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**Article**

## The efficiency of banks and stock performance: Evidence from Saudi Arabia

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## FINANCIAL ECONOMICS | RESEARCH ARTICLE

# The efficiency of banks and stock performance: Evidence from Saudi Arabia

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**Abstract:** The aim of this study is to extend the literature by extensively investigating the efficiency of banks in Saudi Arabia and examining its relationship with stock performance through relying on six measures of efficiency (three price efficiencies and three technical efficiencies). This study employs the data envelopment analysis (DEA) on all listed Saudi commercial banks over the period 2006–2018 ensuring the robustness of the results, and the multiple-regression analysis method is used to empirically test the impact of the efficiency changes on bank stock returns. The results indicate that Saudi banks are more technically efficient, and their price efficiencies are more volatile. Furthermore, changes in bank efficiency are positively related to stock performance; however, these positive relationships are only statistically significant with the changes in profit and scale efficiency measures implying that investors pay much attention to the improvement in bank profitability and future dividends.

**Subjects:** Linear Programming; Quantitative Finance; Linear & Nonlinear Optimization; Middle East Economics; Regression Analysis and Multivariate Statistics; Banking

**Keywords:** Saudi Arabia; Bank efficiency; DEA; Price efficiency; Technical efficiency; Stock performance



Mohammad Alsharif

### ABOUT THE AUTHOR

Dr. Mohammad Alsharif was born in 1985 in Madinah, Saudi Arabia. He is an assistant professor of Finance at the Department of Finance and Economics at the College of Business Administration at Taibah University, Saudi Arabia. He has a Master's degree in Finance from the University of Technology Sydney (UTS), Australia with a high distinction overall grade. He also holds a PhD in Finance from Putra Business School at University Putra Malaysia (UPM). His broad research interests include efficient frontier analysis, data envelopment analysis (DEA), Islamic banking, bank risk management and regulation, and Islamic REITs. He published several papers in high-ranked journals such as the *Journal of Islamic Accounting and Business Research*, *Journal of Banks and Bank Systems*, *Journal of Managerial Finance*, and *Journal of Property Management*.

### PUBLIC INTEREST STATEMENT

The paper “The Efficiency of Banks and Stock Performance: Evidence from Saudi Arabia” discusses the efficiency of banks in Saudi Arabia and how their efficiency related to their stock performance. An efficient frontier analysis is used to identify inefficient units relevant to the best practice. The efficient frontier analysis is an advanced superior method to capture the performance of banks in comparison with the traditional financial ratio analysis. The paper used six measures of efficiency: profit efficiency (PE), revenue efficiency (RE), cost efficiency (CE), overall technical efficiency (OTE), pure technical efficiency (PTE), and scale efficiency (SE). Results showed that Saudi banks were technically efficient, and their price efficiencies were more volatile. Results also showed that efficiency measures were positively related to bank stock returns. Results could help investors in assessing bank stock performance. Finally, policy-makers can better map out bank vulnerabilities by not neglecting the price efficiency of banks.

## 1. Introduction

Saudi Arabia is the largest country in the Middle East region and has the biggest economy in the region with a GDP value of SAR 2,973.6 billion in 2019. It is also a member of the G20 group that accounts for 80% of the world economy. Saudi Arabia is one of the largest oil producers in the world with almost 12.42 million barrels per day (EIA, 2020). The Saudi banking industry, furthermore, is a dual banking system, where conventional and Islamic banks compete together. This Saudi dual-banking industry has the world's biggest Islamic bank (Al-Rajhi Bank) and the Saudi Islamic bank assets account for almost 25% of the global Islamic banking industry (IFSB, 2019, 2020). However, despite the importance of the banking industry in Saudi Arabia, fewer studies have attempted to analyse the efficiency of its banking industry. Some of the few studies are Akhtar (2010), Assaf et al. (2011), and Faraj et al. (2006), who investigated the technical efficiency of Saudi banks before major structural changes were adopted due to the WTO membership (joined in 2005), the implementation of Basel II and III accords (introduced in 2004 and 2010), and the Saudi stock market's crisis (occurred in 2006). Furthermore, the Saudi Vision 2030, which was announced in 2016, aims to increase the size and efficiency of the Saudi financial sector. It also aims to increase the size and depth of the Saudi capital market (Saudi Vision, 2030, 2016). The Saudi Stock Exchange Tadawul is now one of the largest capital markets in the world with a total market value of SAR 9,025.4 billion (Tadawul, 2019).

Therefore, the aim of this study is to extend the literature by extensively investigating the efficiency of Saudi banks and examining their relationship with stock performance. According to Alsharif (2020), the efficient frontier analysis can capture the Saudi bank performance better than the financial ratio analysis, and this is in line with the argument of Siems and Barr (1998), who stated that the efficient frontier analysis is a multi-dimensional measure that takes into account various impacts that go beyond the financial ratio analysis. This study has several contributions to the literature. To the best of the author's knowledge, this is the first study that investigates in depth the efficiency of Saudi banks by employing the data envelopment analysis (DEA) and six measures of efficiencies (three price efficiencies and three technical efficiencies). Second, this is also the first study that analyses the relationship between stock returns and bank efficiency in Saudi Arabia. Thirdly, this study relies on long recent data from 2006 to 2018 that includes all 12 listed Saudi commercial banks. Finally, focusing on Saudi banks apart from other banks in the region will ensure the robustness of the results as building a common frontier for banks across different countries could lead to biased efficiency results (Dyson et al., 2001).

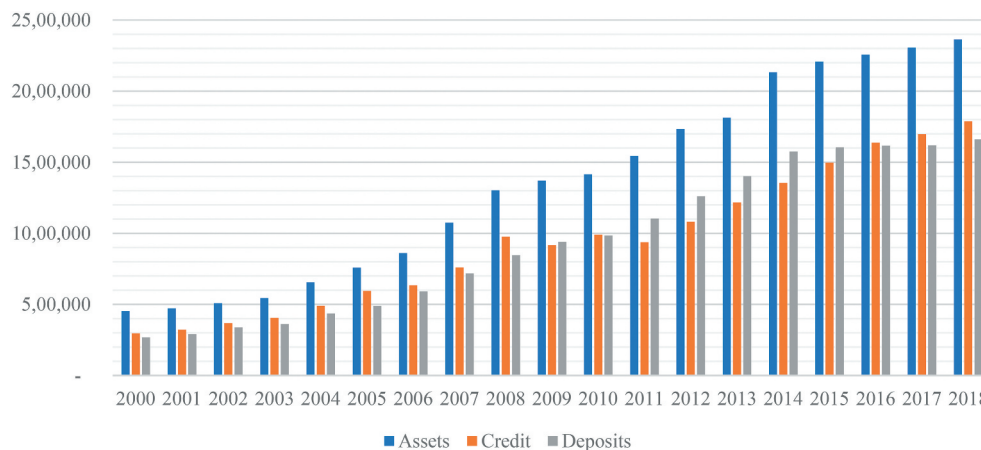
This study is divided into six sections. Section 2 provides an overview of the banking industry in Saudi Arabia. Section 3 reviews the related literature. Section 4 discusses the study methodology and defines the study data and sample. Section 4 presents and interprets the empirical results, while the last chapter concludes and outlines the study's main findings.

## 2. An overview of the Saudi banking industry

The Saudi banking industry is one of the largest GCC banking industries. The depth of the Saudi banking industry has increased significantly from 24% in 2000 to 49% in 2018 as measured by the domestic private credit to GDP. Moreover, Figure 1 illustrates the trend in total assets, loans, and deposits of the Saudi banking sector from 2000 to 2018. It shows that the total value of assets has dramatically increased from SAR 453,272 million in 2000 to SAR 2,363,398 million in 2018 with an annual compounding rate of 9.6%. The credit and deposits have also risen significantly by 10.5% and 10.7% compound annual rates from SAR 296,950 million and SAR 268,216 million in 2000 to SAR 1,787,995 million and SAR 1,661,084 million in 2018, respectively.

Moreover, the Saudi banking industry is a dual banking system that contains conventional and Islamic banks. There are 12 domestic commercial banks in Saudi Arabia in which four of them are fully Islamic banks (see Table 1). The largest commercial bank in Saudi Arabia is the National Commercial Bank with an asset value of SAR 453,209 million that represents 20% of the Saudi

**Figure 1. Total assets, credit and deposits of Saudi banking industry 2000–2018 (SAR million).**



NO	Bank's name	Establishment	Business model	Size rank
1	Alawwal Bank	1926	Offers conventional and Islamic banking products	10th
2	Alinma Bank	2006	Offers only Islamic banking products	8th
3	Al-Rajhi Bank	1978	Offers only Islamic banking products	2nd
4	Arab National Bank	1979	Offers conventional and Islamic banking products	6th
5	Bank Al-Bilad	2005	Offers only Islamic banking products	11th
6	Bank Al-Jazira	1975	Offers only Islamic banking products	12th
7	Bank Saudi Fransi	1977	Offers conventional and Islamic banking products	5th
8	National Commercial Bank	1957	Offers conventional and Islamic banking products	1st
9	Riyad Bank	1957	Offers conventional and Islamic banking products	4th
10	Samba Financial Group	1980	Offers conventional and Islamic banking products	3rd
11	Saudi British Bank	1978	Offers conventional and Islamic banking products	7th
12	Saudi Investment Bank	1976	Offers conventional and Islamic banking products	9th

Note: The size rank is based on the asset value in 2018.

banking industry. Al-Rajhi Bank is the second-largest commercial bank in Saudi Arabia, and it is the largest Islamic bank in the world (IFSB, 2019). The Saudi Islamic banking has a local market share of 51.1%, and it has the second-biggest market share of the global Islamic banking assets of 20.2% (IFSB, 2019). This shows the importance of the Saudi dual-banking system because it has the largest Islamic bank and it contributes to one-fifth of the global Islamic banking industry.

Additionally, the number of bank branches has almost doubled in the last 18 years from 1,184 in 2000 to 2,064 in 2018. The largest banks with branches numbers are Al-Rajhi Bank, National Commercial Bank, and Riyadh Bank with branches numbers 551, 401, and 321, respectively. Furthermore, in Saudi Arabia, there are 15 foreign banks that are restricted to the single branch policy by the Saudi Arabian Monetary Authority (SAMA), except Emirates NBD and Gulf International banks that have 4 and 3 branches, respectively. Thus, this indicates that the Saudi banking sector is dominated by domestic banks that have a market share of 96% in 2018. Moreover, the number of employees in the Saudi banking industry is 47,156 in 2018 that 94% of them are Saudis. Finally, there are 18,685 ATMs in Saudi Arabia that 61% of the cash withdrawals are made through them.

With respect to bank stability, Saudi banks have a capital adequacy ratio of 20.3%, which is significantly higher than the threshold level determined by the Basel Committee under Basel III of 10.5% (Alsharif et al., 2016). Finally, regarding the market structure, measured by the Herfindahl–Hirschman Index (HHI), the HHI Saudi banking industry has improved from 1,246 in 2005 to 1,136 in 2018 since then lower the number the more competitive the market it is.

### 3. Literature review

Although many studies investigate bank efficiency, few studies analyse the relationship between bank efficiency and stock returns (Sufian & Abdul Majid, 2007), and most of these studies are focused on developed countries. In Spain, Adenso-Diaz and Gascon (1997), tried to establish a link between stock performance and four partial measures of efficiency (production cost, branch distribution, systematic risk, and specific risk) by using the DEA method. They found that the specific risk (estimated from the variance of stock returns) was the most influential, whereas the branch distribution (estimated by the DEA) was the least influential in determining the stock performance for Spinach banks. Furthermore, Chu and Lim (1998) examined the profit and cost efficiencies (output-oriented technical efficiencies vs. input-oriented technical efficiencies) of six listed Singaporean banks for the period 1992 to 1996 by using the DEA method. They found that the change in stock performance is only related to profit efficiency. In the USA, Eisenbeis et al. (1999) investigated the efficiency of US banks over the period 1989–1991 by using the DEA and SFA methods. They found that large banks were more efficient than small banks and stock returns are positively associated with cost efficiency. They also argued that both DEA and SFA resulted in the same ranking based on bank efficiency. Moreover, Kirkwood and Nahm (2006) used the DEA to investigate the cost efficiency and its relationship with the stock performance of banks in Australia over the period 1995 through 2002. They defined two approaches for selecting their input–output mixtures, the banking service efficiency (outputs are interest-bearing assets and non-interest income) and the profit efficiency (output is profit before tax). They found that the profit efficiency change is positively related to changes in stock returns of Australian banks.

Furthermore, Beccalli et al. (2006) examined the relationship between the stock returns and cost efficiency of five European countries by using the DEA and SFA methods. They concluded that there is a positive relationship between the cost efficiency and stock returns in European banks and this relationship is only significant under the DEA method only. Similarly, Liadaki and Gaganis (2010) analysed the relationship between stock performance and bank efficiency in 15 European countries over the period 2002–2006. They pointed out that profit efficiency changes were positively related to stock returns, while there was no significant relationship between stock returns and cost-efficiency changes. Moreover, Ioannidis et al. (2008) estimated the cost and profit efficiencies of 19 countries in Asia and Latin America by employing the SFA method over the period 2000 to 2006. They showed that there was a strong positive relationship between stock returns and profit efficiency that was not found in cost efficiency.

Additionally, Hadad et al. (2011) analysed the technical efficiency of Indonesian banks from January 2003 to July 2007. They found that there was a positive correlation between stock prices



and bank efficiency, and foreign banks were less efficient than their domestic counterparts. Gu and Yue (2011), moreover, examined the relationship between the stock returns and the technical efficiencies of the Chinese banks from 2008 to 2010 using the DEA method. They found that there was a positive relationship between the overall technical efficiency and stock returns that was mainly attributed to the pure technical efficiency. Srairi and Kouki (2012) also analysed the relationship between stock performance and technical efficiencies of 25 GCC Islamic banks from 2003 to 2009. They found that pure technical efficiency is positively related to stock performance, while there was no effect of the scale efficiency on stock returns.

Recently, Chan (2016) examined the relationship between technical efficiency and stock returns of banks in five Asian countries from 1990 to 2014. He found that there is a long-run bi-directional relationship between bank efficiency and stock return changes implying that bank efficiency represents a good indicator for the bank's long-term performance. Finally, Liao (2019) examined the relationship between stock returns and bank efficiency in China and Taiwan. He found that the x-efficiency analysis has more power in explaining the changes in stock returns than the financial ratio analysis. Therefore, this study extends the literature by extensively investigating the efficiency of banks in Saudi Arabia and examining its relationship with stock performance through relying on six measures of efficiency (three price efficiencies and three technical efficiencies) and a recent long data set. Saudi Arabia is the largest country in the Middle East region and has the world's largest dual-banking industry.

#### 4. Methodology and data

In this study, three stages of analysis will be followed. First, the six measures of efficiencies, profit, revenue, cost, overall technical, pure technical and scale efficiencies, will be estimated by the non-parametric DEA method. Second, the annual returns of stock prices will be calculated by adding daily returns as daily returns are less volatile compared to annual and monthly returns (Beccalli et al., 2006; Sufian & Abdul Majid, 2007). Finally, the stock returns will be regressed on the yearly changes of the six efficiency measures to assess the relationship between stock returns and bank efficiency.

The data envelopment analysis (DEA) is a linear programming technique that enables someone to construct an efficient frontier for units under consideration to assess their efficiency. The DEA is the most popular method used in the efficient frontier analysis literature (Emrouznejad & Liang, 2018). The DEA has fewer drawbacks compared with the other parametric methods and its efficiency scores are more consistent according to extensive Monte Carlo simulations (Banker & Natarajan, 2008). Furthermore, the DEA does not require a large data set compared to the other parametric methods in order to produce consistent estimates (Chu & Lim, 1998).<sup>1</sup> Moreover, the use of panel data here can minimise the error shortcoming of the DEA by observing bank efficiency over time, which allows them to vary through the years due to the continuous changes in the business environment (Isik & Hassan, 2002).

Regarding the six efficiency measures: profit efficiency (PE) measures the firm ability in maximising their profit (revenue minus cost) compared with best practice when output and input prices are known; revenue efficiency (RE) measures the firm ability in maximising their revenue compared with best practice when output prices are known; cost efficiency (CE) measures the firm ability in minimising their cost compared with best practice when inputs prices are known; overall technical efficiency (OTE) measures the firm ability in minimising their inputs to produce a fixed level of outputs compared with best practice; pure technical efficiency (PTE) measures the firm ability in minimising their inputs to produce a fixed level of outputs compared with best practice that purely related to their managerial behaviour; and scale efficiency (SE) measures the firm ability in minimising their inputs to produce a fixed level of outputs compared with best practice that related to their optimal level of operating scale.<sup>2</sup> However, the price efficiencies are computed under the constant returns to scale (CRS) assumption to avoid the biases in the results due to the variation of bank size in the sample (Dyson et al., 2001).<sup>3</sup>

After estimating the efficiencies of Saudi banks, the stock returns of Saudi banks are regressed against their efficiencies in order to assess the relationship between stock performance and bank efficiency. The regression model is as follows:

$$SR_{it} = \alpha_1 + \alpha_2 EF_{it} + \varepsilon_{it} \tag{1}$$

where

$SR_{it}$  is the annual stock return of bank  $i$  at the end of year  $t$ ;

$EF_{it}$  is the efficiency annual percentage change of bank  $i$  at the end of year  $t$ .

#### 4.1. Sample and data

The current study sample includes all the 12 listed Saudi commercial banks over the period 2006–2018. The data are obtained from the Bloomberg database, and the annual reports of banks are referred to in case of missing observations. However, although there has been a debate in the literature on the selection of inputs and outputs, this study flows the well-known intermediation approach that enables someone to capture the entire performance of banks (Fethi & Pasiouras, 2010). Therefore, based on data availability, this study employs three inputs (labour, fixed assets, and deposits) and two outputs (loans and other earning assets) with their prices. Table 2 presents the descriptive statistics of the outputs and inputs used in this study, while Table 3 sorts the inputs and outputs by banks. Although large banks have more outputs and inputs compared with small banks, the prices of outputs and inputs exhibit a different pattern (see Table 3). Regarding output prices, fully Islamic banks (Bank Al-Bilad, Bank Al-Jazira, and Al-Rajhi Bank) have the highest levels of other earning asset prices implying that Saudi Islamic are less involved in traditional banking activities of borrowing and lending

Table 2. Descriptive statistics of outputs and inputs used in the DEA						
	Variables	Obs.	Min	Max	Mean	Std. Dev
Outputs (SAR million)	Loans ( $Y_1$ )	153	1,112	272,634	88,165	58,898
	Other earning assets ( $Y_2$ )	153	828	175,072	42,360	34,349
Inputs (SAR million)	Personnel expenses ( $X_1$ )	153	246	3,541	1,113	734
	Fixed assets ( $X_2$ )	153	309	8,894	1,483	1,391
	Deposits ( $X_3$ )	153	1,498	332,696	108,356	75,724
Outputs prices (%)	Loan price ( $W_1$ )	153	1.87	85.38	6.12	6.78
	Other earning assets price ( $W_2$ )	153	0.06	35.78	5.20	4.15
Inputs prices (%)	Labor price ( $Z_1$ )	153	0.50	2.32	0.90	0.38
	Fixed assets price ( $Z_2$ )	153	15.16	253.11	73.10	35.67
	Deposits price ( $Z_3$ )	153	0.09	5.28	1.20	1.11

Note: Loan price is the interest income divided by total loans; Other earning assets price is the non-interest income divided by other earning assets; Labor price is the personnel expenses divided by total assets; Fixed assets price is the other operating expenses divided by fixed assets; Deposits price is the interest expenses divided by deposits.



**Table 3. The mean of outputs and inputs used in the DEA sorted by banks**

NO	Bank's name	Y <sub>1</sub>	Y <sub>2</sub>	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	W <sub>1</sub>	W <sub>2</sub>	Z <sub>1</sub>	Z <sub>2</sub>	Z <sub>3</sub>
1	Alawwal Bank	50,465	20,056	530	676	57,729	5.32	4.35	0.73	86.53	1.82
2	Alinma Bank	47,166	17,193	663	1,510	48,712	12.77	2.92	1.08	34.03	0.57
3	Al-Rajhi Bank	172,286	50,438	2,121	4,572	194,963	6.06	7.21	0.90	38.54	0.37
4	Arab National Bank	89,447	36,402	1,087	1,382	105,731	5.47	4.54	0.81	59.51	1.24
5	Bank Al-Bilad	23,485	7,981	600	636	27,847	5.12	12.60	1.81	75.93	0.46
6	Bank Al-Jazira	28,432	14,414	608	547	36,514	5.60	6.64	1.35	72.21	1.46
7	Bank Saudi Fransi	99,628	38,223	930	630	116,539	4.54	4.68	0.60	105.68	1.39
8	National Commercial Bank	177,403	130,624	2,673	3,017	252,043	7.84	3.24	0.81	99.15	1.31
9	Riyad Bank	117,388	55,242	1,302	1,698	135,550	4.94	4.05	0.71	70.18	1.33
10	Samba Financial Group	104,773	70,919	1,269	1,615	147,296	6.25	3.46	0.66	63.51	1.04
11	Saudi British Bank	95,402	37,710	1,040	743	113,705	5.55	5.41	0.71	108.72	1.20
12	Saudi Investment Bank	42,647	23,313	430	777	49,873	5.53	2.79	0.62	54.16	2.13

except for Alinma Bank that relies heavily on traditional banking activities with the highest loan price in the sample of 12.77% on average. Regarding input prices, the four fully Saudi Islamic banks have the highest labour prices indicating Islamic banks have a high level of labour cost. This can be explained by the fact that each Islamic bank must have a board of Islamic scholars that are responsible for checking that all bank operations are in line with the Sharia laws (Zaher & Hassan, 2001). Moreover, Saudi Investment Bank has the highest deposit cost of 2.13% on average, whereas Al-Rajhi Bank has the lowest deposit cost of 0.37% on average. This could be explained by the fact that Al-Rajhi Bank has more market power and it has the largest number of branches and ATMs in the Saudi banking industry, which allows it to pay less interest or profit to attract and keep depositors.

## 5. Empirical results

### 5.1. Saudi banks efficiency

Table 4 shows the results of the six efficiency measures of the 12 Saudi banks over the period 2006 to 2018. The result reveals that Saudi banks, on average, have 91.5%, 91.1%, and 77.2% of profit, revenue, and cost-efficiency levels, respectively. This result indicates that Saudi banks are more profit, revenue, and cost efficient than banks in India. Vidyarthi and Tiwari (2019) analysed Indian banks' efficiency over a similar period from 2005 to 2018 and found that the highest levels of profit, revenue, and cost efficiencies over the period were 88%, 87.7%, and 75.2% on average, respectively. However, the main source of price inefficiency in Saudi banks is the cost inefficiency of 22.8%, which means Saudi banks can reduce their cost by 22.8% if they were cost efficient. This could be explained by the high credit growth in Saudi Arabia in the last decade due to the high increase in oil prices. In Saudi Arabia, bank credit has increased significantly from SAR 297 billion in 2000 to SAR 1788 billion in 2018 with an annual credit growth rate of 10.5%. Under this circumstance, bank managers usually tend to pay less attention to control their cost and this is consistent with the *quite-life hypothesis*.

Additionally, regarding the technical efficiency, Saudi banks obtained overall technical, pure technical and scale efficiency scores of 96.6%, 99.5%, and 97.2% on average, respectively. This implies that Saudi banks technically outperformed the GCC banks that have overall technical, pure technical and scale efficiency scores of 82.7%, 87.7%, and 94.2% on average, respectively (Aghimien et al., 2016). The superiority is largely related to the pure technical efficiency score implying Saudi banks have the best-skilled managers in the region. However, the main source of technical inefficiency in Saudi banks is scale inefficiency. Further analysis shows that Saudi banks mainly exhibit decreasing returns to scale, an increase in inputs results in less increase in outputs (see Table 5). This points to the fact that during the sample period, Saudi Arabia experienced a higher level of GDP growth (e.g., 5%, 10%, and 5.4% in 2010, 2011, and 2012, respectively,) due to the higher oil prices. In this circumstance, supposedly banks increase their branches and resources to meet the high demand for credit. Consequently, as banks getting larger, they reach their optimal scale level, leading them to exhibit diseconomies of scale. Moreover, Table 6 shows that big Saudi banks are more efficient than small ones and the variation is largely in the price efficiencies, especially the cost efficiency. This suggests that big banks benefit from the economy of scale in reducing their cost. However, big and small Saudi banks have comparable pure technical efficiency scores indicating that managerial skills do not vary between big and small Saudi banks.

With respect to Saudi banks individually, BSFR outperforms all Saudi banks in all six measures of efficiency and followed by SIBC, which has the second-best efficiency levels in almost all efficiency measures (except cost efficiency). Interestingly, ALBI, BJAZ, and RJHI banks are the least efficient in most efficiency measures and these banks are Islamic banks that are fully dedicated Islamic financial institutions. This suggests that Saudi Islamic banks are less efficient compared with other Saudi conventional banks that operate with an Islamic window. This agrees with the result found by Alsharif et al. (2019) that GCC Islamic banks are less productive than GCC conventional banks. Furthermore, the largest source of inefficiency in these three Islamic banks is cost inefficiency, which points to that they have a problem in controlling their cost. This because

**Table 4. The mean of price and technical efficiencies of Saudi banks from 2006 to 2018**

NO	Bank's name	Abbreviation	PE	RE	CE	OTE	PTE	SE
1	Alawwal Bank	ALAWWAL	0.956	0.963	0.853	0.989	0.996	0.993
2	Alinma Bank	ALINMA	0.927	0.948	0.499	0.990	0.993	0.997
3	Al-Rajhi Bank	RJHI	0.824	0.840	0.486	0.928	1.000	0.928
4	Arab National Bank	ARNB	0.894	0.914	0.757	0.962	0.971	0.990
5	Bank Al-Bilad	ALBI	0.681	0.688	0.376	0.875	1.000	0.875
6	Bank Al-Jazira	BJAZ	0.799	0.878	0.730	0.905	0.989	0.915
7	Bank Saudi Fransi	BSFR	1.000	1.000	0.995	1.000	1.000	1.000
8	National Commercial Bank	NCB	0.963	0.849	0.939	0.982	1.000	0.982
9	Riyad Bank	RIBL	0.964	0.967	0.807	0.986	0.995	0.990
10	Samba Financial Group	SAMBA	0.995	0.941	0.905	0.999	0.999	1.000
11	Saudi British Bank	SABB	0.978	0.974	0.941	0.986	0.991	0.995
12	Saudi Investment Bank	SIBC	1.000	0.981	0.913	1.000	1.000	1.000
	All		0.915	0.911	0.772	0.966	0.995	0.972

Notes: PE is the profit efficiency; RE is the revenue efficiency; CE is the cost efficiency; OTE is the overall technical efficiency; PTE is the pure technical efficiency; SE is the scale efficiency.

**Table 5. Returns to scale of Saudi banks 2006–2018**

NO	Bank's name	Abbreviation	CRS	IRS	DRS
1	Alawwal Bank	ALAWWAL	54%	31%	15%
2	Alinma bank	ALINMA	60%	20%	20%
3	Al-Rajhi Bank	RJHI	31%	0%	69%
4	Arab National Bank	ARNB	23%	15%	62%
5	Bank Al-Bilad	ALBI	15%	85%	0%
6	Bank Al-Jazira	BJAZ	15%	85%	0%
7	Bank Saudi Fransi	BSFR	100%	0%	0%
8	National Commercial Bank	NCB	77%	0%	23%
9	Riyad Bank	RIBL	54%	0%	46%
10	Samba Financial Group	SAMBA	92%	0%	8%
11	Saudi British Bank	SABB	69%	0%	31%
12	Saudi Investment Bank	SIBC	100%	0%	0%
	All		58%	20%	23%

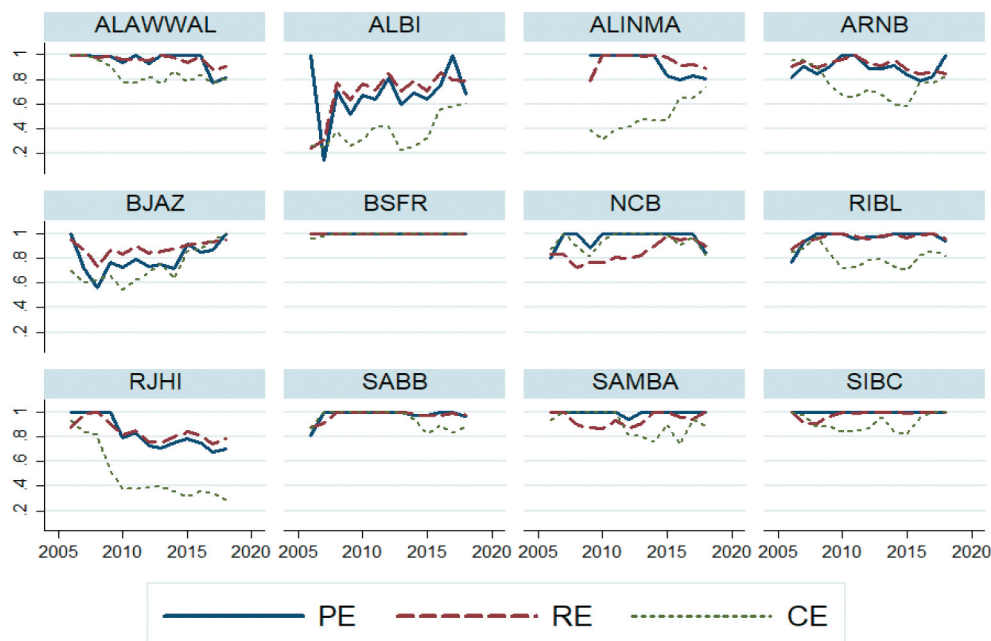
Notes: CRS is constant returns to scale; IRS is increasing returns to scale; DRS is decreasing returns to scale.

**Table 6. The means of price and technical efficiencies of Saudi banks 2006–2018 sorted by size**

Size	Abbreviation	PE	RE	CE	OTE	PTE	SE
Big banks	ARNB		0.894	0.914	0.757	0.962	0.971
	BSFR		1.000	1.000	0.995	1.000	1.000
	NCB		0.963	0.849	0.939	0.982	1.000
	RIBL		0.964	0.967	0.807	0.986	0.995
	RJHI		0.824	0.840	0.486	0.928	1.000
	SAMBA		0.995	0.941	0.905	0.999	0.999
	Average		0.940	0.919	0.815	0.976	0.994
Small banks	ALAWWAL		0.956	0.963	0.853	0.989	0.996
	0.993						
	ALBI		0.681	0.688	0.376	0.875	1.000
	ALINMA		0.927	0.948	0.499	0.990	0.993
	BJAZ		0.799	0.878	0.730	0.905	0.989
	SABB		0.978	0.974	0.941	0.986	0.991
	SIBC		1.000	0.981	0.913	1.000	1.000
Average		0.889	0.904	0.727	0.956	0.995	

Notes: Banks that are above the median of Saudi banks' assets value are considered big, while banks that are below the median of Saudi banks' assets value are considered small.

**Figure 2. The price efficiencies of Saudi banks 2006–2018.**



Islamic banks usually have higher operating cost as they have a *Sharia* supervisory board of scholars and experts that are responsible for *Sharia* screens, *Sharia* purification, and *Zakah* calculation (Zaher & Hassan, 2001). However, NCB bank, which is the largest commercial bank in Saudi Arabia, has comparable performance that is above the efficiency average in comparison with other Saudi banks, except in revenue efficiency it has the third-worst efficiency score of 84.9%. This indicates that NCB has a problem in generating more revenue while using a fixed input level compared with their Saudi counterparts.

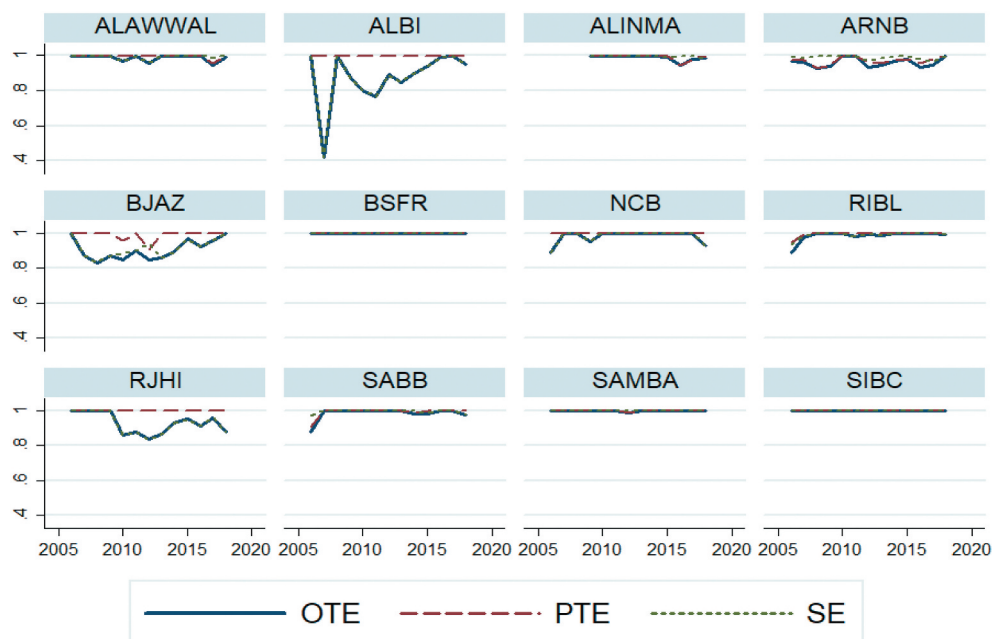
Figures 2 and 3 illustrate the trend of the six efficiency measures over the sample period 2006–2018 across all the Saudi banks. It can be seen that the price efficiency measures are more fluctuated than technical efficiency measures. Figure 2 shows that RJHI price efficiency measures have decreased over time, whereas BJAZ reveals an upward trend in their price efficiencies. Moreover, ALINMA, which is the newest Saudi bank (established in 2006 and listed in 2008), has an upward trend in its revenue efficiency implying that the bank is getting more power in generating more income over time. Furthermore, compared with Saudi banks, ALBI price efficiencies are the most volatile, especially the profit efficiency.

Conversely, the technical efficiencies of Saudi banks are more stable over the sample period, especially the pure technical efficiency measure (see Figure 3). However, ALBI experiences the highest level of deterioration in their scale efficiency and this is because the bank is operating at increasing returns to scale (i.e., they are too small; see Table 5). Nonetheless, ALBI scale efficiency has started to improve over time. Finally, BSFR, SIBC, and SAMBA have stable technical efficiencies over the sample period indicating their technical efficiency superiority to their counterparts.

### 5.2. Regression results

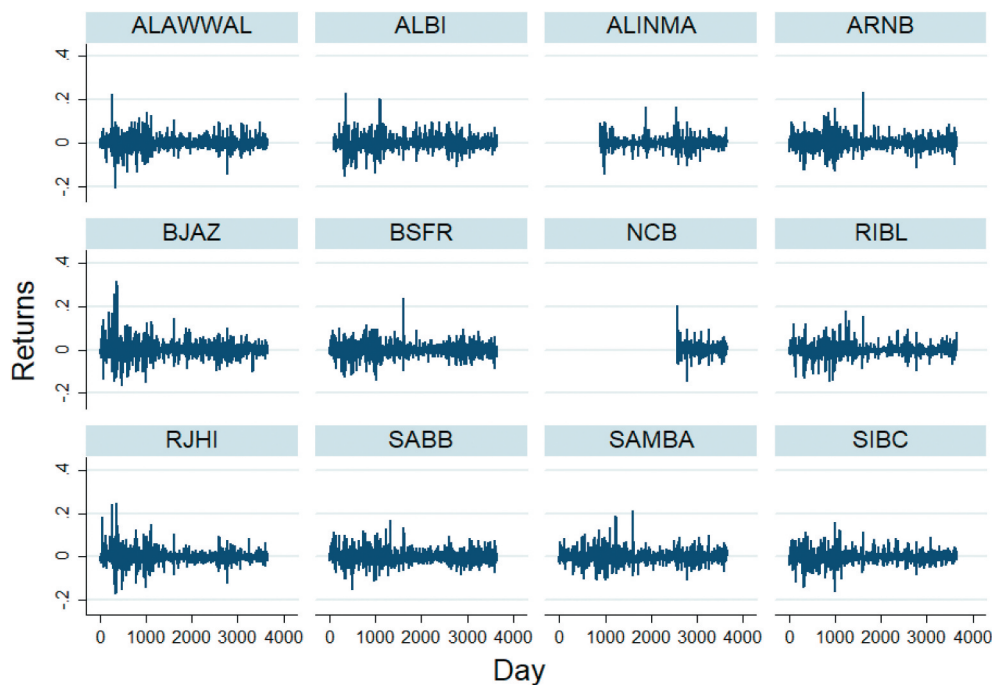
The regression approach is used to examine the relationship between the stock returns and bank efficiency by using panel data for 12 Saudi banks from 2006 to 2018. However, the use of pool OLS will result in biased estimates since the sample is a panel dataset (Gujarati & Porter, 2009). Moreover, further analysis shows that the fixed group effect does not exist as the author fails to reject the null hypothesis since the *F* statistic is very small for the joint-fixed dummies, whereas the null hypothesis under the Breusch-Pagan Lagrange multiplier (LM) test is rejected indicating the

**Figure 3. The technical efficiencies of Saudi banks 2006–2018.**



**Figure 4. The daily returns of Saudi banks stocks from 3/1/2005 to 31/12/2018.**

Notes: the NCB was listed on 12/11/2014.



presence of an individual-specific error variance component (Hun, 2011). Thus, the random effect model will be applied in this study. This result is also confirmed by the Hausman test that indicates the random effect model is preferred since the null hypothesis is not rejected. Moreover, similar to Liadaki and Gaganis (2010), the year fixed effect dummies are used to capture the time effects in stock market returns. Lastly, the robust standard errors have been computed to account for heteroskedasticity and serial correlation.

**Table 7. Regression results of the random effect model**

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Stock Returns	Stock Returns	Stock Returns	Stock Returns	Stock Returns	Stock Returns
PECH	0.135*** (0.0254)					
RECH		0.00962 (0.0198)				
CECH			0.127 (0.0842)			
OTECH				0.355*** (0.0647)		
PTECH					0.604 (0.564)	
SECH						0.357*** (0.0690)
Constant	-0.338*** (0.0462)	-0.346*** (0.0572)	-0.338*** (0.0502)	-0.336*** (0.0438)	-0.328*** (0.0433)	-0.342*** (0.0457)
Observations	143	143	143	143	143	143
Year fixed effect	YES	YES	YES	YES	YES	YES
Robust SD errors	YES	YES	YES	YES	YES	YES
R <sup>2</sup>	0.761	0.738	0.741	0.761	0.740	0.760
LM test	4.28**	4.08**	4.10**	4.17**	3.96**	4.18**
Hausman test	0.58	0.58	0.58	0.62	0.58	0.61

Notes: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$  and \*  $p < 0.1$ . PECH is the annual percentage change of profit efficiency; RECH is the annual percentage change of revenue efficiency; CECH is the annual percentage change of cost efficiency; OTECH is the annual percentage change of overall technical efficiency; PTECH is the annual percentage change of pure technical efficiency; SECH is the annual percentage change of scale efficiency.

Figure 4 illustrates the daily stock returns of Saudi banks. It is shown that the volatility in Saudi banks stocks was higher in the early years of the sample, and this is because of the Saudi stock market crisis in 2006 and the global financial crisis in 2007 and 2008. Nonetheless, the volatility has improved and become smaller in the last years as can be seen from the figure. Moreover, the regression results are presented in Table 7. The results are consistent with the literature that there is a positive relationship between stock returns and bank efficiency changes. However, in Saudi banks context, this result is only statistically significant with profit efficiency changes, overall technical efficiency changes, and scale efficiency changes. According to Liadaki and Gaganis (2010), enhanced profit efficiency implies better profitability that results in more future dividends, which investors are only concerned about, while improved cost efficiency is usually not observed by the market. The significant and positive signs with the scale efficiency changes, moreover, further confirms this finding as according to Belanès et al. (2015), the enhancement in scale efficiency is related to outside factors, such as the increase in market demand indicating more future profitability and dividends.

## 6. Conclusion

This study investigated the efficiency of the banking industry in Saudi Arabia from 2006 to 2018 using the data envelopment analysis (DEA) method. This study employed six measures of efficiency (three



price efficiencies and three technical efficiencies) to extensively analyze the efficiency of Saudi banks and examine their relationship with bank stock performance. It was found that Saudi banks were more technically efficient, and their price efficiencies were more volatile. The results also indicated that the major source of price inefficiency was cost inefficiency, while the main source of technical inefficiency was scale inefficiency. Further analysis showed that the majority of Saudi banks, especially big banks, experienced decreasing returns to scale (i.e., oversized), whereas small Saudi banks exhibited increasing returns to scale (i.e., too small). Furthermore, big Saudi banks were more efficient than small ones; however, both types of banks had a comparable level of pure technical efficiency levels. Moreover, it was found that Saudi fully Islamic banks were less efficient than their counterparts that operate with an Islamic window.

With respect to the relationship between stock performance and bank efficiency, the results indicated that there were positive and significant relationships between bank efficiency changes and stock returns. However, these relationships were only statistically significant with the changes in profit and scale efficiency measures implying that investors pay much attention to the improvement in bank profitability and future dividends. In conclusion, this study showed that relying only on technical efficiencies as an assessment tool of bank performance can overestimate the efficiency of banks. Therefore, for policymakers and regulators, price efficiencies should not be neglected because it provides a broader picture of bank performance. Finally, for shareholders and potential investors, changes in profit and scale efficiency measures incorporate useful information in the assessment of bank stock performance.

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#### Notes

1. However, the present study sample of 12 Saudi banks meets the rule of thumb that achieves a reasonable level of discrimination (Dyson et al., 2001).
2. The input-oriented technical efficiencies are chosen as banks managers usually have more control over their inputs than their outputs that are affected by outside factors.
3. In the interest of brevity, for more technical details (see Cooper et al., 2007).

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