks for different country income levels (low-, lower-middle-, upper-middle-, and high-income countries). The analysis revealed that, on average, Islamic banks' productivity outperformed conventional banks, which could be explained by the high popularity of the stability of Islamic finance stability due to the trust of the Muslim population, which represents a high percentage of the population in Southeast Asia. Additionally, the findings show that the overall productivity of Islamic banks' productivity is at a progressive level, and the Islamic banks in lower-middle-income countries have a larger proportion than upper-middle- and high-income countries because of hybrid legal system's implementation of Shariah and conventional law (Boukhatem & Moussa, 2018). However, conventional banks' productivity progress is the highest in upper-middle-income countries, whereas banks operating in high-income countries indicated the lowest productivity because high-income countries face a high overhead cost, agency cost, and greater competitive pressures that lead to lower productivity (Aluko & Ajayi, 2018; Ghosh, 2016).

Al-Gasaymeh, (2020) found that economic freedom could significantly improve the cost efficiency of countries in the Gulf Cooperation Council (GCC). The findings demonstrate that economic freedom improves, which is important for the GCC countries to attract additional investments and

establish a functional banking system. Furthermore, Asteriou *et al.* (2021) examined the overall economic freedom impact on bank profitability and stability. The empirical findings show that economic freedom significantly and positively impacts banks' profitability, and their finding is consistent with Blau (2017) and Gropper *et al.* (2015). In addition, economic freedom enhanced the banking sector's stability.

The economic freedom Impact on bank profitability and stability has been investigated by Defung and Yudaruddin (2022), but they focused on small, medium, and large banks. In general, the results indicate that economic freedom has a positive relationship with bank stability across the Indonesian banking sectors, and their findings parallel those of Asteriou *et al.* (2021). The economic freedom has positive impact to bank profitability and stability specifically in small- and medium-sized banks, and only the two dimensions of economic freedom (rule of law and market openness) were significantly and positively related to bank stability. One of the indices of market openness is financial freedom. Sufian and Habibullah (2010b) obtained similar results, where the positive impact on the bank's profitability with less government oversight led banks to have more financial freedom to engage in key financial operations. This encourages banks to support the private sector's important financial activities and boost economic growth.

Economic freedom also significantly moderates the relationship between regulatory capital and bank profitability (Abbas & Ali, 2022). In general, economic freedom plays an important role as a mediator between bank capital and profitability, using the sample of US banks from 2002 to 2019. Another recent scholar, Masrizal *et al.* (2022), examined the overall economic freedom impact, specifically on the efficiency of Islamic banks in rural areas of Indonesia. The economic freedom coefficient is positively and significantly related to bank efficiency and indicates lower control levels that could impact high bank efficiency (Sufian & Habibullah 2010a, 2010b). Masrizal *et al.* (2022) suggested that economic freedom is the secret to fostering an atmosphere that supports innovation, entrepreneurship, and cycles of sustainable economic growth and development. High levels of economic independence are typically accompanied by a respectable standard of living and a higher GDP per capita. Moreover, high-economic freedom nations experience low unemployment and inflation rates, and can increase firms' profit margins (Sufian & Habibullah, 2010a; Liao, 2018). Our study aims to contribute by resolving the gap arising from the above discussion

by investigating the impact of trade openness on bank performance across different income levels and over time due to efficiency gains.

Thus, our study aims to provide the link between two different aspects of economic freedom to bank performance via the integration of data envelopment analysis (DEA) with the Malmquist Productivity Index (MPI) which provides a measurement of productivity in a holistic manner and captures the changes over time of bank efficiency given the ability of the method to capture multiple input factors which include endogenous and exogenous measures. The choice of this non-parametric method provides a flexible framework to capture the complex relationship which may be difficult to measure using traditional parametric approaches. In addition, findings from the DEA-MPI analysis could potentially provide industry players with the ability to benchmark their peers across markets. In the context of banking, efficiency is closely related to risk management, the findings from the analysis proxies for the ability of banks to efficiently manage various risks that banks are inherently exposed to. The findings also provide various stakeholders which include potential investors, regulators, customers as well as bank managers to gain valuable insights on the operational effectiveness given the integrated approach adopted in this study, which ultimately drives competitiveness of banks as well as identifying areas of improvement.

Method

In this study, a total of 314 bank sample data are collected from 15 countries (Iran, Oman, Qatar, Bahrain, Egypt, Bangladesh, Jordan, Indonesia, Lebanon, Kuwait, Pakistan, Malaysia, Singapore, Saudi Arabia, and the United Arab Emirates) to reflect lower-middle-, upper-middle-, and high-income economies over the years 2011–2021. The selection of these countries is guided by the homogeneity of the capitalization and access to further capitalization given the relatively smaller and less efficient capital markets in comparison to traditionally high-income economies such as the G7. In addition, these countries tend to have similar levels of government role within the economy especially in the context of the finance and banking industry. State-owned or linked enterprises in these countries tend to play a significant role within the scope of the finance and banking sector which would ultimately affect competition and market efficiency. In addi-

tion, in terms of regional stability, these countries tend to face greater degree of potential economic contagion effect relative to EU or G7 countries, given the potential for shocks arising from financial crises or geopolitical challenges which can ultimately impact economic freedom by affecting investor confidence, trade and access to markets.

For bank-specific determinants, data are obtained from the BankScope database, which provides a comprehensive worldwide banking database. For macroeconomic conditions, data are collected from the International Monetary Fund because it provides the public data on macroeconomic and financial indicators. Data for the economic freedom index are sourced from the Heritage Foundation https://www.heritage.org/index/. The Gross National Income (GNI) per capita, representing the countries level of income, is measured based on the World Bank's definition sourced from the World Development Indicator database of 2021.

The data of GNI of each of the fifteen countries is presented in table 1 above. The World Development Indicators (WDI) from the World Bank defines economies for analytical purposes as follows based on GNI per capita in US Dollars using the World Bank classification: lower-middle-income, upper-middle-income countries high-income countries. Table 1 provides the classifications based on the WDI of the World Bank and the respective GNI per capita figures reported in the WDI database.

Data envelopment analysis-based Malmquist productivity index

The DEA-based Malmquist productivity index (DEA-MPI) has been applied in numerous studies to examine efficiency and productivity; thus, this approach will be used in the first level of data analysis to measure banks' productivity. The productivity changes of banks in the upper-middle-, lower-middle-, and high-income economies are quantified using the output-based Malmquist index, with the total factor productivity change (TFPCH) further divided into technological change (TECHCH) and efficiency change (EFFCH) under the DEA-MPI. Pure technical efficiency change (PTECH) and scale efficiency change (SECH) are affected by EFFCH changes.

Two sub-indices of EFFCH and TECHCH can be written as (Färe *et al.*, 1994):

$$M_0 = EFFCH \times TECHCH \tag{1}$$

where:

$$EFFCH = \frac{D_o^{t+1}(x^{t+1},\ y^{t+1})}{D_o^{t}\ (x^{t}, y^{t})} \tag{2}$$

$$TECHCH = \left[\left(\frac{D_o^{t}(x^{t+1},y^{t+1})}{D_o^{t+1}(x^{t+1},y^{t+1})}\right) \times \left(\frac{D_o^{t}(x^{t},y^{t})}{D_o^{t+1}(x^{t},y^{t})}\right)^{1/2}\right] \tag{3}$$

According to Färe *et al.* (1994), this equation can be used to express a comprehensive DEA-MPI, as follows:

$$M_o(x^{t+1}, y^{t+1}, x^t, y^t) = TECHCH \times PTECH \times SEC \tag{4}$$

or

$$\begin{aligned} M_o(x^{t+1}, y^{t+1}, x^t, y^t) &= \frac{D_o^{t+1}(x^{t+1},\ y^{t+1})}{D_o^{t}\ (x^{t}, y^{t})} \times \\ \times &\left[\left(\frac{D_o^{t}(x^{t+1},y^{t+1})}{D_o^{t+1}(x^{t+1},y^{t+1})}\right) \times \left(\frac{D_o^{t}(x^{t},y^{t})}{D_o^{t+1}(x^{t},y^{t})}\right)^{1/2}\right] \end{aligned} \tag{5}$$

The movements in the production frontier are represented by equation (5). The TFPCH between the two periods, t and $t+1$, is represented by the value of M_o, where x^{t+1}, y^{t+1} , indicating the most recent production points, corresponds to (x^t, y^t), indicating the earlier production points. D_0 denotes the output distance functions. When M_o is higher (lower) than 1, it implies positive (negative) TFP, whereas $M_o = 1$ indicates a negligible or no change in productivity. Accordingly, if the index is greater than 1 for a given technology, more outputs are created at time $t+1$ than at time t.

According to Färe *et al.* (1994), the EFFCH index is further decomposed into PTECH ($\Delta pureEff^{t,t+1}$) and SECH (($\Delta scale^{t,t+1}$), the mutually comprehensive components, as follows:

$$EFFCH = \Delta pureEff^{t,t+1} \times \Delta scale^{t,t+1} \tag{6}$$

where:

$$\Delta pureEff^{t,t+1} = \frac{D_{VRS}^{t+1}\ (x_i^{t+1}, y_i^{t+1})}{D_{VRS}^{t}\ (I,\ y_i^{t})} \tag{7}$$

$$\Delta scale^{t,t+1} = \frac{D_{CRS}^{t+1}(x_i^{t+1}, y_i^{t+1}) / D_{VRS}^{t+1}(x_i^{t+1}, y_i^{t+1})}{D_{CRS}^{t}(I, y_i^{t}) / D_{VRS}^{t}(x_I^{t}, y_i^{t})} \quad (8)$$

The DEA-MPI provides additional insight into the bank's productivity measurement in this study. DEA-MPI offers a perspective on measuring the banking system efficiency phenomenon. The transformation of cutting-edge technology is captured by the component of TECHCH of productivity growth, which provides a natural measure of innovation. Accordingly, technology and innovation progressed in lockstep with product development.

The DEA-MPI analysis applies the rule of thumb by employing the selected inputs and outputs (Cooper *et al.*, 2002). The following equation expresses the requirements for determining and selecting input and output:

$$n \geq max\{m \times x, 3(m + s)\} \quad (9)$$

where n, m, and s denote the number of DMUs, inputs, and outputs, respectively.

The DEA-MPI analysis used three inputs and two output variables. The input vector variables consist of $x1$: deposits (total deposit amount from depositors, investors, and financial intermediaries who deposit their money into a bank account), $x2$: personnel expenses (total employee costs, including salary, benefits, bonuses, and retirements), and $x3$: physical assets (capital, securities, property, and equipment that allow the banks to operate). The output vector variables are $y1$: total loans (total loans the banks have been able to create for their customers and financial intermediaries) and $y2$: total investments (either long-term or short-term in securities or bonds that will be sold or held until maturity). The results from the DEA-MPI analysis which provides individual bank productivity scores (BPS) is used in the multiple regression analysis in order to regress the determinants of change in productivity which includes bank specific characteristics as well as the main variables of interest in this study: regulatory efficiency and market openness.

Multiple-panel regression analysis

Multiple-panel regression analysis is used in the second stage of analysis to determine factors influencing banks' productivity in lower-middle-, upper-middle-, and high-income economies based on OLS. Furthermore,

the Breusch–Pagan Lagrangian multiplier (BPLM) tests the appropriability to perform OLS or generalized least squares (GLS) estimation analysis. In contrast, the Hausman test is used to identify the best FE or RE applied as estimate methods to overcome the heteroscedasticity and autocorrelation issues. Furthermore, the stepwise regression method was utilized instead of simultaneous regression models to avoid significant multicollinearity or duplicate problems. In other words, due to the significant correlation among some of the variables, the regulatory efficiency, market openness, and economic freedom variables are assessed in various regression models.

In this analysis, the banks' productivity scores (BPS) obtained from the DEA-MPI which measures the change in productivity for each individual bank is used as the dependent variables. The following equation estimates the multiple-panel regression model:

$$\begin{aligned} BPS_{ijt} = \alpha + \beta_{jt} LNBF_{jt} + \beta_{jt} LNLF_{jt} + \beta_{jt} LNFF_{jt} + \beta_{jt} LNIF_{jt} + \\ \beta_{ijt} LNTA_{ijt} + +\beta_{ijt} LLPGL_{ijt} + \beta_{ijt} TCETA_{ijt} + \beta_{ijt} BDTD_{ijt} + \\ +\beta_{ijt} LOANSTA_{ijt} + \beta_{ijt} NIETA_{ijt} + \beta_{jt} GDP_{jt} + \beta_{jt} CPI_{jt} + \beta_{jt} COVID + \varepsilon_{ijt} \end{aligned} \quad (10)$$

where BPS_{ijt} measures banks' productivity score, α is the constant term, $\beta_{jt} LNBF_{jt}$ is the natural logarithm of business freedom, $\beta_{jt} LNLF_{jt}$ is the natural logarithm of labor freedom, $\beta_{jt} LNFF_{jt}$ is the natural logarithm of financial freedom, $\beta_{jt} LNIF_{jt}$ is the natural logarithm of investment freedom, $\beta_{ijt} LNTA_{ijt}$ is the natural logarithm of total bank assets, $\beta_{ijt} LLPGL_{ijt}$ is the ratio of loan loss provisions to gross loan, $\beta_{ijt} TCETA_{ijt}$ is the ratio of equity to total assets, $\beta_{ijt} BDTD_{ijt}$ is the ratio of banks' deposit total deposit, $\beta_{ijt} LOANSTA_{ijt}$ is the ratio of total loans to total assets, $\beta_{ijt} NIETA_{ijt}$ is defined as non-interest expense divided by total assets, $\beta_{jt} GDP_{jt}$ is the gross domestic product growth, $\beta_{jt} CPI_{jt}$ is the consumer price index whilst $\beta_{jt} COVID$ is a dummy variable which proxies for the pandemic and ε_{ijt} is the residual term.

In this study, two dimensions of economic freedom, namely, regulatory efficiency and market openness, are measured by four indices, and each index (business freedom, labor freedom, financial freedom, and investment freedom) is assigned a score ranging from 0 to 100. The increase in the value of the score means an increase in economic freedom. Nine control variables consisting of bank-specific characteristics and macroeconomic conditions are applied in the equation model.

Results

Decompositions of banks' productivity by the income level

Table 2 illustrates the geometric mean scores of banks' productivity by income level in terms of TFPCH and its components, namely TECHCH and EFFCH, which can be further subdivided into PTECH, and SECH. The results for bank productivity in lower-middle-income economies are shown in panel A of Table 1. The study findings indicate that the banks made 20% (1.200) more progress in TFPCH during the investigation period. The advancement in the banks' TFPCH was primarily attributed to the 36.4% (1.364) growth in EFFCH, since the TECHCH appears to have a more slowly declining rate of −8.9% (0.911) over the years 2010–2021. According to the analysis of the EFFCH index, PECH, which represents managerial factors (29.6%, or 1.296) rather than the scale measured by SECH (9.8%, or 1.098), is the main driver of the EFFCH increase in the banks. This suggests that even if banks in the lower-middle-income economies have strong managerial efficiency, they have not been operating on the best scale possible.

According to the empirical data in panel B, the banks' TFPCH in the upper-middle income bracket has increased by 24.6% (1.246), which is a faster rate of rise than the banks in the lower-middle income bracket. The decomposition of the TFPCH index into its EFFCH and TECHCH components shows that the 44.3% (1.443) growth in EFFCH has mainly impacted the upper-middle-income banks' TFPCH success, like their peers in lower-middle-income. The banks appear to have had a TECHCH decline of −9.8%. (0.902). When the EFFCH index is subdivided into its PECH and SECH components, it becomes clear that managerial efficiency improvements (41% vs. 12.8%) were the main drivers of the banks' EFFCH growth. Data unequivocally demonstrate that banks in upper-middle-income economies have been conducting business on the incorrect scale.

Based on the experimental observations in panel C, the TFPCH of high-income banks has also increased by 49.2% (1.492), which is the largest increase when compared to banks in lower-middle- and upper-middle-income economies. The breakdown of the TFPCH index into its EFFCH and TECHCH components demonstrates that the growth in EFFCH of 70.5% (1.705) has contributed significantly to the banks' TFPCH progress, and it displays the highest score rather than both lower- and upper-middle-income economies. Additionally, the banks appear to have experienced

a TECHCH decline of −8.6%. (0.914). Since PECH's geometric mean score was greater than SECH (1.623 > 1.180), banks' EFFCH growth was mostly due to managerial effectiveness as opposed to scale.

Finally, the productivity statistics shown in panel D indicate that the banking sector has demonstrated TFPCH progress of 27.2% (1.272), on average, in all-income-level economies. The results indicate that banks have demonstrated TFPCH progress, with higher TFPCH rates of 46.6% (1.466) in 2017 and lower TFPCH rates of 12% (1.120) in 2015. Because the rate of TECHCH appears to be decreasing at −8.5% (0.915) during the study period, the improvement in the entire banking industry's TFPCH can be mostly attributed to the 46.3% (1.463) increase in EFFCH. The segmentation of the EFFCH index shows that PECH, rather than SECH, was primarily responsible for the increase in the EFFCH (1.396 > 1.125). Overall, the findings suggest that although all banks are more managerially effective at controlling costs, they operate at an inappropriate scale throughout the research period in lower-middle, upper-middle, and high-income countries.

Banks' productivity in lower-middle-, upper-middle-, high-income, and all-income-level economies: Analysis based on the number of banks and percentages

The results of the analysis in Table 3 are based on the number of banks' in lower-middle (panel A), upper-middle (panel B), high-income (panel C), and all-level income economies (panel D) facing progressive, regressive, and stagnant conditions. Referring to panel A in Table 2, the findings show that only 62 (38.75%) banks in lower-middle-income economies experienced TFPCH productivity progress in 2010–2011, gradually increasing to reach the peak of 95 (55.56%) in 2013–2014. However, the productivity level dropped to 54 (32.24%) banks in 2016–2017. The highest figures were reported in EFFCH (165 banks, or 94.29%), PECH (161 banks, or 92%), and SECH (123 banks, or 70.29%) in 2017–2018. However, in 2017–2018, progress productivity shows the highest number at 133 (76%) but declined to 51 (32.08%) in 2020–2021.

Regarding the progress of TFPCH for banks in upper-middle-income in panel B, the results indicate that in the overall years of investigation (2010–2021), the total number of banks varied, and based on the findings, only 26 banks (34.21%) in 2015–2016 reported the lowest in TFPCH progress and 64 banks (79.01%) reported the highest in 2017–2018. The highest progress

figures are recorded in EFFCH (72 banks, or 88.89%), PECH (68 banks, or 83.95%), and SECH (71 banks, or 87.65%) in the same period of 2017–2018.

Panel C discusses the changes in banks' productivity numbers and percentages in high-income economies. The observations clearly indicate that the number of banks in high-income economies indicates that TFPCH declined from 34 banks (60.71%) in 2010–2011 to 31 banks (57.41%) in 2016–2017, then inclined significantly to 56 banks (96.55%) in 2017–2018 and showed the highest number for the entire period specifically in high-income economies. EFFCH, PECH, and SECH similarly reported the highest numbers and percentages of the progress of banks in 2017–2018, where EFFCH = 57 banks (98.28%), PECH = 55 banks (94.83%), and SECH = 51 banks (87.93%).

Finally, the results in panel D of Table 3 indicate that 127 banks (44.56%) in all-income-level economies experienced productivity growth in 2011, gradually to 161 banks (53.49%) in 2013–2014 before declining to 112 banks (37.71%) in 2016–2017. A further observation indicates that the number of banks at all income levels, which faced progress in EFFCH decreased from 160 banks (56.14%) in 2010–2011 to 140 banks (140%) in 2016–2017. Although the TFPCH progress shows a decline from 118 (41.40%) to 20 (6.37%) in 2017–2018, the PECH and SECH progress also exhibited a declining banks' numbers and percentage from 2010–2011 to 2012–2013. Nevertheless, the overall trend in 2017–2018 clearly shows that these years are the best and boom years for all banks at all levels of income economies because all the progress in TFCH, EFFCH, PECH, and SECH recorded the highest numbers of banks and percentages.

Significant differences in bank productivity by years using univariate tests

Table 4 indicates a substantial mean difference between the banks' productivity in lower-middle-, upper-middle-, and high-income economies during 2010–2021. It shows the results of parametric (t-test) and nonparametric (Mann–Whitney [Wilcoxon] and Kruskal–Wallis) tests that are summarized in panels A, B, and C. Panel A in Table 3 shows empirical results that suggest banks in lower-middle-income are more productive (TFPCH) than banks in upper-middle and high-income economies only for two years (2018 and 2021). However, the difference was only statistically significant at 1% under both parametric and nonparametric tests during 2018. However, in the overall years from 2010 to 2021, the results show that

banks' productivity in lower-middle-income economies is lower compared to the upper-middle- and high-income economies and significantly different at the level of 1% in t-test and the level of 5% in the Mann–Whitney [Wilcoxon] and Kruskal–Wallis tests. The findings also show that the components of banks' productivity, including EFFCH, EFFCH, PECH, and SECH scores, are lower than other income levels and significant in parametric and nonparametric tests, and only TECHCH shows higher but insignificant results.

Furthermore, panel B presents the results for banks operating in upper-middle-income economies. It shows a high TFPCH in upper-middle-income economies rather than lower-middle- and high-income in 4 years (2012, 2013, 2019, and 2020), but all findings are insignificant in all tests. In addition, the overall 'ear'' results illustrate that the mean difference in banks' productivity for TFPCH in upper upper-middle income is lower than in lower-middle- and high-income economies but insignificant in all tests. In the analysis of the productivity components, the TECHCH indicates a higher and significant difference under the Mann–Whitney [Wilcoxon] and Kruskal–Wallis, but none of the results for the EFFCH, PECH, and SECH show a significant difference. In addition, both PECH and SECH in upper-middle-income economies are higher than in lower- and high-income economies.

Finally, the results on the mean difference for banks in high-income economies presented in panel C revealed that high-income banks' productivity (TFPCH) is higher in most of the years (except 2012). Most of the results show significance at levels 1% and 10% for the years 2011, 2017, 2018, and 2020 under parametric and nonparametric tests. This indicates that banks in high-income economies are more productive than those in lower-middle and upper-middle-income economies due to the better quality of the credit portfolio and the allocation efficiency in the credit market of high-income economies. This argument has been supported by the result of the mean difference in the overall years, which shows that the mean difference for banks in high-income economies is higher than other banks in lower- and upper-middle-income economies and significant at levels 1% and 5% in both tests. The detailed components of the TECHCH, EFFCH, PECH, and SECH also appear to have a higher mean difference than all other components, and most of the findings are significant except for the TECHCH in all tests.

Banks-specific characteristics and macroeconomic conditions' impact on banks' productivity

Tables 5–8 show the regression analysis results of the bank-specific characteristics and macroeconomic conditions of banks' productivity in lower-middle-, upper-middle-, high-income, and all-income-level economies. The explanatory power of the models is within expectations given that R squared and adjusted R squared values are consistent with empirical priors (e.g.: Kamarudin *et al*., 2022). In addition, the F statistic of the models is significant at 1% providing evidence of joint significance of predictors in the model which provide further confidence in the techniques employed to perform the analysis and the results provide a meaningful fit to the data. Using the BPLM test, the chi-square (χ^2) is significant at the level of 1% in all models (Models 1–4) in all tables (Tables 5–8). This indicates that the panel data are most appropriate for use in the GLS analysis under the FE and RE estimation methods. Furthermore, the χ^2 for the Hausman test exhibits significance at the level of 1% in lower-middle- and all-income level economies under Tables 5 and 8 in all models (Models 1–4). However, it is insignificant in the upper-middle- and high-income economies under Tables 6 and 7 in all models (Models 1–4). Thus, this indicates all the explanations of the statistical results of the bank-specific characteristics and macroeconomic conditions to the bank productivity in lower-middle and all-income-level economies are based on the FE estimation method, whereas the RE estimation will be used for the justification of the findings in the upper-middle and high-income economies.

Regarding the effect of the bank-specific characteristics, the overhead expenses do not impact banks' productivity due to the insignificant coefficient of NIETA at all income levels. However, the other determinants of bank-specific characteristics — bank size (LNTA), credit risk (LLPGL), capitalization (TCETA), market power (BDTD), liquidity (LOANSTA), and noninterest expenses over total assets (NIETA) — and macroeconomic conditions — economic growth (GDP), inflation (CPI) and COVID-19 years (COVID) — show a significant relationship with banks' productivity in lower-middle-, upper-middle-, high-income, and all-level-income economies.

Discussion

The banks' size (LNTA) shows a favorable and significant impact on the banks' productivity in lower-middle-, upper-middle-, high-income, and all-level incomes (Tables 5–8). The results revealed that large-scale banks may have additional alternatives for cost-cutting and revenue growth because of their substantial total assets. Moreover, they are more likely to benefit from economies of scale, allowing them to produce more effectively than banks with medium- or small-scale operations (Asteriou *et al.*, 2021). Given that this relationship holds across all income levels, it provides an interesting observation that scale plays an important role across the different classifications of income levels. Thus, confirming the intuitive view, size seems to be a major factor in determining bank performance in these markets and the effect is important over time. Larger banks are more like to benefit from mergers and acquisitions, portfolios of international currencies as well as transactions (Moudud-Ul-Huq, 2021).

The results from Table 7 reveal a significant negative relationship between the impact of credit risk (LLPGL) and the productivity of banks in all four models at levels of 5% and 10% in high-income economies. The finding indicates that banks in high-income economies with higher credit risk tend to exhibit lower productivity levels. This could strengthen the argument that banks with high credit risk will experience lower productivity levels since non-performing loans diminish the overall performance of banks due to the failure of debtors to comply with their obligations to the banks (Bitar *et al.*, 2016; Haque & Brown, 2017; Veeramoothoo & Hammoudeh, 2022). The consistent observation across the income levels indicates that risk management remains an important element in ensuring bank performance. It is thus imperative in ensuring bank efficiency over time and is important to the stability of the banking sector which is consistent with the findings in the literature (Siddique *et al*., 2021; Abdelaziz *et al*., 2022) .

The capitalization (TCETA) provides significant positive results at the level of 5% for bank productivity only in upper-middle-income economies presented in Table 6, specifically in Models 3 and 4. The high capital levels reduce borrowing costs, which are predicted to lessen the risk of financial distress and provide more protection against negative shocks, while simultaneously providing more potential for better productivity levels (Hassan, 2020). The results indicate that the growth in efficiency arising from in-

creased capitalization is captured at the upper-middle income countries, which potentially arises from enhanced reputation and increased confidence that outweigh losses brought about by increased capital reserves requirements. Our results provide additional insights into the argument from Mirzaei and Samet (2022) that capitalization plays an important role across different macro-prudential regimes. The findings also contrast the findings in the literature on European banks, where capital is found to not significantly affect banks' performance (Adelopo *et al*., 2022).

The findings across all-income-level economies point to a strong negative relationship between market power (BDTD) and bank productivity. Since expanding and maintaining market share may require additional costs and inputs, the negative link between market power and bank productivity over time suggests that a limited market share may result in higher productivity because fewer costs are involved. Our findings are inline with the arguments in the literature where lenders with higher market shares tend to charge lower loan rates (Saidi & Streitz, 2021). Additionally, weak competition and high costs due to banks' large market share influence banks to ignore cost control, impairs their productivity over time, thus supporting the notion proposed in the literature where market power is a useful predictor of differences in bank efficiency (Egan *et al*., 2022)

However, banks' productivity is only significantly positively correlated with liquidity (LOANSTA) in lower-middle-income economies and all-income-level economies (Tables 5 and 8). This could be due to increased liquidity that encourages banks to extend loans by boosting and raising their volumes in the market, which enables banks to increase productivity over time where it can be seen that there is heterogeneity in the ability of banks to capture gains in efficiency by the degree of liquidity which lends support to findings in the literature where liquidity requirements have a limited influence on bank performance but is rather aimed at ensuring stability in the banking sector (Adelopo *et al*., 2022).

The reliability of the results will next be evaluated by looking at the macroeconomic condition factors as additional control variables. It has been demonstrated that the GDP coefficient can positively or negatively impact the productivity of banks. From one side, economic growth greatly and favors banks' productivity in all-income-level economies, ranging from 1% to 5%. (Table 8). Countries with higher per capita incomes may draw more deposits and produce more cash flow than countries with lower incomes as economic growth is proven to be a major driver of financial de-

velopment, which benefits bank efficiency (Nasreen *et al*., 2020). On the other hand, the results show that in lower-middle-income economies, the GDP coefficient negatively and significantly impacts banks' productivity over time. Banks might face a weaker demand for their financial services, increased loan defaults, and consequently poorer output because of erratic economic growth and thus adversely affect bank efficiency when faced with such uncertainties in the macro-environment (Ullah *et al*., 2022)

Furthermore, the inflation rate (CPI) shows a 1% negative level association with the productivity of banks in lower-middle-income economies (Table 5) and all-income-level economies (Table 8). The negative sign and insignificant level demonstrate that banks in economies with a higher (lower) CPI tend to dominate at lower (higher) productivity levels. This could support the notion that bank management neglects to assess future unanticipated inflation and execute cost adjustments properly, causing costs to grow faster than revenue. The literature also documents mixed findings in different inflationary regimes (Le *et al*., 2023).

Finally, it is discovered that the impact of COVID-19 had a significant negative impact at the level of 1% on banks' productivity in lower-middle, upper-middle-, and all-income-level economies, as shown in all tables and models (except Table 7). This indicates that during the COVID-19 pandemic the banks' total credit supply remained unchanged, loan loss provisions inclined, non-performing loans, borrowers, and banks became more vulnerable, stock returns declined, and undercapitalization were reasons for the lower productivity of banks. These findings are consistent with those of Hasan *et al.* (2009). However, in Table 7 (all models), the opposite verdicts reveal that COVID-19 had a positive and significant impact at the level of 1% on the banks' productivity in high-income economies. This could be due to the institutional environment and financial development system, larger bank size, well-diversified banks, high liquidity, the better health care system and low market competition (Demirgüç-Kunt *et al*., 2021; Hu & Zhang, 2021; Jubilee *et al*., 2022; Mateev & Bachvarov, 2021; Xiazi & Shabir, 2022).

Do regulatory efficiency, market openness, and economic freedom promote banks' productivity?

To address the question of whether regulatory efficiency and market openness in terms of economic freedom matter in determining the banks'

productivity of banks in lower-middle-, upper-middle-, high-income, and all-income-level economies, this study included four indices of economic freedom in all equation models (Tables 5–8 in all Models 1–4). Business freedom (lnBF) and labor freedom (lnLF) indices were used to measure regulatory efficiency, while market openness used financial freedom (lnFF) and investment freedom (lnIF) indices.

The empirical results in Tables 4" 5, and 7 indicate that business freedom (lnBF) coefficients are statistically significant at 1% to banks' productivity in lower-middle, upper-middle-, and all-income-level economies. However, business freedom has a mixed impact on all-income-level economies. From one side, the coefficient of lnBF under Model 1 significantly negatively impacts banks' productivity in lower-middle- and all-income-level economies. The researchers found that the easier (harder) it was for banks to launch, run, and shut down a business, the lower (higher) their output. The results also demonstrate that granting banks more freedom to open, run, and shut down enterprises on the market lowers their net interest margins. A plausible explanation is that easier access to licenses would lead to more competition, reducing banks' productivity. The findings are in-line with similar studies, where it was found that increased competition makes banks less efficient (Sufian & Habibullah, 2010a; Sufian & Habibullah, 2010b).

On the other hand, the business freedom index (lnBF) described an opposite finding, since the lnBF shows a positive impact on the productivity of banks in the upper-middle- and high-income economies, but only banks in upper-middle-income economies show significance at the level of 1% in Table 5 under Model 1. This implies that the business freedom in upper-middle- and high-income countries enables banks to easily and swiftly start, get licenses, and close their businesses. In fact, businesses in upper-middle-income economies require 20 days on average to start a business and only 11 days in high-income economies, while the longest is in lower-middle-income economies, which require 24 days. Thus, due to the short time requirement to start their business, banks manage to ensure the efficiency of regulations at the optimum level to set up strategies, operations, and capital. Whilst our results somewhat concur to the literature (Asteriou *et al*., 2021), the variation in results provide an avenue which would require further investigation for future studies. According to Dietrich and Wanzenried (2014) and Hassan (2020), banks in middle-income economies are better capitalized than those in low-income economies, which indicates that

banks in middle-income economies are better capitalized than in low- and high-income countries, leading to high banks' productivity. Thus, these banks are able to better capitalize from scale. However, the results suggest that business freedom significantly and negatively impacts banks' productivity in all-income-level economies, as shown in Table 7, Model 1. The results are attributed to increased competition eroding banks performance (Rakshit & Bardhan, 2022).

Considering the effect of labor freedom (lnLF), the empirical results in Tables 5 and 7 in Model 2 show significant positive results for banks' productivity at the level of 1% in upper-middle- and all-income-level economies. The results imply that greater labor freedom contributes to higher banks' productivity, since banks are given more freedom to freely employ, make a contract, and remove redundant labor based on their own demand. This will allow banks to construct their regulations on hiring, managing, and monitoring their own staff to ensure the staff's quality and cost efficiency and decrease corruption via supervision and regulation. The standard set by banks to train their own staff, which is not restricted by any regulations, will increase the skills and knowledge of the staff without any barriers. Furthermore, because of the bank's flexibility to freely contract people and remove excessive labor, the bank might reduce the cost of personnel expenses, such as paying staff wages. The issue of corruption among the staff could be minimized or eliminated since the banks could apply their own standard bank regulation and supervision without any intervention from the physical policy, government, or labor unions. In general, labor freedom positively impacts banks' productivity in all-income-level economies since banks could optimize their in-house regulations. Our findings lend credence to the emerging evidence in the market whereby labor mobility is associated with lower cost structures for the banking sector (Al-Gasaymeh, 2020).

Turning to the impact of market openness and the dimension of economic freedom on the banks' productivity in lower-middle, upper-middle, high-income economies, and all-income-level economies, it can be observed from the financial freedom and investment freedom indices in Model 3 in Tables 4 to 7. The bank's capacity to make independent financial decisions without intervention from governmental oversight and referring to Tables 4, 5, and 7 in Model 3, the financial freedom (lnFE) coefficient is negative and statistically significant at 1% and 5%, respectively. Empirical results clearly show that financial freedom and banks' productivity are negatively

related in lower-middle-, high-income, and all-income-level economies, and this suggests that the government should intervene in the banking industry to provide qualified advice on financial decisions. This kind of relationship implies that financial security and immunity from governmental supervision have a detrimental effect on banks' output. Despite the tremendous financial freedom provided to banks, the costs of diversification implementation typically outweigh the savings resulting from economies-of-scale among banks. The increasing number of banks entering the market with higher levels of financial freedom could result in higher costs to exploit resources that could be physical capital, technology, or human capital necessary to compete effectively in the financial market.

Government or authority intervention is required to lower costs by introducing and forcing regulations to permit foreign nations to supply more labor at lower wages, grant a tax exemption or rate reduction to banks that invest in high-tech equipment, and manage competition between banks. This finding, however, is at odds with research findings by Chortareas *et al.* (2013), Masrizal *et al.* (2022), and Sarpong-Kumankoma *et al.* (2020), which suggest that banks may be more likely to adopt competitive policies when operating in a less constrained environment than other financial intermediaries, leading to higher levels of operational and other efficiencies. Our findings are of particular interest given that the literature suggests the potential for moral hazard leading to sub-optimal decision-making during crisis periods arising from government intervention in the form of government guarantees even in markets where such problems tend to be less likely to occur (Acharya, 2021)

Finally, it can be observed from Model 4 in Tables 4, 6, and 7 that the investment freedom (lnIF) relationship to the banks' productivity is negative and significant at the levels of 1% and 5%, respectively in lower-middle-, high-income, and all-income-level economies. The negative impact of investment freedom indicates greater government restrictions on investment and higher bank productivity. The increase in investment freedom influences public investors to freely make any investment without any regulations to comply with and to have varieties to invest according to their preferences, a matter that negatively impacts possible investments in banking industries. In addition, this finding on the impact of investment freedom is similar to the impact of financial freedom on banks' productivity since more freedom given to the banking sector will contribute to lower productivity due to the lack of government intervention in providing pro-

fessional advice and formulating good policies to support the banks performance. Uncontrollable investment activities may lead to high default investment and increased inflation, affecting banks' productivity. The empirical findings obviously show that increased (decreased) government interference in the market boosts (declines) banks' productivity, particularly in lower-middle, high-income, and all-income-level economies. The findings are consistent with Athari and Bahreini (2023) where regulatory control tends to lead to increased bank profitability.

A monetary policy characterized by stability and reliability is important to the business environment. It can support firms and societies to invest their money, save, and implement long-term plans. However, the increased inflation rates not only absorb the wealth but also mismanage resources, distort pricing, and increase business costs. The value of a currency significantly influences the monetary policy of a country. When a prudent monetary policy is in place to contain inflation and preserve price stability, businesses can rely on market prices for their long-term investment plans. The government could, therefore, manage increases in the prices dominated by market leaders by enforcing price controls, even if stability of prices is the ideal situation for a free market. Should anything be investigated, the negative investment freedom would support government interference in the market and highlight the significance of pricing and exchange rate regulations on the productivity of the banking sectors in lower-middle, high-income, and all-income-level economies.

In summary, regulatory efficiency and the dimension of economic freedom, measured by lnBF and lnLF, significantly negatively and positively influence banks' productivity changes in all-income-level economies indicating potential gains over time. The issue of starting, getting the licenses, and closing the business under business freedom negatively influences banks' productivity. Meanwhile, the hiring, management, and monitoring the staff's issues under labor freedom significantly and positively impact banks' productivity. Furthermore, both the lnFF and lnIF indices under the market openness dimension significantly and negatively influence banks' productivity changes across time in all-income-level economies. The government or authority's intervention was needed to introduce and implement regulations that would allow foreign nations to supply more labor at lower wages, grant a tax exemption or rate reduction to banks that invested in high-tech equipment, and manage competition between banking sectors

to minimize costs, in addition to avoiding dumping of uninvested funds and controlling the increasing inflation rates.

Conclusions

This paper's main objective is to investigate banks' productivity levels and the effect of economic freedom, namely regulatory efficiency, and market openness, on banks' productivity in lower-middle-, upper-middle-, and high-income economies in 15 countries over the years 2011 and 2021. This study provides two levels of analysis: at the first level, the score of banks' productivity which captures changes between time periods is identified using the DEA-MPI approach, and parametric (t-test) and nonparametric (Mann–Whitney [Wilcoxon] and Kruskal–Wallis) tests are applied to test the significant differences in the banks' productivity levels among the three levels of income. Then, OLS, FE, and RE panel multiple regression were utilized to analyze the effect of regulatory efficiency, market openness, economic freedom, and other determinants on banks' productivity in the second stage.

The result of the DEA-MPI approach showed that the TFPCH of high-income banks has increased by 49.2% (1.492), which is the biggest increase compared to lower-middle-income and upper-middle-income banks. The growth in EFFCH of 70.5% (1.705) has significantly contributed to the banks' TFPCH progress and displays the highest score rather than both lower- and upper-middle-income. Furthermore, the banks appear to have experienced a TECHCH decline of −8.6%. (0.914). Since the PECH geometric mean score was higher than the SECH's (1.623 > 1.180), the growth in the banks' EFFCH was mostly due to managerial effectiveness, rather than scale, according to the deconstruction of the EFFCH index into its PECH and SECH components. In addition, banks in high-income economies are more productive than banks operating in lower-middle-, and upper-middle-income economies due to the better credit portfolio quality and credit mark*et al*location efficiency in the high-income economies. This argument has been supported by the result of the mean difference in the overall years that shows that the high-income banks are higher than other banks in lower and upper-middle-income and significant at 1% and 5% in both tests.

The panel regression analysis results summarized the effect of bank-specific characteristics: the overhead expenses do not impact banks' productivity due to the insignificant coefficient of NIETA at all income levels. However, the other determinants of banks-specific characteristics — bank size (LNTA), credit risk (LLPGL), capitalization (TCETA), market power (BDTD) and liquidity (LOANSTA) — and macroeconomic condition — economic growth (GDP), inflation (CPI) and COVID19 years (COVID) shows — a significant relationship with bank productivity in lower-middle-, upper-middle-, high-income, and all-income-level economies. Additionally, as assessed by business freedom (lnBF) and labor freedom (lnLF), regulatory effectiveness has a considerable negative and positive influence on banks' productivity in all-income-level economies.

Looking at contributing towards the role of business freedom, our study finds that the matters of starting, obtaining permits, and shutting down businesses have a detrimental effect on banks' output indicating that business freedom as an important determinant in enhancing bank performance and the effect is evident across time given the DEA-MPI captures changes across the observed time period. Next, looking at the freedom of movement of labor, our study documents banks' freedom effects on employing, managing, and supervision of staff members have a substantial favorable impact on productivity changes across time. Furthermore, in all-income-level economies, the financial freedom (lnFF) and investment freedom (lnIF) indices under the market openness dimension tend to negatively influence banks' productivity changes across the observed time period. Government or authority intervention is required to introduce and put into effect regulations that would allow foreign countries to supply more labor at lower wages, provide tax breaks or rate reductions to banks that invested in high-tech equipment, manage competition between banks to reduce costs, avoid the dump of uninvested assets, and control the rises in inflation rates.

The empirical findings of this study could be valuable and have important consequences for regulators, bankers, investors, and academics in lower-middle, upper-middle, and high-income economies. Regulators or policymakers can devise measures to boost productivity, resulting in increased profitability for the banking sector which could lead to greater resilience in times of crisis. It is clear that whilst business freedom and labor freedom enhance bank performance via increased efficiency changes across time, financial and investment freedom impedes efficiency changes. Thus, our study contributes to the literature by providing the basis of mar-

ket openness whilst ensuring robust regulatory regimes to enhance bank efficiency which in turn increases the access of capital for firms and thus leads to economic growth and prosperity.

TFP significantly indicates a bank's high or low profitability. Accordingly, the study findings help investors efficiently allocate their investment portfolios by analyzing the banks' performance in various income-level economies. Finally, limited research on regulatory efficiency and market openness in lower-middle-, upper-middle-, and high-income exists. Therefore, academics will be able to fill these scholarly gaps using the empirical findings of this study.

The current study is limited from the perspective of considering the bank specific factors such as capitalization and size in tandem with regulatory efficiency and market efficiency in a single model. Thus, whilst our analysis provides meaningful insights it does not consider the joint effect of these endogenous and exogenous factors within a singular framework across the different income levels. Thus, future studies are delegated the task of providing a more in-depth analysis which considers the combined effect of these predictors of bank performance in order to capture and understand the non-additive effects as well as potential conditional effects that may arise. It is likely that such an analysis would provide additional contributions to the literature whilst improving the predictive power to further explain the effects observed in the context of the current study. Furthermore, the current study does not consider the effect arising from different market structures which lead to systemic risks that could undermine economic freedom and regulatory efficiency and thus affecting bank efficiency. Future studies aimed at recognizing this effect would provide further insights of the findings discussed in the current study. Lastly, our study highlights the potential for moral hazard in the banking sector arising from potential government intervention leading to excessive risk taking or sub-optimal decision making by the banking sector. Thus, this merits further investigation on the consequences of such potential especially during times of crisis across different regulatory frameworks and governance structures.

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Annex

Table 1. GNI Per Capita 2021 of sample countries

No	Country Name	GNI Per Capita 2021 (Atlas Method)	WDI Classification
1	Pakistan	1,470.00	Lower Middle
2	Bangladesh	2,570.00	Lower Middle
3	Iran, Islamic Rep.	3,510.00	Lower Middle
4	Egypt, Arab Rep.	3,520.00	Lower Middle
5	Indonesia	4,170.00	Lower Middle
6	Jordan	4,210.00	Lower Middle
7	Lebanon	4,970.00	Upper Middle
8	Malaysia	10,740.00	Upper Middle
9	Oman	17,960.00	High Income
10	Saudi Arabia	24,030.00	High Income
11	Bahrain	24,720.00	High Income
12	Kuwait	34,850.00	High Income
13	United Arab Emirates	43,590.00	High Income
14	Qatar	62,400.00	High Income
15	Singapore	63,000.00	High Income

Source: World Development Indicator, World Bank.

Table 2. Banks' productivity index decompositions under DEA-MPI

Year	DEA-MPI Decompositions					Year	DEA-MPI Decompositions				
	TFPCH	**EFFCH**	**TECHCH**	**PECH**	**SECH**		**TFPCH**	**EFFCH**	**TECHCH**	**PECH**	**SECH**
	Panel A: Lower-Middle-Income Economies						*Panel B: Upper-Middle-Income Economies*				
2010	1.000	1.000	1.000	1.000	1.000	2010	1.000	1.000	1.000	1.000	1.000
2011	0.978	1.416	0.681	1.525	1.087	2011	1.238	2.527	0.582	2.632	1.125
2012	1.223	1.404	0.914	1.325	1.106	2012	1.263	1.495	0.903	1.483	1.140
2013	1.290	1.341	0.983	1.337	1.039	2013	1.029	1.061	1.026	0.957	1.145
2014	1.092	1.950	0.696	1.563	1.228	2014	1.315	1.601	0.892	1.594	1.033
2015	1.149	1.314	0.900	1.228	1.072	2015	1.007	1.327	0.787	1.200	1.196
2016	1.219	1.245	1.012	1.244	1.021	2016	1.525	1.567	1.011	1.470	1.311
2017	1.359	1.467	0.960	1.345	1.126	2017	1.373	1.608	0.871	1.350	1.352
2018	1.239	1.289	1.002	1.235	1.155	2018	1.386	1.366	1.019	1.605	0.941
2019	1.297	1.312	1.004	1.299	1.061	2019	1.419	1.449	0.994	1.462	1.098
2020	1.315	1.446	0.892	1.250	1.188	2020	1.164	1.382	0.870	1.203	1.203
2021	1.316	1.362	0.984	1.285	1.120	2021	1.366	1.386	0.982	1.539	1.065
Geometric Mean	***1.200***	***1.364***	***0.911***	***1.296***	***1.098***	*Geometric Mean*	***1.246***	***1.443***	***0.902***	***1.410***	***1.128***

Table 2. Continued

Year	DEA-MPI Decompositions					Year	DEA-MPI Decompositions				
	TFPCH	EFFCH	TECHCH	PECH	SECH		TFPCH	EFFCH	TECHCH	PECH	SECH
	Panel C: Higher-Income Economies						*Panel D: All Levels Income Economies*				
2010	1.000	1.000	1.000	1.000	1.000	2010	1.000	1.000	1.000	1.000	1.000
2011	2.194	4.472	0.596	3.149	1.718	2011	1.265	2.256	0.681	2.104	1.211
2012	1.567	1.900	0.921	1.769	1.214	2012	1.297	1.519	0.914	1.448	1.135
2013	1.700	1.847	0.932	1.968	1.187	2013	1.298	1.361	0.983	1.354	1.093
2014	1.445	1.498	1.027	1.573	0.963	2014	1.215	1.778	0.808	1.572	1.129
2015	1.177	1.703	0.754	1.034	1.633	2015	1.120	1.393	0.844	1.184	1.211
2016	1.362	1.303	1.043	1.492	0.928	2016	1.322	1.336	1.018	1.348	1.074
2017	1.887	2.125	0.887	2.008	1.252	2017	1.466	1.630	0.924	1.477	1.205
2018	1.182	1.090	1.092	1.199	1.077	2018	1.265	1.270	1.002	1.321	1.086
2019	1.651	1.746	0.966	2.118	1.049	2019	1.396	1.429	1.004	1.496	1.069
2020	1.544	1.840	0.845	1.519	1.319	2020	1.318	1.501	0.892	1.286	1.215
2021	1.580	1.553	1.047	1.628	1.086	2021	1.377	1.403	0.984	1.414	1.099
Geometric Mean	***1.492***	***1.705***	***0.914***	***1.623***	***1.180***	***Geometric Mean***	***1.272***	***1.463***	***0.915***	***1.396***	***1.125***

Note: TFPCH = Total Factor Productivity Change, TECHCH = Technology Change, EFFCH = Efficiency Change, PECH = Pure Technical Efficiency change, SECH = Scale Efficiency Change

Table 3a. Number and percentage of lower-middle-, upper-middle-, high-income economies banks with productivity progress, regress and stagnant

Year	TFPCH						EFFCH						TECHCH					
	Progress		Regress		No D		Progress		Regress		No D		Progress		Regress		No D	
	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)
Panel A: Lower-Middle-Income																		
2010-2011	62	(38.75%)	65	(40.63%)	33	(20.63%)	85	(53.13%)	70	(43.75%)	5	(3.13%)	77	(48.13%)	82	(51.25%)	1	(0.63%)
2011-2012	76	(47.50%)	58	(36.25%)	26	(16.25%)	108	(67.50%)	47	(29.38%)	5	(3.13%)	36	(22.50%)	124	(77.50%)	0	(0.00%)
2012-2013	92	(58.23%)	65	(41.14%)	1	(0.63%)	76	(48.10%)	77	(48.73%)	5	(3.16%)	88	(55.70%)	70	(44.30%)	0	(0.00%)
2013-2014	95	(55.56%)	75	(43.86%)	1	(0.58%)	97	(56.73%)	66	(38.60%)	8	(4.68%)	43	(25.15%)	128	(74.85%)	0	(0.00%)
2014-2015	75	(44.91%)	89	(53.29%)	3	(1.80%)	104	(62.28%)	58	(34.73%)	5	(2.99%)	63	(37.72%)	103	(61.68%)	1	(0.60%)
2015-2016	81	(48.50%)	84	(50.30%)	2	(1.20%)	87	(52.10%)	72	(43.11%)	8	(4.79%)	52	(31.14%)	114	(68.26%)	1	(0.60%)
2016-2017	54	(32.34%)	112	(67.07%)	1	(0.60%)	62	(37.13%)	104	(62.28%)	1	(0.60%)	49	(29.34%)	117	(70.06%)	1	(0.60%)
2017-2018	133	(76.00%)	42	(24.00%)	0	(0.00%)	165	(94.29%)	10	(5.71%)	0	(0.00%)	8	(4.57%)	167	(95.43%)	0	(0.00%)
2018-2019	51	(32.28%)	64	(40.51%)	43	(27.22%)	67	(42.41%)	87	(55.06%)	4	(2.53%)	80	(50.63%)	77	(48.73%)	1	(0.63%)
2019-2020	42	(26.25%)	38	(23.75%)	80	(50.00%)	113	(70.63%)	32	(20.00%)	15	(9.38%)	21	(13.13%)	119	(74.38%)	20	(12.50%)
2020-2021	51	(32.08%)	58	(36.48%)	50	(31.45%)	100	(62.89%)	54	(33.96%)	5	(3.14%)	28	(17.61%)	126	(79.25%)	5	(3.14%)
Panel B: Upper-Middle-Income																		
2010-2011	31	(44.93%)	36	(52.17%)	2	(2.90%)	39	(56.52%)	28	(40.58%)	2	(2.90%)	22	(31.88%)	47	(68.12%)	0	(0.00%)
2011-2012	37	(50.68%)	31	(42.47%)	5	(6.85%)	39	(53.42%)	31	(42.47%)	3	(4.11%)	25	(34.25%)	48	(65.75%)	0	(0.00%)
2012-2013	40	(52.63%)	31	(40.79%)	5	(6.58%)	38	(50.00%)	35	(46.05%)	3	(3.95%)	37	(48.68%)	38	(50.00%)	1	(1.32%)
2013-2014	39	(51.32%)	35	(46.05%)	2	(2.63%)	47	(61.84%)	28	(36.84%)	1	(1.32%)	16	(21.05%)	60	(78.95%)	0	(0.00%)
2014-2015	45	(56.96%)	32	(40.51%)	2	(2.53%)	53	(67.09%)	24	(30.38%)	2	(2.53%)	32	(40.51%)	47	(59.49%)	0	(0.00%)
2015-2016	26	(34.21%)	46	(60.53%)	4	(5.26%)	27	(35.53%)	45	(59.21%)	4	(5.26%)	31	(40.79%)	44	(57.89%)	1	(1.32%)
2016-2017	27	(35.53%)	48	(63.16%)	1	(1.32%)	39	(51.32%)	37	(48.68%)	0	(0.00%)	8	(10.53%)	68	(89.47%)	0	(0.00%)
2017-2018	64	(79.01%)	17	(20.99%)	0	(0.00%)	72	(88.89%)	9	(11.11%)	0	(0.00%)	7	(8.64%)	74	(91.36%)	0	(0.00%)
2018-2019	42	(60.00%)	24	(34.29%)	4	(5.71%)	41	(58.57%)	29	(41.43%)	0	(0.00%)	38	(54.29%)	31	(44.29%)	1	(1.43%)
2019-2020	31	(45.59%)	19	(27.94%)	18	(26.47%)	45	(66.18%)	20	(29.41%)	3	(4.41%)	19	(27.94%)	47	(69.12%)	2	(2.94%)
2020-2021	28	(40.58%)	36	(52.17%)	5	(7.25%)	39	(56.52%)	28	(40.58%)	2	(2.90%)	6	(8.70%)	63	(91.30%)	0	(0.00%)
Panel C: High-Income																		
2010-2011	34	(60.71%)	21	(37.50%)	1	(1.79%)	36	(64.29%)	18	(32.14%)	2	(3.57%)	19	(33.93%)	37	(66.07%)	0	(0.00%)
2011-2012	28	(50.00%)	28	(50.00%)	0	(0.00%)	25	(44.64%)	30	(53.57%)	1	(1.79%)	23	(41.07%)	33	(58.93%)	0	(0.00%)
2012-2013	28	(51.85%)	25	(46.30%)	1	(1.85%)	28	(51.85%)	24	(44.44%)	2	(3.70%)	30	(55.56%)	24	(44.44%)	0	(0.00%)
2013-2014	27	(50.00%)	27	(50.00%)	0	(0.00%)	32	(59.26%)	21	(38.89%)	1	(1.85%)	8	(14.81%)	46	(85.19%)	0	(0.00%)
2014-2015	24	(44.44%)	30	(55.56%)	0	(0.00%)	20	(37.04%)	34	(62.96%)	0	(0.00%)	32	(59.26%)	22	(40.74%)	0	(0.00%)
2015-2016	24	(44.44%)	29	(53.70%)	1	(1.85%)	28	(51.85%)	25	(46.30%)	1	(1.85%)	18	(33.33%)	36	(66.67%)	0	(0.00%)
2016-2017	31	(57.41%)	23	(42.59%)	0	(0.00%)	39	(72.22%)	13	(24.07%)	2	(3.70%)	2	(3.70%)	52	(96.30%)	0	(0.00%)
2017-2018	56	(96.55%)	2	(3.45%)	0	(0.00%)	57	(98.28%)	1	(1.72%)	0	(0.00%)	5	(8.62%)	53	(91.38%)	0	(0.00%)
2018-2019	21	(37.50%)	34	(60.71%)	1	(1.79%)	22	(39.29%)	34	(60.71%)	0	(0.00%)	35	(62.50%)	21	(37.50%)	0	(0.00%)
2019-2020	19	(33.93%)	19	(33.93%)	18	(32.14%)	30	(53.57%)	26	(46.43%)	0	(0.00%)	26	(46.43%)	30	(53.57%)	0	(0.00%)
2020-2021	26	(47.27%)	28	(50.91%)	1	(1.82%)	34	(61.82%)	21	(38.18%)	0	(0.00%)	2	(3.64%)	53	(96.36%)	0	(0.00%)

Table 3a. Continued

Year	TFPCH						EFFCH						TECHCH					
	Progress		Regress		No D		Progress		Regress		No D		Progress		Regress		No D	
	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)
Panel D: All Level Incomes																		
2010-2011	127	(44.56%)	122	(42.81%)	36	(12.63%)	160	(56.14%)	116	(40.70%)	9	(3.16%)	118	(41.40%)	166	(58.25%)	1	(0.35%)
2011-2012	141	(48.79%)	117	(40.48%)	31	(10.73%)	172	(59.52%)	108	(37.37%)	9	(3.11%)	84	(29.07%)	205	(70.93%)	0	(0.00%)
2012-2013	160	(55.56%)	121	(42.01%)	7	(2.43%)	142	(49.31%)	136	(47.22%)	10	(3.47%)	155	(53.82%)	132	(45.83%)	1	(0.35%)
2013-2014	161	(53.49%)	137	(45.51%)	3	(1.00%)	176	(58.47%)	115	(38.21%)	10	(3.32%)	67	(22.26%)	234	(77.74%)	0	(0.00%)
2014-2015	144	(48.00%)	151	(50.33%)	5	(1.67%)	177	(59.00%)	116	(38.67%)	7	(2.33%)	127	(42.33%)	172	(57.33%)	1	(0.33%)
2015-2016	131	(44.11%)	159	(53.54%)	7	(2.36%)	142	(47.81%)	142	(47.81%)	13	(4.38%)	101	(34.01%)	194	(65.32%)	2	(0.67%)
2016-2017	112	(37.71%)	183	(61.62%)	2	(0.67%)	140	(47.14%)	154	(51.85%)	3	(1.01%)	59	(19.87%)	237	(79.80%)	1	(0.34%)
2017-2018	253	(80.57%)	61	(19.43%)	0	(0.00%)	294	(93.63%)	20	(6.37%)	0	(0.00%)	20	(6.37%)	294	(93.63%)	0	(0.00%)
2018-2019	114	(40.14%)	122	(42.96%)	48	(16.90%)	130	(45.77%)	150	(52.82%)	4	(1.41%)	153	(53.87%)	129	(45.42%)	2	(0.70%)
2019-2020	92	(32.39%)	76	(26.76%)	116	(40.85%)	188	(66.20%)	78	(27.46%)	18	(6.34%)	66	(23.24%)	196	(69.01%)	22	(7.75%)
2020-2021	105	(37.10%)	122	(43.11%)	56	(19.79%)	173	(61.13%)	103	(36.40%)	7	(2.47%)	36	(12.72%)	242	(85.51%)	5	(1.77%)

Note: Progressive in productivity: TFPCH > 1, regressive in productivity: TFPCH < 1, stagnancies in productivity: TFPCH = 1, progressive in technological changes: TECHCH > 1, regressive in technological changes: TECHCH < 1, stagnancies in technological changes: TECHCH = 1; progressive in efficiency, pure technical and scale efficiency changes: EFFCH, PTECH and SECH > 1, regressive in efficiency, pure technical and scale efficiency changes: EFFCH, PTECH and SECH < 1, stagnancies in efficiency, pure technical and scale efficiency changes: EFFCH, PTECH and SECH = 1

Table 3b. Number and percentage of lower-middle-, upper-middle-, high-income economies banks with productivity progress, regress and stagnant – Continued

Year	PECH						SECH					
	Progress		Regress		No D		Progress		Regress		No D	
	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)
Panel A: Lower-Middle-Income												
2010-2011	94	(58.75%)	58	(36.25%)	8	(5.00%)	68	(42.50%)	62	(38.75%)	30	(18.75%)
2011-2012	92	(57.50%)	60	(37.50%)	8	(5.00%)	70	(43.75%)	66	(41.25%)	24	(15.00%)
2012-2013	81	(51.27%)	70	(44.30%)	7	(4.43%)	57	(36.08%)	76	(48.10%)	25	(15.82%)
2013-2014	99	(57.89%)	61	(35.67%)	11	(6.43%)	59	(34.50%)	87	(50.88%)	25	(14.62%)
2014-2015	93	(55.69%)	62	(37.13%)	12	(7.19%)	83	(49.70%)	60	(35.93%)	24	(14.37%)
2015-2016	86	(51.50%)	69	(41.32%)	12	(7.19%)	65	(38.92%)	82	(49.10%)	20	(11.98%)
2016-2017	56	(33.53%)	109	(65.27%)	2	(1.20%)	66	(39.52%)	100	(59.88%)	1	(0.60%)
2017-2018	161	(92.00%)	14	(8.00%)	0	(0.00%)	123	(70.29%)	52	(29.71%)	0	(0.00%)
2018-2019	89	(56.33%)	61	(38.61%)	8	(5.06%)	44	(27.85%)	93	(58.86%)	21	(13.29%)
2019-2020	115	(71.88%)	31	(19.38%)	14	(8.75%)	84	(52.50%)	50	(31.25%)	26	(16.25%)
2020-2021	92	(57.86%)	58	(36.48%)	9	(5.66%)	74	(46.54%)	61	(38.36%)	24	(15.09%)
Panel B: Upper-Middle-Income												
2010-2011	33	(47.83%)	32	(46.38%)	4	(5.80%)	40	(57.97%)	20	(28.99%)	9	(13.04%)
2011-2012	44	(60.27%)	23	(31.51%)	6	(8.22%)	25	(34.25%)	36	(49.32%)	12	(16.44%)
2012-2013	37	(48.68%)	35	(46.05%)	4	(5.26%)	29	(38.16%)	41	(53.95%)	6	(7.89%)
2013-2014	41	(53.95%)	34	(44.74%)	1	(1.32%)	40	(52.63%)	27	(35.53%)	9	(11.84%)
2014-2015	46	(58.23%)	31	(39.24%)	2	(2.53%)	33	(41.77%)	36	(45.57%)	10	(12.66%)
2015-2016	23	(30.26%)	49	(64.47%)	4	(5.26%)	28	(36.84%)	36	(47.37%)	12	(15.79%)
2016-2017	32	(42.11%)	43	(56.58%)	1	(1.32%)	36	(47.37%)	38	(50.00%)	2	(2.63%)
2017-2018	68	(83.95%)	13	(16.05%)	0	(0.00%)	71	(87.65%)	9	(11.11%)	1	(1.23%)
2018-2019	46	(65.71%)	22	(31.43%)	2	(2.86%)	23	(32.86%)	41	(58.57%)	6	(8.57%)
2019-2020	48	(70.59%)	16	(23.53%)	4	(5.88%)	28	(41.18%)	32	(47.06%)	8	(11.76%)
2020-2021	36	(52.17%)	30	(43.48%)	3	(4.35%)	40	(57.97%)	19	(27.54%)	10	(14.49%)
Panel C: Higher-Income												
2010-2011	35	(62.50%)	18	(32.14%)	3	(5.36%)	26	(46.43%)	25	(44.64%)	5	(8.93%)
2011-2012	23	(41.07%)	30	(53.57%)	3	(5.36%)	25	(44.64%)	25	(44.64%)	6	(10.71%)
2012-2013	29	(53.70%)	22	(40.74%)	3	(5.56%)	17	(31.48%)	33	(61.11%)	4	(7.41%)
2013-2014	28	(51.85%)	24	(44.44%)	2	(3.70%)	32	(59.26%)	17	(31.48%)	5	(9.26%)
2014-2015	21	(38.89%)	32	(59.26%)	1	(1.85%)	23	(42.59%)	26	(48.15%)	5	(9.26%)
2015-2016	24	(44.44%)	29	(53.70%)	1	(1.85%)	22	(40.74%)	27	(50.00%)	5	(9.26%)
2016-2017	38	(70.37%)	14	(25.93%)	2	(3.70%)	33	(61.11%)	20	(37.04%)	1	(1.85%)
2017-2018	55	(94.83%)	3	(5.17%)	0	(0.00%)	51	(87.93%)	7	(12.07%)	0	(0.00%)
2018-2019	27	(48.21%)	29	(51.79%)	0	(0.00%)	18	(32.14%)	34	(60.71%)	4	(7.14%)
2019-2020	37	(66.07%)	18	(32.14%)	1	(1.79%)	19	(33.93%)	32	(57.14%)	5	(8.93%)
2020-2021	25	(45.45%)	30	(54.55%)	0	(0.00%)	38	(69.09%)	13	(23.64%)	4	(7.27%)

Table 3b. Continued

Year	PECH						SECH					
	Progress		Regress		No D		Progress		Regress		No D	
	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)
Panel D: All Level Incomes												
2010-2011	162	(56.84%)	108	(37.89%)	15	(5.26%)	134	(47.02%)	107	(37.54%)	44	(15.44%)
2011-2012	159	(55.02%)	113	(39.10%)	17	(5.88%)	120	(41.52%)	127	(43.94%)	42	(14.53%)
2012-2013	147	(51.04%)	127	(44.10%)	14	(4.86%)	103	(35.76%)	150	(52.08%)	35	(12.15%)
2013-2014	168	(55.81%)	119	(39.53%)	14	(4.65%)	131	(43.52%)	131	(43.52%)	39	(12.96%)
2014-2015	160	(53.33%)	125	(41.67%)	15	(5.00%)	139	(46.33%)	122	(40.67%)	39	(13.00%)
2015-2016	133	(44.78%)	147	(49.49%)	17	(5.72%)	115	(38.72%)	145	(48.82%)	37	(12.46%)
2016-2017	126	(42.42%)	166	(55.89%)	5	(1.68%)	135	(45.45%)	158	(53.20%)	4	(1.35%)
2017-2018	284	(90.45%)	30	(9.55%)	0	(0.00%)	245	(78.03%)	68	(21.66%)	1	(0.32%)
2018-2019	162	(57.04%)	112	(39.44%)	10	(3.52%)	85	(29.93%)	168	(59.15%)	31	(10.92%)
2019-2020	200	(70.42%)	65	(22.89%)	19	(6.69%)	131	(46.13%)	114	(40.14%)	39	(13.73%)
2020-2021	153	(54.06%)	118	(41.70%)	12	(4.24%)	152	(53.71%)	93	(32.86%)	38	(13.43%)

Note: Progressive in productivity: TFPCH > 1, regressive in productivity: TFPCH < 1, stagnancies in productivity: TFPCH = 1, progressive in technological changes: TECHCH > 1, regressive in technological changes: TECHCH < 1, stagnancies in technological changes: TECHCH = 1; progressive in efficiency, pure technical and scale efficiency changes: EFFCH, PTECH and SECH > 1, regressive in efficiency, pure technical and scale efficiency changes: EFFCH, PTECH and SECH < 1, stagnancies in efficiency, pure technical and scale efficiency changes: EFFCH, PTECH and SECH = 1

Table 4. Parametric and non-parametric robustness test for banks' productivity in lower-middle, upper-middle-, high-income economies

Year	Parametric Test *t*-test t(*Pro>t*)					Mann-Whitney Test (Wilcoxon Rank-Sum) test z(*Pro>z*)					Kruskal-Test Equality of Population test x^2 (*Pro>*x^2)				
	TFPCH	**EFFCH**	**TECHCH**	**PECH**	**SECH**	**TFPCH**	**EFFCH**	**TECHCH**	**PECH**	**SECH**	**TFPCH**	**EFFCH**	**TECHCH**	**PECH**	**SECH**
Panel A: Lower-Middle-Income															
2011	-1.293	1.873[c]	**[3.462[a]]**	-1.540	-1.724[c]	-0.958	-2.186[b]	**[-3.213][a]**	-0.584	-1.813[c]	-0.917	4.777[b]	**[10.326][a]**	-0.341	3.287[c]
2012	-0.458	**[0.365]**	-3.520[a]	-1.199	**[2.104][b]**	-0.108	**[-1.517]**	-3.076[a]	-0.101	**[-2.097][b]**	0.012	**[2.302]**	9.464[a]	0.010	**[4.399][b]**
2013	-1.277	-1.423	**[1.770][c]**	-1.721[c]	-0.248	-0.047	-0.507	**[-1.253]**	-0.210	-1.150	0.002	0.257	**[1.569]**	0.044	1.322
2014	-0.044	-0.685	**[2.751][a]**	-0.499	-0.777	-0.259	-0.921	**[-2.590][b]**	-0.216	-2.669[a]	0.067	0.849	**[6.710][b]**	0.047	7.126[a]
2015	-0.797	-0.563	-1.686[c]	-1.373	**[0.708]**	-0.580	-0.737	-2.156[b]	-0.577	**[-0.665]**	0.337	0.543	4.647[b]	0.333	**[0.442]**
2016	-0.110	-0.271	-0.312	-0.203	-1.590	-1.685[c]	-1.855[c]	-0.822	-2.930[a]	-0.663	2.838[c]	3.441[c]	0.676	8.584[a]	0.439
2017	-3.331[a]	-4.424[a]	**[4.599][a]**	-2.522[b]	-2.417[b]	-2.507[b]	-4.420[a]	**[-4.198][a]**	-4.176[a]	-3.066[a]	6.287[b]	19.538[a]	**[17.624][a]**	17.442[a]	9.399[b]
2018	**[-3.823][a]**	**[-4.350][a]**	1.008	**[-3.533][a]**	**[-2.943][a]**	**[-3.692][a]**	**[-4.021][a]**	-0.807	**[-2.820][a]**	**[-2.886][a]**	**[13.629][a]**	**[16.167][a]**	0.651	**[7.953][a]**	**[8.328][a]**
2019	-1.475	-1.238	-0.628	-1.275	-1.200	-1.072	-0.854	-1.198	-0.764	-0.013	1.150	0.729	1.436	0.584	0.001
2020	-2.228[b]	**[2.527][b]**	-7.436[a]	-0.146	**[4.384][a]**	-1.308	**[-3.201][a]**	-5.947[a]	-1.568	**[-4.634][a]**	1.712	**[10.246][a]**	35.370[a]	2.458	**[21.470][a]**
2021	**[0.573]**	-1.103	**[6.951][a]**	**[0.876]**	-4.091[a]	**[-0.794]**	-0.908	**[-6.660][a]**	**[-1.220]**	-4.001[a]	**[0.630]**	0.825	**[44.349][a]**	**[1.489]**	16.011[a]
All years	-3.852[a]	-4.413[a]	**[0.653]**	-4.007[a]	-2.774[a]	-2.140[b]	-1.973[b]	**[-1.779][c]**	-0.562	-2.099[b]	4.580[b]	3.893[b]	**[3.163][c]**	0.315	4.404[b]
Panel B: Upper-Middle-Income															
2011	-0.572	-0.128	-2.579[b]	-0.774	**[1.676]**	-0.731	-0.440	-2.514[b]	-0.996	**[-2.395][b]**	-0.534	0.193	6.322[b]	-0.992	**[5.738][b]**
2012	**[0.969]**	**[0.843]**	**[0.807]**	**[1.730][c]**	**[-2.303][b]**	**[-0.394]**	**[-0.009]**	**[-1.442]**	**[-1.535]**	**[-2.705][a]**	**[0.155]**	**[0.001]**	**[2.079]**	**[2.356]**	**[7.315][a]**
2013	**[0.171]**	**[0.134]**	-0.563	-0.174	**[0.534]**	**[-0.16]**	**[-0.329]**	-0.608	-0.161	**[-0.470]**	**[0.026]**	**[0.108]**	0.369	0.026	**[0.221]**
2014	-1.364	-0.885	-1.243	-0.583	-0.176	-0.137	-0.543	-1.011	-0.085	-1.306	0.019	0.295	1.021	0.007	1.706
2015	-0.074	-0.122	-0.078	**[0.757]**	-0.634	-1.501	-1.061	-0.500	**[-0.990]**	-0.351	2.254	1.125	0.250	**[0.980]**	0.123
2016	-2.637[a]	-2.726[a]	**[1.690][c]**	-3.595[a]	**[0.841]**	-1.877[b]	-2.567[b]	**[-0.554]**	-3.418[a]	**[-1.093]**	3.522[b]	6.591[b]	**[0.307]**	11.680[a]	**[1.194]**
2017	-0.174	**[0.775]**	-3.106[a]	**[1.118]**	-1.152	-0.804	**[-0.454]**	-2.997[a]	**[-0.454]**	-0.236	0.646	**[0.207]**	8.982[a]	**[0.207]**	0.056
2018	-0.921	-0.484	-1.708[c]	**[0.549]**	**[0.278]**	-0.607	-0.215	-1.860[c]	**[-0.477]**	**[-0.736]**	0.369	0.046	3.459[c]	**[0.228]**	**[0.542]**
2019	**[1.499]**	**[1.618]**	-0.377	**[0.782]**	**[1.971][b]**	**[-2.634][a]**	**[-2.467][b]**	-0.673	**[-1.637]**	**[-0.610]**	**[6.940][a]**	**[6.086][b]**	0.453	**[2.68]**	**[0.372]**
2020	**[0.944]**	-1.331	**[2.735][a]**	**[0.176]**	-2.316[b]	**[-1.709][c]**	-1.049	**[-1.936][b]**	**[-0.195]**	-1.849[c]	**[2.921][c]**	1.100	**[3.747][b]**	**[0.038]**	3.418[c]
2021	-1.121	-0.464	-3.451[a]	**[0.163]**	-0.230	-1.089	-0.191	-3.292[a]	**[-0.047]**	-0.351	1.185	0.037	10.837[a]	**[0.002]**	0.123
All years	-0.629	-0.209	-1.342	**[0.819]**	**[0.2717]**	-0.393	-0.684	-1.704[c]	**[-0.176]**	**[-0.885]**	0.155	0.468	2.903[c]	**[0.031]**	**[0.784]**

Table 4. Continued

Year	Parametric Test *t*-test t(*Pro>t*)					Mann-Whitney Test (Wilcoxon Rank-Sum) test z(*Pro>z*)					Kruskal-Test Equality of Population test x^2 ($Pro>x^2$)				
	TFPCH	EFFCH	TECHCH	PECH	SECH	TFPCH	EFFCH	TECHCH	PECH	SECH	TFPCH	EFFCH	TECHCH	PECH	SECH
								Panel C: High-Income							
2011	**[1.817]**[c]	**[2.070]**[b]	-1.416	**[1.952]**[c]	**[0.462]**	**[-1.984]**[b]	**[-2.256]**[b]	-1.302	**[-1.803]**[c]	**[-0.318]**	**[3.935]**[b]	**[5.088]**[b]	1.696	**[3.249]**[c]	**[0.101]**
2012	-0.642	-1.507	**[2.789]**[a]	-0.776	-0.117	-0.569	-1.898[b]	**[-2.284]**[b]	-1.814[c]	-0.335	0.324	3.604[b]	**[5.217]**[b]	3.290[c]	0.112
2013	**[1.049]**	**[1.214]**	-1.455	**[1.489]**	-0.287	**[-0.121]**	**[-0.275]**	-0.911	**[-0.450]**	-1.997[b]	**[0.015]**	**[0.075]**	0.830	**[0.202]**	3.987[b]
2014	**[0.987]**	**[1.395]**	-2.119[b]	**[0.888]**	**[1.204]**	**[-0.179]**	**[-0.575]**	-2.200[b]	**[-0.375]**	**[-1.967]**[b]	**[0.032]**	**[0.330]**	4.839[b]	**[0.141]**	**[3.870]**[b]
2015	**[0.864]**	**[0.654]**	**[2.279]**[b]	**[0.727]**	-0.188	**[-0.971**	**[-2.169]**[b]	**[-2.214]**[b]	**[-1.881]**[c]	-0.457	**[0.943]**	**[4.704]**[b]	**[4.902]**[b]	**[3.540]**[c]	0.209
2016	**[1.713]**[c]	**[1.929]**[b]	-2.093[b]	**[1.879]**[c]	**[0.740]**	**[-0.044]**	**[-0.519]**	-1.684[c]	**[-0.098]**	**[-0.384]**	**[0.002]**	**[0.269]**	2.837[c]	**[0.010]**	**[0.147]**
2017	**[3.611]**[a]	**[3.763]**[a]	-2.826[a]	**[2.050]**[b]	**[2.984]**[a]	**[-4.134]**[a]	**[-5.171]**[a]	-2.009[b]	**[-4.858]**[a]	**[-3.676]**[a]	**[17.092]**[a]	**[26.742]**[a]	4.037[b]	**[23.598]**[a]	**[13.514]**[a]
2018	**[5.220]**[a]	**[5.210]**[a]	**[0.904]**	**[2.764]**[a]	**[2.773]**[a]	**[-5.410]**[a]	**[-5.388]**[a]	**[-1.064]**	**[-4.148]**[a]	**[-2.864]**[a]	**[29.268]**[a]	**[29.035]**[a]	**[1.133]**	**[17.204]**[a]	**[8.202]**[a]
2019	**[0.229]**	-0.200	**[1.485]**	**[0.713]**	-2.614[a]	**[-1.515]**	-1.606	**[-0.767]**	**[-0.819]**	-0.677	**[2.294]**	2.580	**[0.589]**	**[0.671]**	0.458
2020	**[1.923]**[b]	-1.771[c]	**[7.200]**[a]	**[0.002]**	-3.097[a]	**[-0.202]**	-2.865[a]	**[-5.337]**[a]	**[-1.745]**[c]	-3.793[a]	**[0.041]**	8.208[a]	**[28.489]**[a]	**[3.046]**[c]	14.387[a]
2021	**[0.477]**	**[1.621]**	-4.747[a]	-1.278	**[3.781]**[a]	**[-0.186]**	**[-1.346]**	-4.778[a]	-1.581	**[-4.637]**[a]	**[0.035]**	**[1.813]**	22.831[a]	2.501	**[21.501]**[a]
All years	**[4.496]**[a]	**[4.567[a]]**	**[0.700]**	**[3.213]**[a]	**[2.807]**[a]	**[-2.280]**[b]	**[-1.746]**[c]	**[-0.366]**	**[-0.908]**	**[-1.681]**[c]	**[5.199]**[b]	**[3.047]**[c]	**[0.134]**	**[0.825]**	**[2.826]**[c]

Note:

1. Lower-middle-income - bold and [ ] illustrates mean difference of banks' productivity in lower middle income is higher than upper-middle- and high-income economies
2. Upper-middle-income - bold and [ ] illustrates mean difference of banks' productivity in upper middle income is higher than lower-middle- and high-income economies
3. High-income - bold and [ ] illustrates mean difference of banks' productivity in high middle income is higher than lower-middle- and upper-middle-income economies

[a], [b], [c] indicates significance at 1%, 5% and 10% levels respectively.

Table 5. Regression results on banks' productivity in lower-middle-income economies

Variable	Model 1			Model 2			Model 3			Model 4		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**
Constant	1.201[a]	0.897[a]	1.201[a]	0.921[a]	0.476[a]	0.921[a]	1.159[a]	0.776[a]	1.159[a]	1.107[a]	0.953[a]	1.107[a]
	(0.075)	*(0.187)*	*(0.076)*	*(0.066)*	*(0.193)*	*(0.067)*	*(0.065)*	*(0.175)*	*(0.066)*	*(0.067)*	*(0.179)*	*(0.067)*
Economic Freedom:												
Regulatory Efficiency												
LNBF	-0.003[a]	-0.003[a]	-0.003[a]									
	(0.001)	*(0.001)*	*(0.001)*									
LNLF				0.003[a]	0.002	0.003[a]						
				(0.001)	*(0.002)*	*(0.001)*						
Market Openness												
LNFF							-0.002[a]	-0.003[a]	-0.002[a]			
							(0.000)	*(0.001)*	*(0.000)*			
LNIF										-0.002[b]	-0.005[a]	-0.002[b]
										(0.001)	*(0.001)*	*(0.001)*
Bank-Specific Characteristics												
LNTA	0.032[b]	0.105[b]	0.032[b]	0.031[a]	0.140[a]	0.031[b]	0.026[b]	0.131[a]	0.026[b]	0.033[b]	0.103[b]	0.033[b]
	(0.013)	*(0.047)*	*(0.013)*	*(0.013)*	*(0.047)*	*(0.013)*	*(0.013)*	*(0.046)*	*(0.013)*	*(0.013)*	*(0.046)*	*(0.013)*
LLPGL	0.003	0.004	0.003	0.003	0.005	0.003	0.003	0.006[c]	0.003	0.004	0.006[b]	0.004
	(0.003)	*(0.003)*	*(0.003)*	*(0.003)*	*(0.003)*	*(0.003)*	*(0.003)*	*(0.003)*	*(0.003)*	*(0.003)*	*(0.003)*	*(0.003)*
TCETA	0.000	-0.001	0.000	0.000	-0.001	0.000	0.000	-0.001	0.000	0.000	-0.001	0.000
	(0.001)	*(0.002)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.001)*
BDTD	-0.743[a]	-4.685[a]	-0.743[a]	-0.660[b]	-4.510[a]	-0.660[b]	-0.546[b]	-4.711[a]	-0.546[b]	-0.760[a]	-4.956[a]	-0.760[b]
	(0.282)	*(0.894)*	*(0.284)*	*(0.282)*	*(0.896)*	*(0.285)*	*(0.284)*	*(0.894)*	*(0.287)*	*(0.284)*	*(0.891)*	*(0.283)*
LOANSTA	0.000	0.002[c]	0.000	0.000	0.002[b]	0.000	0.000	0.002[a]	0.000	0.000	0.002[b]	0.000
	(0.000)	*(0.001)*	*(0.000)*	*(0.000)*	*(0.001)*	*(0.000)*	*(0.000)*	*(0.001)*	*(0.000)*	*(0.000)*	*(0.001)*	*(0.000)*
NIETA	-0.001	0.011	-0.001	0.000	0.011	0.000	-0.001	0.010	-0.001	-0.003	0.011	-0.003
	(0.003)	*(0.010)*	*(0.003)*	*(0.003)*	*(0.010)*	*(0.003)*	*(0.003)*	*(0.010)*	*(0.003)*	*(0.003)*	*(0.010)*	*(0.003)*

Table 5. Continued

Variable	Model 1			Model 2			Model 3			Model 4		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**
Macroeconomics Conditions												
GDP	-0.016[a]	-0.009	-0.016[a]	-0.025[a]	-0.013[b]	-0.025[a]	-0.023[a]	-0.017[a]	-0.023[a]	-0.017[a]	-0.013[b]	-0.017[a]
	(0.005)	*(0.006)*	*(0.005)*	*(0.005)*	*(0.006)*	*(0.005)*	*(0.005)*	*(0.006)*	*(0.005)*	*(0.005)*	*(0.006)*	*(0.005)*
CPI	-0.013[a]	-0.018[a]	-0.013[a]	-0.014[a]	-0.018[a]	-0.014[a]	-0.015[a]	-0.018[a]	-0.015[a]	-0.013[a]	-0.017[a]	-0.013[a]
	(0.001)	*(0.002)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.001)*	*(0.002)*	*(0.002)*	*(0.002)*
COVID	-0.106[a]	-0.106[a]	-0.106[a]	-0.095[a]	-0.096[a]	-0.095[a]	-0.086[a]	-0.081[a]	-0.086[a]	-0.094[a]	-0.095[a]	-0.094[a]
	(0.013)	*(0.014)*	*(0.014)*	*(0.013)*	*(0.014)*	*(0.013)*	*(0.013)*	*(0.014)*	*(0.013)*	*(0.013)*	*(0.013)*	*(0.013)*
R^2	0.092	0.170	0.092	0.093	0.164	0.093	0.095	0.170	0.095	0.088	0.180	0.088
Adj R^2	0.087	0.075	0.087	0.088	0.068	0.088	0.090	0.076	0.090	0.083	0.086	0.083
F-stat.	18.075[a]	1.794[a]	18.075[a]	18.310[a]	1.718[a]	18.310[a]	18.684[a]	1.801[a]	18.684[a]	17.256[a]	1.924[a]	17.256[a]
B&PLM χ^2		13.200[a]			18.650[a]			15.400[a]			10.940[a]	
Hausman χ^2		53.312[a]			17.070[a]			62.348[a]			94.790[a]	
Obs.		1799			1799			1799			1799	

Note: [a, b, c] indicates significance at 1%, 5% and 10% levels respectively. Figure in parentheses ( ) are Standard Error.

Table 6. Regression results on banks' productivity in upper-middle-income economies

Variable	Model 1			Model 2			Model 3			Model 4		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**
Constant	0.725[a]	0.081	0.725[a]	0.669[a]	0.215	0.669[a]	0.726[a]	0.178	0.726[a]	0.794[a]	0.481	0.794[a]
	(0.084)	*(0.283)*	*(0.086)*	*(0.091)*	*(0.271)*	*(0.093)*	*(0.106)*	*(0.268)*	*(0.108)*	*(0.100)*	*(0.324)*	*(0.102)*
Economic Freedom												
Regulatory Efficiency												
LNBF	0.002[a]	0.003a	0.002[a]									
	(0.001)	*(0.001)*	*(0.001)*									
LNLF				0.003[a]	0.003a	0.003[a]						
				(0.001)	*(0.001)*	*(0.001)*						
Market Openness												
LNFF							0.001	0.002	0.001			
							(0.001)	*(0.002)*	*(0.001)*			
LNIF										0.000	-0.003c	0.000
										(0.001)	*(0.002)*	*(0.001)*
Bank-Specific Characteristics												
LNTA	0.030	0.176b	0.030	0.031	0.131c	0.031	0.043[b]	0.175b	0.043[b]	0.040[c]	0.170b	0.040[c]
	(0.022)	*(0.074)*	*(0.022)*	*(0.022)*	*(0.079)*	*(0.022)*	*(0.022)*	*(0.076)*	*(0.022)*	*(0.022)*	*(0.076)*	*(0.022)*
LLPGL	-0.001	-0.004	-0.001	-0.001	-0.003	-0.001	-0.002	-0.002	-0.002	-0.002	-0.001	-0.002
	(0.008)	*(0.009)*	*(0.009)*	*(0.009)*	*(0.008)*	*(0.009)*	*(0.009)*	*(0.009)*	*(0.009)*	*(0.009)*	*(0.008)*	*(0.009)*
TCETA	0.001	0.003	0.001	0.001	0.003	0.001	0.003	0.003c	0.003[b]	0.003b	0.004b	0.003[b]
	(0.001)	*(0.002)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.001)*
BDTD	-0.366[c]	-2.281a	-0.366[c]	-0.367[c]	-2.410a	-0.367[c]	-0.367[c]	-2.376a	-0.367[c]	-0.352	-2.648a	-0.352
	(0.216)	*(0.834)*	*(0.220)*	*(0.216)*	*(0.866)*	*(0.221)*	*(0.217)*	*(0.841)*	*(0.222)*	*(0.217)*	*(0.934)*	*(0.221)*
LOANSTA	-0.001	0.001	-0.001	-0.001	0.002	-0.001	0.000	0.001	0.000	0.000	0.002	0.000
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
NIETA	0.004	0.003	0.004	0.003	-0.006	0.003	0.000	0.001	0.000	-0.001	-0.005	-0.001
	(0.010)	*(0.026)*	*(0.011)*	*(0.010)*	*(0.025)*	*(0.011)*	*(0.010)*	*(0.026)*	*(0.011)*	*(0.010)*	*(0.025)*	*(0.011)*

Table 6. Continued

Variable	Model 1			Model 2			Model 3			Model 4		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**
Macroeconomics Conditions												
GDP	0.000	0.002	0.000	0.001	0.003	0.001	0.000	0.001	0.000	0.000	-0.001	0.000
	(0.003)	*(0.002)*	*(0.003)*	*(0.003)*	*(0.002)*	*(0.003)*	*(0.003)*	*(0.002)*	*(0.003)*	*(0.003)*	*(0.002)*	*(0.003)*
CPI	-0.001	0.001	-0.001	0.000	0.002	0.000	-0.001	0.001	-0.001	-0.002	0.001	-0.002
	(0.002)	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*
COVID	-0.195[a]	-0.164a	-0.195[a]	-0.182[a]	-0.149a	-0.182[a]	-0.191[a]	-0.157a	-0.191[a]	-0.195[a]	-0.152a	-0.195[a]
	(0.022)	*(0.021)*	*(0.022)*	*(0.022)*	*(0.019)*	*(0.022)*	*(0.022)*	*(0.023)*	*(0.022)*	*(0.022)*	*(0.023)*	*(0.022)*
R^2	0.110	0.194	0.110	0.110	0.198	0.110	0.102	0.191	0.102	0.101	0.190	0.101
Adj R^2	0.099	0.094	0.099	0.099	0.098	0.099	0.090	0.090	0.090	0.089	0.089	0.089
F-stat.	9.920[a]	1.928a	9.920[a]	9.903[a]	1.972a	9.903[a]	9.034[a]	1.887a	9.034[a]	8.933[a]	1.876a	8.933[a]
B&PLM χ^2		12.570[a]			12.520[a]			10.980[a]			11.210[a]	
Hausman χ^2		8.733			7.068			8.890			11.692	
Obs.		810			810			810			810	

Note: [a, b, c] indicates significance at 1%, 5% and 10% levels respectively. Figure in parentheses ( ) are Standard Error.

Table 7. Regression results on banks' productivity in high-income economies

Variable	Model 1			Model 2			Model 3			Model 4		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**
Constant	-2.014	1.293[a]	-1.945	-3.309	0.574	-3.144	0.804	0.556	0.887	1.376	1.121[a]	1.430
	(2.339)	*(0.495)*	*(2.036)*	*(2.497)*	*(0.431)*	*(2.056)*	*(1.366)*	*(0.420)*	*(1.512)*	*(1.088)*	*(0.445)*	*(1.186)*
Economic Freedom												
Regulatory Efficiency												
LNBF	0.001	-0.005[a]	0.000									
	(0.015)	*(0.002)*	*(0.016)*									
LNLF				0.011	0.001	0.011						
				(0.014)	*(0.001)*	*(0.012)*						
Market Openness												
LNFF							-0.022[a]	0.000	-0.023[b]			
							(0.006)	*(0.002)*	*(0.012)*			
LNIF										-0.024b	-0.006[a]	-0.024[b]
										(0.010)	*(0.002)*	*(0.011)*
Bank-Specific Characteristics												
LNTA	0.892[b]	0.016	0.880[b]	0.954[b]	0.080	0.933[a]	0.649[b]	0.092	0.637[b]	0.518[b]	0.045	0.513[b]
	(0.377)	*(0.095)*	*(0.338)*	*(0.391)*	*(0.094)*	*(0.355)*	*(0.344)*	*(0.089)*	*(0.291)*	*(0.218)*	*(0.093)*	*(0.241)*
LLPGL	-0.049[b]	0.000	-0.047[b]	-0.045[b]	0.000	-0.043[c]	-0.054	0.000	-0.052[b]	-0.060[b]	0.000	-0.057[b]
	(0.024)	*(0.005)*	*(0.023)*	*(0.023)*	*(0.005)*	*(0.022)*	*(0.037)*	*(0.005)*	*(0.023)*	*(0.025)*	*(0.004)*	*(0.024)*
TCETA	0.008	-0.001	0.007	0.010	0.000	0.009	0.003	0.000	0.002	-0.003	0.000	-0.003
	(0.010)	*(0.002)*	*(0.012)*	*(0.009)*	*(0.002)*	*(0.011)*	*(0.006)*	*(0.002)*	*(0.012)*	*(0.012)*	*(0.002)*	*(0.013)*
BDTD	-2.071[b]	-0.826[a]	-1.942[c]	-2.476[a]	-0.898[a]	-2.300[b]	-1.169[b]	-0.905[a]	-1.075	-0.550	-0.892[a]	-0.485
	(0.938)	*(0.149)*	*(1.013)*	*(0.881)*	*(0.146)*	*(0.988)*	*(0.611)*	*(0.146)*	*(0.770)*	*(0.615)*	*(0.150)*	*(0.668)*
LOANSTA	-0.004	0.001	-0.005	-0.002	0.001	-0.003	-0.012[c]	0.001	-0.012	-0.014[c]	0.001	-0.014
	(0.007)	*(0.001)*	*(0.008)*	*(0.007)*	*(0.001)*	*(0.007)*	*(0.007)*	*(0.001)*	*(0.008)*	*(0.008)*	*(0.001)*	*(0.009)*
NIETA	0.344	-0.033	0.348	0.322	-0.031	0.329	0.338	-0.031	0.339	0.360	-0.031	0.357
	(0.255)	*(0.025)*	*(0.325)*	*(0.248)*	*(0.026)*	*(0.318)*	*(0.269)*	*(0.025)*	*(0.313)*	*(0.299)*	*(0.025)*	*(0.315)*

Table 7. Continued

Variable	Model 1			Model 2			Model 3			Model 4		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**
Macroeconomics Conditions												
GDP	-0.022	0.012[a]	-0.020	-0.019	0.013[a]	-0.017	-0.026	0.013[a]	-0.025	-0.015	0.014[a]	-0.014
	(0.027)	*(0.003)*	*(0.024)*	*(0.027)*	*(0.003)*	*(0.024)*	*(0.032)*	*(0.003)*	*(0.024)*	*(0.024)*	*(0.002)*	*(0.024)*
CPI	-0.005	0.007[a]	-0.005	0.002	0.006[a]	0.001	-0.010	0.006[a]	-0.008	-0.008	0.006[a]	-0.007
	(0.047)	*(0.002)*	*(0.044)*	*(0.049)*	*(0.002)*	*(0.046)*	*(0.027)*	*(0.003)*	*(0.045)*	*(0.045)*	*(0.002)*	*(0.044)*
COVID	0.763[b]	-0.135[a]	0.778[a]	0.810[b]	-0.139[a]	0.820[a]	0.814[c]	-0.143[a]	0.829[a]	0.819[a]	-0.126[a]	0.832[a]
	(0.336)	*(0.018)*	*(0.290)*	*(0.338)*	*(0.017)*	*(0.301)*	*(0.474)*	*(0.017)*	*(0.289)*	*(0.294)*	*(0.016)*	*(0.291)*
R^2	0.034	0.250	0.030	0.036	0.240	0.031	0.040	0.240	0.036	0.046	0.251	0.042
Adj R^2	0.018	0.156	0.014	0.019	0.146	0.015	0.024	0.145	0.020	0.030	0.158	0.026
F-stat.	2.121[a]	2.677[a]	1.874[b]	2.199[a]	2.543[a]	1.927[b]	2.474[a]	2.539[a]	2.240[b]	2.902[a]	2.693[a]	2.620[a]
B&PLM χ^2		8.770[a]			8.490[a]			8.610[a]			8.880[a]	
Hausman χ^2		14.616			11.206			12.553			19.543	
Obs.		607			608			609			610	

Note: [a, b, c] indicates significance at 1%, 5% and 10% levels respectively. Figure in parentheses ( ) are Standard Error.

Table 8. Regression results on banks' productivity in all level incomes economies

Variable	Model 1			Model 2			Model 3			Model 4		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**
C	0.872[a]	0.583[a]	0.872[a]	0.822[a]	0.247	0.822[a]	0.892[a]	0.435[a]	0.892[a]	0.943[a]	0.776[a]	0.943[a]
	(0.040)	*(0.163)*	*(0.041)*	*(0.040)*	*(0.156)*	*(0.040)*	*(0.041)*	*(0.113)*	*(0.041)*	*(0.043)*	*(0.160)*	*(0.043)*
Economic Freedom												
Regulatory Efficiency												
LNBF	-0.001	-0.002[a]	0.001									
	(0.001)	*(0.001)*	*(0.001)*									
LNLF				0.001[c]	0.003[a]	0.001[c]						
				(0.000)	*(0.001)*	*(0.001)*						
Market Openness												
LNFF							-0.001[b]	-0.001[b]	-0.001[c]			
							(0.001)	*(0.000)*	*(0.001)*			
LNIF										-0.001[a]	-0.005[a]	-0.001[a]
										(0.001)	*(0.001)*	*(0.001)*
Bank-Specific Characteristics												
LNTA	0.025[a]	0.130[a]	0.025[a]	0.021[b]	0.136[a]	0.021[b]	0.023[a]	0.137[a]	0.023[a]	0.022[a]	0.105[a]	0.022[a]
	(0.008)	*(0.039)*	*(0.008)*	*(0.008)*	*(0.039)*	*(0.008)*	*(0.008)*	*(0.030)*	*(0.008)*	*(0.008)*	*(0.039)*	*(0.008)*
LLPGL	0.003	0.004	0.003	0.003	0.004	0.003	0.003	0.002	0.003	0.003	0.005[c]	0.003
	(0.002)	*(0.003)*	*(0.002)*	*(0.002)*	*(0.003)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.003)*	*(0.002)*
TCETA	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.000)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
BDTD	-0.291[a]	-1.140[a]	-0.291[a]	-0.318[a]	-1.167[a]	-0.318[a]	-0.283[a]	-1.388[a]	-0.283[a]	-0.266[a]	-1.190[a]	-0.266[a]
	(0.061)	*(0.190)*	*(0.062)*	*(0.061)*	*(0.190)*	*(0.062)*	*(0.061)*	*(0.188)*	*(0.062)*	*(0.061)*	*(0.189)*	*(0.062)*
LOANSTA	0.001	0.002[b]	0.001	0.001	0.002[b]	0.001	0.001	0.002[a]	0.001	0.001	0.002[b]	0.001
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
NIETA	0.001	0.008	0.001	0.002	0.007	0.002	0.001	0.001	0.001	0.000	0.008	0.001
	(0.003)	*(0.009)*	*(0.003)*	*(0.003)*	*(0.009)*	*(0.003)*	*(0.003)*	*(0.008)*	*(0.003)*	*(0.003)*	*(0.009)*	*(0.003)*

Table 8. Continued

Variable	Model 1			Model 2			Model 3			Model 4		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**	**OLS**	**FE**	**RE**
Macroeconomics Conditions												
GDP	0.004[b]	0.004[b]	0.004[b]	0.005[a]	0.006[a]	0.005[a]	0.004[b]	0.006[a]	0.004[b]	0.004[a]	0.005[b]	0.004[a]
	(0.002)	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*
CPI	-0.005[a]	-0.007[a]	-0.005[a]	-0.004[a]	-0.007[a]	-0.004[a]	-0.006[a]	-0.006[a]	-0.006[a]	-0.006[a]	-0.007[a]	-0.006[a]
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*
COVID	-0.139[a]	-0.148[a]	-0.139[a]	-0.137[a]	-0.140[a]	-0.137[a]	-0.138[a]	-0.122[a]	-0.138[a]	-0.137[a]	-0.135[a]	-0.137[a]
	(0.010)	*(0.011)*	*(0.010)*	*(0.010)*	*(0.011)*	*(0.010)*	*(0.010)*	*(0.008)*	*(0.010)*	*(0.010)*	*(0.011)*	*(0.010)*
R^2	0.072	0.136	0.072	0.072	0.136	0.072	0.073	0.174	0.073	0.075	0.146	0.075
Adj R^2	0.069	0.040	0.069	0.069	0.039	0.069	0.070	0.081	0.070	0.072	0.050	0.072
F-stat.	24.799[a]	1.414[a]	24.799[a]	24.998[a]	1.407[a]	24.998[a]	25.091[a]	1.880[a]	25.091[a]	26.118[a]	1.529[a]	26.118[a]
B&PLM χ^2		37.900[a]			38.960[a]			39.410[a]			36.700[a]	
Hausman χ^2		61.444[a]			57.279[a]			48.549[a]			80.337[a]	
Obs.		3216			3216			3216			3216	

Note: [a, b, c] indicates significance at 1%, 5% and 10% levels respectively. Figure in parentheses ( ) are Standard Error.