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Does intellectual capital enhance firm efficiency? Evidence from Vietnam's banking sector

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Abstract: As a result of the rise of a knowledge-based economy, intellectual capital (IC) has replaced tangible inputs as the primary resource and driver of organisational performance. This is the first study to examine the relationship between IC and its components of Vietnamese banks from 2011 to 2018, utilising the modified value-added intellectual coefficient (MVAIC) and stochastic frontier analysis to determine technical efficiency. We find substantial variation in the performance of Vietnamese banks and note a decreasing trend in efficiency, with foreign banks being among the least efficient. Examining the relationship between IC and efficiency as a collective revealed a positive correlation. When the IC components were examined separately, human capital efficiency (HCE) was discovered to be the most significant contributor to efficiency. At the same time, other forms of IC failed to show statistical significance and may even establish a significant inverse relationship. As some valuable resources may be value-destructive, the findings herein have significant implications for resource-based theory. In addition, practitioners may wish to note that HCE is the most significant contributor to efficiency in the Vietnamese banking sector.

Keywords: technical efficiency; banks; intellectual capital; performance evaluation; Vietnam.

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1 Introduction

The production of financial services requires physical and knowledge-based resources (Adesina, 2019), from which extant literature studies emphasise knowledge-based resources as having greater importance (El-Bannany, 2008). Intellectual capital (IC), a part of knowledge-based resources (such as investments in human resources, brand building, systems, and processes,) aids the banking industry to provide high-quality services to customers and is increasingly replacing traditional production components (Clarke and Gholamshahi, 2018). IC also serves as a differentiating factor in a firm's value generation (Serenko and Bontis, 2013; Jain et al., 2017) and fuels the banking sector towards economic progress (Kim et al., 2016).

The benefits that stem from IC have driven researchers to define IC theoretically (Secundo et al., 2018), establish effective IC-based output measures (Mohapatra et al., 2019) and investigate IC's relationship with businesses, industries, and regional characteristics (Hussinki et al., 2017). Banks are not an exception to this investigation. Through IC, banks can leverage inputs to produce outputs to increase efficiency and establish competitive advantages (Coskun and Frohlich, 1992). Given the importance of efficiency and IC on performance, it is therefore fitting to quantify their relationship and simultaneously address a gap in the Vietnamese banking sector literature.

Vietnam has experienced tremendous economic growth as a developing Southeast Asian country since signing a Bilateral Trade Agreement with the USA in 2001 and joining the World Trade Organization in 2007.[1] These accords have created both challenges and opportunities for the Vietnamese banking sector, which act as the cornerstone of the country's financial sector. To mobilise resources for designated socio-political lending projects and ignite the Vietnamese government's commitment to banking sector liberalisation, the country established a two-tier banking system whereby the State Bank of Vietnam (SBV) acts as a true central bank. As such, commercial banking functions are delegated to state-owned and private commercial banks. From this two-tier approach and the country's development, international interest increased and contributed to foreign banks' expansion into the country (Huy et al., 2021; Le, 2019).

Deregulation in the baking sector in Vietnam has resulted in a market where state-owned banks had near-monopolistic power, but now 100% foreign-owned banks are permitted. The infancy of Vietnam's financial market (Doan et al., 2020) and its need for capital demonstrates that Vietnamese banks must exhibit management efficiency. Recent banking reforms have emphasised the IC's growing significance, particularly given that banking is considered the most knowledge-intensive service industry in the world (Desmarchelier et al., 2013) and Vietnam's service sector is predicted to grow at a rate higher than the rest of its economy (Giam, 2021). The financial sector's employment and economic contribution to the nation further cement its importance to the local government.[2] For these reasons, the effects of IC and its relationship to technical efficiency (TE) is of interest. Most research on this relationship has been done in just a few sectors and locales (Mention and Bontis, 2013), showing a gap in the literature.

To address the gaps in the literature and add to the current literature on bank IC and efficiency, Section 2 of this study explores this relationship in a Vietnamese context, reviews the literature, and formulates the study's hypotheses. Section 3 describes the data set and outlines the research design. Section 4 calculates efficiency scores and

discusses empirical results on efficiency's association with IC. Section 5 concludes and provides practical and theoretical implications.

2 Vietnamese banking overview, literature review, theoretical framework, and hypothesis development

2.1 Overview of the Vietnamese banking industry

As the smallest of the Association of Southeast Asian Nations (ASEAN) five dominant member states,[3] Vietnam has made significant progress in transitioning from a centrally planned economy to a market economy. Political and economic reforms (doi moi) began in 1986 and have assisted the country in obtaining lower-middle-income status, increasing income per capita from US$43 to US$2,777 in 2020 (Boothroyd et al., 2000; CEIC, 2020). Poverty rates fell precipitously from over 70% in 2002 to less than 6% in 2019 (US$3.2/day PPP) (Quyen, 2019). The banking sector expanded in lockstep with the country's growth. Banking assets increased to approximately US$521 billion in 2020 (Le et al., 2020),[4] nearly twice that of its GDP.

Table 1 Non-performing loans as a percentage of gross loans

Country/year	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*Mean*
Indonesia	3.29	2.53	2.14	1.77	1.69	2.07	2.43	2.90	2.56	2.29	2.43	2.37
Malaysia	3.63	3.35	2.68	2.02	1.85	1.65	1.61	1.61	1.55	1.48	1.53	2.09
Philippines	3.49	3.38	2.56	2.22	2.44	2.02	1.89	1.72	1.58	1.67	1.97	2.27
Thailand	*5.22*	*3.89*	*2.93*	2.43	2.30	2.31	*2.68*	*2.99*	*3.07*	*3.08*	*3.13*	*3.09*
Vietnam	1.80	2.09	2.79	*3.44*	*3.11*	*2.94*	2.34	2.28	1.82	1.80	1.50	2.36

Note: Italic font highlights the country with the greatest NPLs as a percentage of gross loans.

Source: WorldBank.org

Despite recent growth, risks associated with financial asset bubbles and intra-bank lending activities brought Vietnam's banking sector to the brink of failure in late 2009. To stabilise the banking system and address short-term issues while ensuring long-term security and sustainable development, three government-led long-term restructuring solutions were enacted for concurrent implementation from 2011 to 2019 (To and Le, 2020). The first solution was strengthening financial capacity as non-performing loans (NPLs) adversely impacted bank health and efficiency and had become one of Vietnam's most critical banking hazards (Rachman et al., 2018). Table 1 compares the NPL rates of the five central ASEAN countries and highlights that Vietnam's NPLs were the highest in the region from 2012–2014, primarily due to the decline in the value of commercial banks' real estate collateral in 2009. To maintain NPLs under 3%, the SBV created the Vietnam Asset Management Company (VAMC) and required banks to sell NPLs in exchange for SBV bonds (Ha, 2020). This solution also required banks to increase their charter capital and retain more profits to resolve bad debts. The second restructuring approach was the alignment of management systems with global standards. This solution improved internal control and audit systems, established new company strategies, raised managerial competency standards, and implemented

Basel Committee-style risk management. The third solution required restructuring bank operations to raise minimum equity requirements from VND 70 bn to VND 3 tn (about $150 m). The combined results of these initiatives saw the NPL decrease to 1.50% in 2019.

Efficiency is crucial for transition economies' economic growth (Koivu, 2002), yet the evidence on whether bank ownership type increases efficiency is inconclusive (Le et al., 2019). Despite the ambiguity, when financial markets liberalise, access to domestic markets increases and economic growth is stimulated (Levine, 2001). Below, we highlight the three categories of bank ownership in Vietnam:

1 state-owned commercial banks (SOCB), which are entirely owned by the government or state sector;

2 joint-stock commercial banks (JSCB), which are jointly owned by the public and private sectors.

3 foreign banks (FB), which are foreign bank branches that belong to overseas-headquartered foreign banks and include joint-venture banks that are 50% owned by foreign banks and 50% owned by a domestic bank.

Table 2 shows that the number of SOCBs increased from five to seven during this study period, and FBs rose from nine to 11. Despite these increases, the total number of commercial banks decreased from 51 to 46.

Table 2 Banks by type and year

Bank type	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*
State-owned commercial banks (SOCB)	5	5	5	5	7	7	7	7
Joint stock commercial banks (JSCB)	37	34	34	30	28	28	28	28
Foreign and joint venture commercial banks (FB)	9	9	9	9	8	8	11	11
Sum	51	48	48	44	43	43	46	46

2.2 Bank efficiency

The term 'productive efficiency' originates with Farrell's (1957) work, in which the author further classified into allocative and TE. Allocative efficiency quantifies a firm's potential to produce optimally by relating marginal input costs to pricing. TE refers to a business's ability to generate the maximum output with a set of inputs (Mor and Gupta, 2021). For financial intuition, TE refers to an institution's ability to generate diverse financial goods or services from diverse inputs (Haralayya et al., 2021). Because financial institutions operate as financial intermediaries, efficiency is crucial to success.

Commercial bank performance has been extensively studied due to the variety of goods and services handled. Researchers frequently employ frontier-based production models to separate institutions that perform well from those that do not, for a strong negative relationship exists between efficiency and bank failure (Moudud-Ul-Huq, 2019), Efficiencies reduce future bank risks and demonstrate managerial effectiveness (Bitar et al., 2018). Stochastic frontier analysis (SFA) is a common frontier-based approach which Nguyen and Pham (2020) suggests it fits banks' production functions

better with less significant variability than data envelopment analysis, a common alternative frontier-based model.

2.2.1 Vietnamese bank efficiency

Efficiency studies examining Vietnamese financial institutions predominately analyse efficiency levels and their determinants. An examination of the Vietnamese Government's restructuring plans from 1999–2008, Vo and Nguyen (2018) showed that restructuring reduced efficiency due to a shift in environmental variables, such as a financial crisis and domestic economic downturn. A 2008 to 2018 study by Le and Ho (2020), showed that the efficiency of the Vietnamese banking sector's deposit and loan divisions fell and that, through a period of liberalisation, private banks performed better. Nguyen and Nghiem's (2020) 2000–2014 study found that Vietnamese banks were 92.8% efficient, on average.

In examining bank efficiency by bank type, researchers (see Naaborg et al., 2004; Goh, 2005; Claessens and van Horen, 2012) demonstrate that foreign banks are, on average, more efficient than their domestic counterparts in developing countries. In comparing the relative performance of international and domestic banks in Vietnam, Nahm and Vu (2008) discovered that, surprisingly, FB had a lower profit efficiency than SOCB. And Vu and Turnell (2010) discovered that there was no difference in performance between the two types of banks when reexamined using a different technique.

2.3 Intellectual capital

Although IC lacks a universal definition, several definitions exist. For example, Itami and Roehl's (1991) key IC study defines IC as intangible assets vital to a firm's competitive power. Dumay et al. (2020) regard IC as wealth-building knowledge, information, intellectual property, and experience. According to Ramadan et al. (2017), IC comprises of employees, their organisation, and their value-adding abilities. Combined, IC combines intangible assets that offer organisations unique competitive advantages.

Much like IC definitions, there are several IC measurement models. Pulić's (1998) VAIC™ model is however, most adopted by most researchers as its simplicity facilitates effective comparison across enterprises or countries (Xu and Wang, 2019). IC measurement models traditionally highlight three major efficiency components: human capital efficiencies (HCE), capital employed efficiencies (CEE), and structural capital efficiencies (SCE). Limitations of the VAIC model[5], however, this resulted in Ulum et al. (2014) amending Pulić's (1998) model to include relational capital efficiency (RCE) and creating the modified value-added intellectual coefficient (MVAIC) method.

When examined in isolation or collectively, IC reveals organisational knowledge (Ataseven et al., 2018). Because IC contributes positively to a firm's financial performance (Tran and Vo, 2020a), we hypothesise that greater IC leads to greater efficiency in Vietnamese banks.

Hypothesis 1 IC is positively associated with Vietnamese bank efficiency.

2.3.1 Human capital efficiency

Tran and Vo (2020b) define HCE as the capacity to behave in a variety of settings that develop tangible and intangible assets. Much of HCE comprises an organisation's knowledge, which can manifest through its personnel as employees contribute to increased business productivity through their abilities, talents, and intellectual agility (Capozza and Divella, 2019). HCE fosters innovation and regeneration (Faggian et al., 2017) and aligns with resource-based theory (RBT). RBT states that organisations require high-quality human resources to compete. Based on the benefits of HCE, we propose that boosting HCE is associated with increased Vietnamese bank efficiency.

Hypothesis 2a HCE is positively associated with Vietnamese bank efficiency.

2.3.2 Structural capital efficiency

SCE is a less visible, more specialised IC component and is characterised as an organisation's goods and knowledge complex (Abualoush et al., 2018). SCE items include inventions, processes, copyright, patents, technologies, strategy, and systems (Joshi et al., 2010). Organisations with high structural capital foster a supportive culture that encourages individuals to experiment, fail, learn, and try again (Smriti and Das, 2018). Effective structural capital creates knowledge-acquisition systems and provides a mechanism for aggregating and integrating learned knowledge (Zhang et al., 2015; Hejazi et al., 2016). Because SCE is associated with an organisation's success, we test the following hypothesis.

Hypothesis 2b SCE is positively associated with Vietnamese bank efficiency.

2.3.3 Capital employed efficiency

Dalwai and Salehi (2021) define CEE as a capital utilised indicator that quantifies and contextualises the value created by a firm. CEE accounts for the value of each dollar invested in financial or physical capital (Nawaz and Haniffa, 2017). Capital is the value of a business's assets at book value, and its efficient use is critical (Berger and Bouwman, 2013; Nawaz, 2017). Murthy and Mouritsen (2011) observed that, while intangible capital complements financial capital, financial capital is also an essential input generated through the business's budgeting processes. Because enhanced business performance necessitates intellectual and financial capital, we hypothesise that CEE positively correlates with bank efficiency.

Hypothesis 2c CCE is positively associated with Vietnamese bank efficiency.

2.3.4 Relational capital efficiency

RCE is considered one of the most important intangible assets due to the complexity of organisations' interactions with outside entities (de Leaniz and del Bosque, 2013).[6] Consumer and brand loyalty, market image and goodwill, bargaining leverage, strategic alliances, and coalitions fall under the scope of RCE and are predicated on the premise that firms are not isolated systems but interdependent on their environment (Laghi

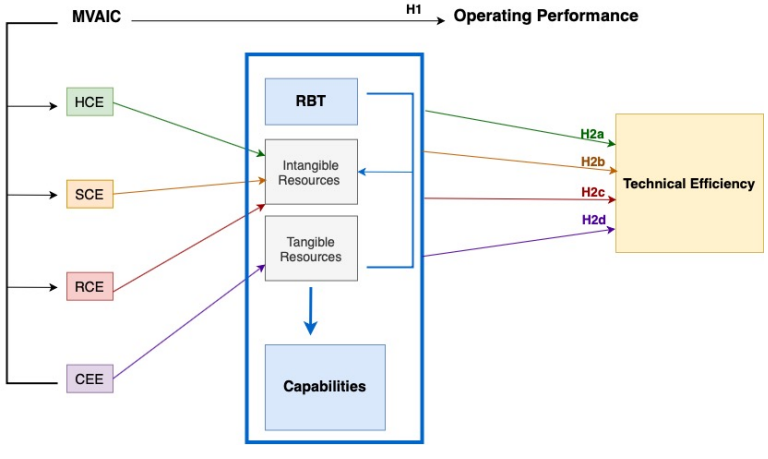
et al., 2020). Researchers associate RCE with strong and lasting relationships with stakeholders as it positively affects an organisation's competitiveness (Corvino et al., 2019). A company's ability to understand, analyse, and make decisions about its industry is directly related to the relationships mentioned above, influencing its performance potential. We, therefore, hypothesise that higher RCE is positively associated with efficiency.

Hypothesis 2d RCE is positively associated with Vietnamese bank efficiency.

2.4 Theoretical framework

Establishing a theoretical framework to characterise firms' operations and facilitate identifying factors and conditions that can influence firm performance has piqued the interest of scholars and economic and management experts. The idea that a firm's resources are the basis of its long-term success is based on the premise that its resources and skills provide strategic direction and are its primary profit source (Grant, 1991). Porter and Advantage (1985) supports this foundation for success in noting that for a firm to generate returns over its cost of capital is contingent upon its attractiveness within its industry and the creation of a competitive edge over its rivals. These concepts align with the resource-based viewpoint, focus on knowledge management and organisational learning, and highlight knowledge as an indispensable resource. RBT finds that owning and controlling tangible and intangible strategic assets is the basis for a sustainable comparative advantage (Riahi-Belkaoui, 2013) and ultimately for its performance (Dubey et al., 2019). Barney (1991) asserts that if all firms had the same resources, there would be no discrepancies in their profitability.

Figure 1 Theoretical framework (see online version for colours)



The advent of a knowledge-based economy identified knowledge and IC as major production variables and essential drivers of companies' sustained competitive advantages. Knowledge-based resources complement resource-based view and IC management (Theriou et al., 2009). IC is a core managerial duty from which scholars

have underlined scarcity, value, and the inability of replication or substitution as strategic aspects for lasting competitive advantage (Massaro et al., 2018). Numerous studies have examined the relationship between IC and firm performance through the lens of RBT.[7] In RBT, strategic resources enable businesses to compete more effectively and economically (Huo et al., 2016) and that firm failure is due to the heterogeneity of firm resources (Capron et al., 1998). Firm value is determined by its ability to organise its resources and capabilities. RBT emphasises the importance of organisations conceptualising and successfully exploiting tangible and intangible assets (Seo and Kim, 2020), which comprise a company's administrative capabilities, routines and organisational processes, and the information and knowledge under control (Araya-Castillo et al., 2019). To better understand the institutional potential of IC, we extend extant research by examining IC and efficiency through the lens of RBT – a source of a firm's core competency and infused into each IC dimension. Figure 1 illustrates this study's hypothesis and its association with RBT. The intangible components include HCE, SCE and RCE, while CEE is the tangible component.

3 Methodology and data

3.1 Variable measurement

3.1.1 Measurement of intellectual capital

This study follows Tran et al. (2020) and Soetanto and Liem (2019) in using the MVAIC model as an IC proxy and as the IV independent variable. MVAIC is calculated as the sum of HCE, SCE, CEE, and RCE as per equation (3.1).

$$MVAIC_i = HCE_i + SCE_i + CEE_i + RCE_i \tag{3.1}$$

The four components of MVAIC are estimated as follows:

$$HCE_{it} = \mathrm{VA}_{it}/\mathrm{HC}_{it} \tag{3.2}$$

$$SCE_{it} = \mathrm{SC}_{it}/\mathrm{VA}_{it} \tag{3.3}$$

$$CEE_{it} = \mathrm{VA}_{i}/\mathrm{CE}_{it} \tag{3.4}$$

$$RCE_{it} = \mathrm{RC}_{i}/\mathrm{VA}_{it} \tag{3.5}$$

where equations (3.2)–(3.5) are human capital efficiency, structural capital efficiency, capital employed efficiency, and relational capital efficiency, respectively. HCE is human capital proxied by funds spent compensating employees for their abilities, experience, knowledge, and productivity. SCE is structural capital efficiency and is the result of VA less HCE. CEE is capital employed proxied by the net of total assets less total liabilities, RCE is relational capital proxied by expenditures associated with maintaining a relationship between customers, suppliers, shareholders, and the government, i.e., marketing and sales expense. Value Added (VA) is the difference between output and inputs as per equation (3.6). Higher CEE, HCE, SCE, and RCE values indicate greater IC value creation.

$$VA_{it} = \text{Output} - \text{Input}_{it} \tag{3.6}$$

where *output* is total bank revenue made up of interest and non-interest income, including fees and commissions. *Input* is calculated as operation costs, including interest, administration, and other expenses, excluding personnel costs (salaries, wages, and other benefits).

3.1.2 Measurement of bank efficiency

Following researchers (Anwar, 2019; Martens, 2021), we use SFA to quantify efficiency. A comprehensive evaluation of a bank's efficiency score considers three dimensions (intermediation, profitability, and production); however, we focus on the intermediation dimension, which assumes that banks collect deposits and converts them into loans and other assets using labour and capital (Miller and Noulas, 1996).

The fundamental concept of SFA *TE* can be expressed as the ratio of realised output to maximum attainable output, as defined in equation (3.7):

$$TE_{it} = \frac{y_{it}}{y_{it}^{*}} = \frac{f\left(x_{it};\beta\right)e^{-u_{it}}e^{v_{it}}}{f\left(x_{it};\beta\right)e^{v_{it}}} = e^{-u_{it}} \in (0,1] \tag{3.7}$$

where y_{it}^{*} is the maximum attainable output for unit i given x_{it} and where $f(x_{it};\beta)$ is a log-linear production function. ϵ denotes the error term.

The estimation for the parameters of the SFA model can be achieved by applying the maximum likelihood estimation method, which estimates the likelihood function in terms of two variance parameters (Kea et al., 2016). We note this as per equation (3.8):

$$\gamma = \sigma_u^2/\sigma_s^2; \sigma_s^2 = \sigma_v^2 + \sigma_u^2 \tag{3.8}$$

where γ reflects the impact of random disturbances (v,u) and will fall between zero and one. The closer γ is to one, the smaller the gap between actual and maximum possible output. When γ is at one, the sample bank is fully efficient, whereas a γ close to zero is essentially meaningless since it indicates that SFA output is uncontrolled by random factors.

Following Ding and Sickles (2018), we specify a cost frontier model with two-output (γ) , and three-input (w), parameters via the translog functional form as per equation (3.9).

$$\begin{aligned}\ln\left(\frac{TOC}{w_3}\right) = {} & \beta_0 + \sum_m \alpha_m \ln y_m + \sum_n \beta_n \ln\left(\frac{w_n}{w_3}\right) \\ & + \frac{1}{2}\sum_m \sum_j \alpha_{mj} \ln y_m \ln y_j \\ & + \frac{1}{2}\sum_n \sum_k \beta_{nk} \ln\left(\frac{w_n}{w_3}\right) \ln\left(\frac{w_k}{w_3}\right) \\ & + \sum_n \sum_m \gamma \ln\left(\frac{w_n}{w_3}\right) \ln y_m + u + v\end{aligned} \tag{3.9}$$

Table 3 Sample descriptive analysis

Variable	*Definition*	*Source*	*Mean*	*Std dev*	*Min*	*Max*
		Intellectual capital arguments				
MVAIC	Modified value added intellectual capital. As per equation (3.1)	BankFocus	3.811403	1.055959	1.650858	6.893624
HCE	Human capital efficiency. As per equation (3.2)	BankFocus	2.763238	0.894337	0.926556	5.487889
SCE	Structure capital efficiency. As per equation (3.3)	BankFocus	0.592017	0.160844	-0.079266	0.817781
CEE	Capital employed efficiency. As per equation (3.4)	BankFocus	0.282682	0.156028	0.019398	0.794450
RCE	Relational capital efficiency. As per equation (3.5)	BankFocus	0.173466	0.1620728	-0.003348	1.077799
VA	Value added. As per equation (3.6)	BankFocus	253596.6	344997.2	5885.2	1920939.0
		Stochastic frontier arguments				
y1	Output 1: total loans. Net loans (gross loans – reserve for loan loss	BankFocus	1,684,145.0	1,592,669.0	27,764.8	7,145,195.0
y2	Output 2: total financial securities. Securities held to maturity + securities held for sale	BankFocus	7,108,681.0	9,281,370.0	98,868.9	46,700,000.0
w1	Input 1: price of deposits. Interest expense/total deposits	BankFocus	431,539.0	497,166.0	3,940.0	2,424,408.0
w2	Input 2: price of labour. Salaries/total assets	BankFocus	85,276.0	111,321.0	4,684.0	636,584.0
w3	Input 3: price of physical capital. Expenditure on premises + fixed assets/premises + fixed assets	BankFocus	31,128.0	43,082.0	-42.0	308,570.0
TOC	Total operating cost	BankFocus	169,456.6	200,715.6	9,452.6	1,080,252.0
TE	Technical efficiency		0.815307	0.029568	0.703424	0.891260

Note: All figures in millions of USD except ….

Table 3 Sample descriptive analysis (continued)

Variable	*Definition*	*Source*	*Mean*	*Std dev*	*Min*	*Max*
	Bank specific arguments					
ROA	Ratio of net income to average total assets	BankFocus	0.0069	0.0059	–0.0104	0.0285
CAP	Capitalisation natural logarithm of total equity	BankFocus	678,614.0	640,017.3	134,637.6	2,843,491.0
LIQ	Ratio of liquid assets to total assets	BankFocus	0.0001	0.0003	0.0000	0.0014
SIZE	Size. Natural logarithm of total assets	BankFocus	15.5166	1.1299	12.5310	17.8442
SOLV	Solvency. Total shareholders equity to total assets	BankFocus	0.0985	0.0781	0.0326	0.6141
IncDiv	Income diversity. Non-interest income by total operating income	BankFocus	–0.1559	10.5343	–120.0426	14.3610
OWN	Ownership structure. Dummy variables for SOCB, JSCB and FB bank. 1 if yes, 0 otherwise	State Bank Vietnam	0.0511	0.2209	0.0000	1.0000
	Industry specific arguments					
INDcon	Industry concentration Ratio of total assets of largest five banks to total assets	BankFocus	0.5961	0.0625	0.5460	0.7973
	Country specific arguments					
GDP	Real GDP annual growth rate	World Bank	6.2859	0.5821	5.2500	7.0800
INFL	Inflation, average consumer price (percentage change)	World Bank	4.8361	3.8365	0.9000	18.7000

Note: All figures in millions of USD except ….

TOC is a vector of the dependent variable total cost, γ_m is the m^{th} bank's outputs ($m = 1, 2$). w_n is n^{th} input price ($n = 1, 2$). w_3 is the price of borrowed funds. β is a vector of the coefficients to be estimated. v is a random error identically and independently distributed as $N(0, \sigma_{2n})$. The term μ measures the distance of an individual bank to the efficient frontier and represents a one-sided inefficiency of a bank. For simplicity of presentation, subscripts denoting firm and year have been dropped. SFA inputs and outputs are detailed in Table 3 under stochastic frontier arguments.

3.2 Empirical models

The truncated distribution of bank efficiency scores (between 0 and 1) makes it unsuitable for use with ordinary least square (OLS)[8] regression as it may lead to biased estimated coefficients. We follow previous researchers (Simar and Wilson, 2007; Doan et al., 2018) and employ the bootstrapped truncated regression models[9] as it gives consistent results. For additional robustness, Tobit and fractional regression analysis are also applied as they impose the desired constraint on the dependent variables (Ramalho and da Silva, 2009). We test two models as shown in equations (3.10) and (3.11). The former examines IC as a composite on bank efficiency; the latter examines the individual components of IC on bank efficiency.

$$\begin{aligned} \mathit{Eff}_{i,t} = {} & \beta_0 + \beta_1 \text{MVAIC}_{i,t} + \alpha_1' \sum \text{Bank controls}_{i,t} \\ & + \alpha_2' \sum \text{Industry control}_{i,t} + \lambda' \sum \text{Country controls}_{i,t} \\ & + \sum \text{Year}_i + e_{i,t} \end{aligned} \tag{3.10}$$

$$\begin{aligned} \mathit{Eff}_{i,t} = {} & \beta_0 + \beta_1 \text{HCE}_{i,t} + \beta_2 \text{SCE}_{i,t} + \beta_3 \text{CEE}_{i,t} \\ & + \beta_4 \text{RCE}_{i,t} \alpha_1' \sum \text{Bank controls}_{i,t} + \alpha_2' \sum \text{Industry control}_{i,t} \\ & + \lambda' \sum \text{Country controls}_{i,t} + \sum \text{Year}_i + e_{i,t} \end{aligned} \tag{3.11}$$

where $\mathit{Eff}_{i,t}$ is the TE scores of bank i in time t. *Eff* is positive and equal to zero for a bank with zero efficiencies and one for perfect efficiency. The models incorporate bank, industry and country-specific control variables to account for the influence of confounding factors and bank performance; these are outlined in Table 3. Individual year dummy controls variables were also included to control for year-specific effects.

3.3 Data collection and description

We collected the financial data of 30 Vietnamese commercial banks from 2011 to 2018 from BankFocus. To avoid survivorship bias, past and present commercial banks are included. The sample excludes banks with insufficient financial data for SFA or IC purposes. Banks with less than two years of data were left out, as were those with negative equity, interest expenses, and total revenue.

Table 8 details the efficiency scores by bank and year (see Table 9 for the complete name and the corresponding abbreviation). Over the sample period, efficiency scores declined on average by 0.95%, and of the banks examined, none were fully efficient.

The maximum efficiency score was 0.89 (PVCom), and the minimum efficiency score was 0.70 (VPB). The sample mean efficiency score is 0.818, which implies the average bank could produce 18.2% more output without increasing inputs. Table 8 also presents data by rank size and efficiency. VBARD was the largest bank, measured by total assets, while VIETIN ranked highest by mean efficiency score. Efficiency scores for foreign banks (FB) ranked in the bottom third of the banks examined. FB efficiency scores are at odds with results shown in other foreign country studies and may be attributed to market entry restrictions[10] resulting in an inability to meet local cultural and trust requirements.

Table 3 displays the values for the IC arguments and shows that the mean MVAIC score is 3.81 and largely aligns with Hoang et al.'s (2020) firm performance study. HCE, SCE, CEE, and RCE mean values are all positive; however, the minimum values for SCE and RCE are negative, suggesting wide variation in value creation. As evidenced by the mean score. HCE is the most important of MVAI's components. Also shown in Table 3, the average total assets (SIZE) of Vietnamese banks are approximately VND 5.04 trillion.[11] Summary statistics on the efficiency inputs, bank-specific arguments, industry-specific arguments, and country-specific arguments are also reported in the table. Table 12 provides further descriptive data on the input and output values across the sample period and the respective year-on-year changes. Notably, input values decreased significantly from 2013 to 2015, yet outputs grew from 2014 to 2015 despite decreasing inputs.

Table 11 shows unit roots test. The Phillips-Perron (PP) test does not find evidence against the null hypothesis of unit root for four control variables (LIQ, SOLV, IncDiv, INFL). We note, however, that PP does not perform well on small sample sizes (Cheung and Lai, 1997).[12] Using the augmented Dickey-Fuller (ADF) test, we conclude that all variables are stationary.

Table 10 shows the Pearson correlation coefficients of IC, efficiency, and regression control variables. Correlation figures show a positive relationship between MVAIC and efficiency, indicating that increased IC is associated with efficiency. Examination of the individual IC inputs reveals that all the intangible resources bring increased efficiency withstanding CEE. The inverse relationship between CEE and efficiency aligns with Vidyarthi (2019). Interestingly, CEE is positively correlated with ROA, and in a majority of studies, CEE was found to have a substantially positive association with at least one key performance metric (Zeghal and Maaloul, 2010). In Table 13, variance inflation factor (VIF), a multicollinearity test among independent variables is presented. All VIF values are less than 10, indicating they do not exhibit multicollinearity.[13]

4 Empirical results and discussion

4.1 Truncated, fractional, and Tobit regression models

Regression results for the 240 bank-year observations[14] are displayed in Table 4 and contain the results of truncated, fractional, and Tobit regression, respectively. In the first column of the respective regression, MVAIC is examined against efficiency controlled by this study's respective bank, industry, and country control variables. The results demonstrate a significant positive association between MVAIC and efficiency, suggesting that IC positively affects efficiency. This finding aligns with scholars (see

Adesina, 2019; Meles et al., 2016) and has provided banks with numerous benefits, for it assists them in achieving management and shareholder profit objectives while also guarantying financial stability. Through increasing IC efficiency, banks can avoid increasing asset risk, thereby achieving a certain level of profitability.

Table 4 Regression results

Variable	*Truncated (1)*	*Truncated (2)*	*Fractional (1)*	*Fractional (2)*	*Tobit (1)*	*Tobit (2)*
MVAIC	0.013***		0.049***		0.013***	
	0.00		–0.01		0.00	
HCE		0.018***		0.068***		0.018***
		0.00		–0.01		0.00
SCE		0.02		0.06		0.02
		–0.03		–0.07		–0.03
CEE		–0.159***		–0.568***		–0.159***
		–0.02		–0.05		–0.02
RCE		–0.015		–0.056		–0.015
		–0.02		–0.05		–0.02
ROA	–1.945**	0.078	–7.058***	0.378	–1.945**	0.078
	–0.66	–0.39	–1.99	–1.11	–0.65	–0.39
CAP	–0.03	–0.054***	–0.108**	–0.201***	–0.03	–0.054***
	–0.02	–0.01	–0.04	–0.02	–0.02	–0.01
LIQ	–5.411	–3.416	–20.126	–12.533	–5.411	–3.416
	–6.49	–5.47	–21.19	–17.32	–6.73	–5.55
SIZE	0.017	0.048***	0.063	0.177***	0.017	0.048***
	–0.02	–0.01	–0.03	–0.02	–0.02	–0.01
SOLV	0.11	0.171	0.402**	0.637***	0.11	0.171
	–0.27	–0.12	–0.15	–0.12	–0.24	–0.12
IncDiv	0.00	0.00	0.001*	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
OWN	0.007	–0.007*	0.024*	–0.023**	0.007	–0.007*
	0.00	0.00	–0.01	–0.01	0.00	0.00
INDcon	0.496	0.719	1.524	2.227	0.496	0.719
	–0.97	–0.61	–3.28	–2.03	–0.97	–0.64
GDP	–0.027	–0.041**	–0.09	–0.139**	–0.027	–0.041**
	–0.02	–0.01	–0.08	–0.05	–0.02	–0.01
INFL	–0.025***	–0.009***	–0.089***	–0.033***	–0.025***	–0.009***
	0.00	0.00	–0.01	–0.01	0.00	0.00
Constant	0.824	0.645*	1.034	0.434	0.824	0.645*
	–0.43	–0.27	–1.45	–0.88	–0.44	–0.28
Obs	143	143	143	143	143	143
Wald χ^2	1,535.00	2,988.46	1,628.15	3,817.32	1,613.63	3,112.12
Prob > F	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Coefficients are displayed in the top line with significance denoted as follows: *$\rho < 0.10$, **$\rho < 0.05$, ***$\rho < 0.01$. t-values are presented below the coefficients. Data from 2011–2018.

Table 5 Regression results by bank type

Bank type	*FB and JV*		*SOCB*		*JSCB*	
	(1)	*(2)*	*(1)*	*(2)*	*(1)*	*(2)*
MVAIC	0.006***		–0.047*		0.040***	
	0.00		–0.02		–0.01	
HCE		–0.211***		0.181***		0.052***
		0.00		–0.01		–0.01
SCE		2.913***		–0.675***		0.061
		0.00		–0.16		–0.07
CEE		0.448***		–0.763***		–0.521***
		0.00		–0.04		–0.03
RCE		–0.501***		0.155***		–0.056
		0.00		–0.01		–0.05
_cons	–1.333***	8.278***	4.924**	–1.221***	0.791	0.243
	0.00	0.00	–1.69	–0.25	–1.41	–0.94
Controls	yes	yes	yes	yes	yes	yes
Obs	11	11	20	20	112	112
Wald χ^2	1,260,000	2,860,000	69,067.85	13,300,000	212.54	830.42
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00

Notes: To save space, control variables were not reported. Fractional regression is the testing method. Coefficients are displayed in the top line. Significance is denoted as *$\rho < 0.10$, **$\rho < 0.05$, ***$\rho < 0.01$. t-values are presented below the coefficients. Data from 2011–2018.

Table 6 Endogeneity check results

	2SLS (1)	*2SLS (2)*	*SGMM (1)*	*SGMM (2)*
Lag_Eff				
MVAIC	0.018*		0.040**	
	–0.01		–0.01	
HCE		0.050***		0.116**
		–0.01		–0.03
SCE		–0.008		–0.064*
		–0.01		–0.03
CEE		–0.037***		–0.053*
		0.00		–0.02
RCE		–0.006**		–0.013
		0.00		–0.01
_cons	0.917***	0.764***	12.151	12.095
	–0.03	–0.04	–11.8	–7.7
Controls	yes	yes	yes	yes
Obs	176	173	176	173
Durbin/AR1 (Prob)	0.000	0.030	0.232	0.505
Wu-Hausman/AR2 (Prob)	0.000	0.035	0.064	0.370
Sargan/Sargan	0.026	0.030	0.000	0.017
Basmnann/Hansen	0.026	0.035	1.000	1.000

Notes: To save space, control variables were not reported. 2SLS is two-stage least squares regression. SGMM is system generalised methods of moments regression. Coefficients are displayed in the top line. AR(1) and AR(2) are Arrelano-Bond tests for first-order and second-order serial correlation, respectively, under the null hypothesis of no serial correlation. The Sargan and Hansen statistics examine the validity of the independent variable. Significance is denoted as *$\rho < 0.10$, **$\rho < 0.05$, ***$\rho < 0.01$. t-values are presented below the coefficients. Data from 2011–2018.

Table 7 Summary of study results

	Truncated	*Fractional*	*Tobit*	*2SLS*	*SGMM*	*FB*	*SOCB*	*JSCB*
MVAIC	+✓	+✓	+✓	+✓	+✓	+✓	–✓	+✓
HCE	+✓	+✓	+✓	+✓	+✓	–✓	+✓	+✓
SCE	+	+	+	–	–✓	+✓	–✓	–
CEE	–✓	–✓	–✓	–✓	–✓	+✓	–✓	–✓
RCE	–	–	–	–✓	–	–✓	+✓	–

Notes: The + (–) indicates positive (negative) association with efficiency.
The check-mark (✓) indicates statistical significance.

When examining the four IC inputs individually, only HCE and CEE showed statistical significance, and CEE's coefficient was strongly negative. The positive relationship between HCE and efficiency supports Hypothesis 2a and demonstrates the critical role of human capital in enhancing efficiency via an enhanced knowledge base. Without academic knowledge and practical experience, which stems from HCE, banks may fail to handle financial risks and client relations. This results in decreased efficiency.

The large negative CEE coefficient indicates that greater capital resources reduce efficiency. This finding also aligns with Adesina (2019) and Chen et al. (2005) yet fails to support Hypothesis 2d. The authors have shown a strong positive correlation between all IC inputs and efficiency. The rationale for this finding might be linked to competition incentives. In environments with high competition, banks strive for higher capital ratios yet are required to maintain a set level of capital depending on their asset risk, particularly in nations with a smaller banking sector (Brewer et al., 2008). The State Bank of Vietnam required banks to maintain a capital adequacy ratio (CAR) 1% higher than the Basel II accord requires (Dao and Nguyen, 2020). Reducing capital levels may bring about greater efficiency but causes risk management difficulties. From this opposing relationship, it follows that banks should evaluate such a trade-off solely to improve efficiency. The findings that greater capital employed brings about decreased efficiency find support in Dang's (2019) finding that banks with bigger capital buffers take fewer risks and are less profitable. This finding is further corroborated by the market capitalisation control variable, demonstrating that greater capital reserves are associated with reduced efficiency.

Neither SCE nor RCE were found to impact TE levels, thus finding no support for Hypothesis 2b or Hypothesis 2d. SCE findings align with Ozkan et al. (2017), Joshi et al. (2013) and Ting and Lean (2009) who likewise found no significant relationship between SCE and performance. While Corvino et al. (2019) also failed to find a relationship between RCE and performance in European listed banks.

In explaining the effects of included control variables, we first note the negative association between ROA and efficiency, which suggests that riskier banks are less efficient as ROA connects abnormal operating activity with performance (Huang and Sun, 2017; Martens et al., 2020). Second, when the IC components are examined individually, results reveal a positive association between size and efficiency, indicating that bigger banks are more efficient in allocating expenditures. This conclusion is corroborated by Peng et al. (2017). Third, controlling for industry concentration failed to influence bank efficiency levels. This finding directly opposes the central tenant of the quiet life hypothesis, which asserts that market power enables businesses to raise prices and generate additional revenue otherwise wasted due to cost inefficiencies (Berger and

Hannan, 1998). Fourth, the country factors of GDP and inflation are inversely associated with efficiency. This latter finding infers that a favourable economic environment of increased GDP per capita may result in increased bank savings and deposits, reduced customer deposit fees, and reduced efficiency due to decreased inputs (Martens et al., 2021). Inflation, a critical component in economic growth, harms bank profitability, particularly when undetected. Profitability is contingent upon effective cost control. However, rising inflation distorts cost-cutting efforts (Guru et al., 2002).

4.2 Results by bank type

While the earlier models present our baseline data, we also conduct sensitivity assessments by evaluating a subset of banks by ownership type. We analyse SOCB, JSCB, and FB separately using fractional regression due to the small sample size and conditional mean. Table 5 shows that despite lower efficiency scores for FB,[15] MVAIC reports a positive impact on efficiency, as does SCE and CEE. These results reveal notably different results than when testing all banks collectively for HCE revealed them to have a significantly negative relationship with efficiency. This finding is in direct opposition to earlier findings suggesting structural capital and capital employed were internally transformed to the bank's advantage differently than in other bank ownership types.

SOCB shows all individual IC variables as statistically significant, with SCE and CEE showing an inverse relationship with efficiency. Attribution of this novelty may be the commitment of SOCB to acquire and retain both internal and external structural capital (Rahman and Ahmed, 2012), In SOCB, MVAIC purports to be inversely related to efficiency. However, we suggest this variable is weighed by the strongly negative effect of CEE and SCE. The results for JSCB show complete alignment with the results of the collective.

4.3 Endogeneity check

Econometrically, MVAIC and its constituents may be endogenous due to omitted variables and cause reverse causality. Further, economic success may also influence MVAIC as wealthy banks may raise staff bonuses, thereby raising HCE. Wealthy banks may also reinvest earnings in physical and financial assets, thereby growing CEE (Vo and Nguyen, 2018). To manage endogeneity concerns, the system generalised method of moments (SGMM) is an ideal testing method for Soto et al. (2009) notes that in an examination of the bidirectional relationship of IC finds that SGMM is the best estimator for small sample sizes and short time horizons. SGMM can also incorporate internal instruments. As a result, we re-estimate equations (3.10) and (3.11) using a robust one-step SGMM, and one-period lagged independent variables. We also conduct instrument-based two-staged least squares (2SLS) for comparison purposes.[16] To account for the endogeneity in the association between efficiency and IC requires instrumental variables (IV) related to one endogenous variable but not to the other (Elsas et al., 2010). Lagged variables are often utilised in econometrics as IVs; we therefore follow Chen et al. (2018) and utilise year dummy variables as standard IVs. Endogeneity regressions results are shown in Table 6.

Endogeneity tests largely confirm earlier results, with the exception of SCE. Earlier results show a positive yet insignificant result for SCE. Using 2SLS, SCE becomes

negative yet insignificant. In SGMM, SCE becomes negative and statistically significant, suggesting it may correlate with other factors within the study. This does not change the decision on Hypothesis 2b, as we continue to reject a positive association between SCE and efficiency. Overall, from earlier baseline results and these endogeneity checks, we find validity in Hypotheses 1 and 2a. Table 7 provides a summary of the results from this study.

5 Conclusions

This study is the first to examine the linkages between IC (and its components: HCE, SCE, CEE, and RCE) on performance as measured by TE in the Vietnamese banking sector. This provides a unique opportunity to investigate the association of IC and TE after controlling for bank type, industry, and country factors. As a thriving banking sector is essential to the financial system and the expansion of an economy, examining the efficiency trend and the IC factors that influence efficiency provides evidence of which factors provide the greatest long-term stability. The examination also helps identify the basic drivers of organisational performance, which, according to resource-based theory, are the firm's resources, both real and intangible (Kamaluddin and Rahman, 2013).

Examining IC and its components using various regression methods on Vietnamese bank data from 2011 to 2018 reveals that not all resources contribute to efficiency. Increases in relationship capital are ineffective at increasing efficiency, except in State-owned banks. Their monopolistic power, increased government support, and early entry restrictions on foreign competition may have contributed to greater brand loyalty, as demonstrated by the positive RCE and efficiency relationship. Additionally, research suggests that the FB and JSCB banks in Vietnam have been ineffective in implementing relational capital in promoting long-term business growth. The inability of the latter banks to directly convert relationship capital into high levels of efficiency suggests that indirect relationship capital with partners, customers, vendors, and the general public may require examination. Findings also reveal that employing greater amounts of capital results in decreased efficiency. Decreasing capital may, however, detrimentally impact risk management. Throughout the study, human capital was found to favourably impact efficiency except in Foreign-owned banks. This latter finding might suggest that foreign banks have not fully prioritised human resource development over physical capital asset development. The data demonstrates most convincingly that human capital has a favourable effect on TE. Thus, it can be seen that activities such as staff training provide the organisation with the competencies needed for increased productivity.

5.1 Practical implications

Four practical implications flow from the current findings. First, these insights serve the broader corporate sector as they shed light on ways to improve efficiency through IC. Banks should prioritise the human capital component of IC. The data indicates the other IC components have limited or non-existent efficiency-enhancing characteristics. Second, the report's findings may aid Vietnam's regulators in governing the banking sector. Regulators are suggested to review IC components that align with national objectives and allocate investing funding to IC areas that benefit the country's long-term

economic trends. Third, banks may balance input efficiency factors, prioritising those that boost their business's performance and competitive edge. By identifying inefficient inputs, such as capital employed, managers can avoid growing capital employed and increasing bank risk. Fourth, all stakeholders may benefit from creating IC development programs that prioritise human capital, such as training and education.

5.2 Theoretical implications

Resources are frequently thought to have intrinsic worth, while RBT recognises that resources have numerous applications. A move to a knowledge-based economy imposes new strategic management needs, necessitating the development of novel perspectives on value creation and sustained competitive advantage. The RBT framework has linked value, strategy, and IC in pursuit of an ongoing quest for a deeper understanding of the value creation process. RBT's concern with the development and conservation of precious resources, as examined through Vietnamese banks reveals that tangible resources play a smaller role in value creation than intangible resources. This finding is consistent with Firer and Williams (2003), and thus a theoretical disconnect emerges for some precious resources may be value-destroying.

5.3 Limitations

We are aware that our study focuses exclusively on Vietnamese banks during a period of economic expansion. Future studies may consider reviewing specific periods (i.e., in 2013, the output growth noted a remarkable decline) to ascertain the degree to which generalised findings for the entire period may have been moderated by a single year. It may also be of interest to extend the study to include additional emerging market banks to increase the transferability of findings to other markets. Vietnam-specific accounting procedures and security exchange regulations may affect study inputs and outputs; consequently, the findings may be localised to a single market.

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Notes

1 Vietnam was once considered to be the next Asian dragon as its gross domestic product (GDP) grew approximately 6.2%, compared to China's 8.36%.

2 The service sector is expected to account for 60% of GDP by 2030, while the financial sector employs nearly 500,000 people and contributes roughly 5.37% of GDP to the Vietnamese economy (Statista, 2021).

3 Behind Indonesia, Malaysia, Philippines, and Thailand as measured by gross domestic product in 2020.

4 Averaging a 9.6% annual growth rate.

5 Ståhle et al. (2011) notes the VAIC only focuses on corporate labour and capital investment efficiency rather than IC efficiency, while Smriti and Das (2018) states the original VAIC model ignores the firm's relational and innovation capital.

6 Outside entities include consumers, shareholders, and banks. and any other agents that may impact the organisation's well-being.

7 See Isola et al. (2020) and Murale et al. (2010).

8 The OLS approach is based on the assumption of a normal and homoskedastic distribution (Maddala and Lahiri, 1992).

9 We utilise 5,000 simulated observations to verify the regression model's goodness of fit and to estimate bootstrap confidence intervals for the parameter estimates $\widehat{\beta}_1 - \widehat{\beta}_3$.

10 Foreign banks with 100% foreign ownership was not granted until 2008 and was only given full national treatment in 2011.

11 At the start of this study's period, only 21% of Vietnamese adults held a bank account. That figure rose to 30% in 2017, indicating that the update in banking services and penetration of banking services is low. World Bank (2017) suggests that the banks in Vietnam have not had more than two decades of operational experience.

12 Sample sizes between 100–10,000.

13 VIF approaching 10 is a commonly used rule of thumb indicator of problematic collinearity (O'Brien, 2007).

14 Pooled data of 30 banks and eight years (2011–2018).

15 As noted by the efficiency rank in Table 3.

16 Durbin-Wu-Hausman results in Table 6 we reject the null hypothesis that all regressors are exogenous) at the 5% level.

Appendix 1

Table 8 Efficiency scores by banks by years

Bank	*Year*								*Descriptives*				*Rank*	
	2011	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*Mean*	*CAGR*	*Max*	*Min*	*Size*	*Efficiency*
							JSCB							
ABB	0.000	0.000	0.849	0.842	0.825	0.815	0.802	0.793	0.821	–1.13%	0.849	0.793	19	16
ACB	0.846	0.812	0.818	0.812	0.803	0.791	0.779	0.766	0.803	–1.23%	0.846	0.766	6	26
BACA	0.000	0.000	0.842	0.847	0.842	0.834	0.832	0.819	0.836	–0.46%	0.847	0.819	20	6
BVSC	0.000	0.000	0.854	0.000	0.000	0.839	0.838	0.834	0.841	–0.59%	0.854	0.834	22	3
HDB	0.000	0.000	0.850	0.830	0.811	0.809	0.786	0.774	0.810	–1.55%	0.85	0.774	12	23
KLB	0.000	0.000	0.825	0.795	0.795	0.777	0.753	0.728	0.827	–2.06%	0.825	0.728	26	10
LPB	0.000	0.000	0.834	0.841	0.829	0.816	0.786	0.771	0.844	–1.30%	0.841	0.771	13	2
MDB	0.000	0.000	0.796	0.823	0.000	0.000	0.000	0.000	0.831	1.68%	0.823	0.796	29	8
MBB	0.853	0.842	0.843	0.835	0.826	0.805	0.776	0.748	0.779	–1.63%	0.853	0.748	7	28
NAB	0.000	0.000	0.853	0.839	0.825	0.810	0.000	0.000	0.813	–1.28%	0.853	0.810	23	22
NVB	0.842	0.819	0.835	0.834	0.831	0.806	0.806	0.000	0.810	–0.62%	0.842	0.806	21	24
PGB	0.000	0.000	0.845	0.842	0.834	0.829	0.812	0.796	0.816	–0.99%	0.845	0.796	27	18
SCB	0.000	0.000	0.836	0.839	0.838	0.000	0.826	0.794	0.832	–1.03%	0.839	0.794	4	7
SHB	0.847	0.836	0.841	0.828	0.821	0.807	0.795	0.803	0.825	–0.66%	0.847	0.795	10	14
SBS	0.821	0.805	0.805	0.788	0.798	0.790	0.800	0.743	0.826	–1.24%	0.821	0.743	5	12
SSB	0.000	0.000	0.000	0.000	0.000	0.000	0.835	0.818	0.827	–1.02%	0.835	0.818	14	9
TPB	0.000	0.000	0.864	0.860	0.862	0.849	0.815	0.778	0.822	–1.73%	0.864	0.778	18	15
EIB	0.859	0.830	0.841	0.838	0.809	0.806	0.793	0.763	0.827	–1.47%	0.859	0.763	11	10
VIB	0.000	0.000	0.836	0.829	0.824	0.818	0.803	0.783	0.809	–1.09%	0.836	0.783	17	25
MSB	0.000	0.000	0.829	0.805	0.791	0.794	0.788	0.782	0.838	–0.97%	0.829	0.782	15	5
VPB	0.000	0.000	0.817	0.809	0.775	0.758	0.718	0.703	0.826	–2.47%	0.817	0.703	8	13
PVCOM	0.000	0.000	0.891	0.000	0.818	0.812	0.000	0.000	0.776	–2.29%	0.891	0.812	16	29
TCB	0.850	0.832	0.823	0.817	0.809	0.801	0.793	0.780	0.817	–1.07%	0.850	0.78	9	17

Note: Means scores are calculated on data points where available. Growth rates are estimated as the annual compound growth rate from the first non-zero observation to the last non-zero observation. Size rank is listed from largest to smallest based on Total Assets, with one being the largest. Efficiency rank is based on mean efficiency and listed from most to least efficiency, with one being the most efficient. CAGR is compounded annual growth rate.

Table 8 Efficiency scores by banks by years (continued)

Bank	*Year*								*Descriptives*				*Rank*	
	2011	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*Mean*	*CAGR*	*Max*	*Min*	*Size*	*Efficiency*
							FB							
HLBVN	0.000	0.000	0.000	0.827	0.826	0.000	0.000	0.000	0.816	–0.001	0.827	0.826	30	19
SCBV	0.000	0.000	0.830	0.830	0.800	0.803	0.787	0.000	0.815	–0.011	0.830	0.787	24	20
WB	0.000	0.000	0.000	0.000	0.000	0.000	0.855	0.834	0.798	–0.012	0.855	0.834	28	27
IVB	0.000	0.000	0.847	0.850	0.846	0.854	0.835	0.830	0.763	–0.003	0.854	0.830	25	30
							SOCB							
VCB	0.840	0.846	0.842	0.844	0.838	0.825	0.813	0.803	0.840	–0.006	0.846	0.803	3	4
VBARD	0.000	0.783	0.763	0.807	0.793	0.784	0.766	0.734	0.813	–0.009	0.807	0.734	1	21
VIETIN	0.836	0.829	0.828	0.823	0.822	0.809	0.792	0.782	0.845	–0.008	0.836	0.782	2	1
Mean	*0.253*	*0.274*	*0.751*	*0.718*	*0.710*	*0.675*	*0.693*	*0.625*	*0.818*	*–0.95%*	*0.89%*	*0.70%*		

Note: Means scores are calculated on data points where available. Growth rates are estimated as the annual compound growth rate from the first non-zero observation to the last non-zero observation. Size rank is listed from largest to smallest based on Total Assets, with one being the largest. Efficiency rank is based on mean efficiency and listed from most to least efficient, with one being the most efficient. CAGR is compounded annual growth rate.

Appendix 2

Table 9 List of commercial banks in the research sample

No.	*Name of bank*	*Abbreviation*
	Joint stock commercial banks (JSCB)	
1	An Binh Joint Stock Commercial Bank	ABB
2	Asia Joint Stock Commercial Bank	ACB
3	Bac A Joint Stock Commercial Bank	BACA
4	Bao Viet Joint Stock Commercial Bank	BVSC
5	Ho Chi Minh City Development Joint Stock Commercial Bank	HDB
6	Kien Long Joint Stock Commercial Bank	KLB
7	Lien Viet Post Joint Stock Commercial Bank	LPB
8	Mekong Development Joint Stock Commercial Bank	MDB
9	Military Joint Stock Commercial Bank	MBB
10	Nam A Joint Stock Commercial Bank	NAB
11	National Citizen Joint Stock Commercial Bank	NVB
12	Petrolimex Group Joint Stock Commercial Bank	PGB
13	Sai Gon Joint Stock Commercial Bank	SCB
14	Saigon-Hanoi Joint Stock Commercial Bank	SHB
15	Saigon Thuong Tin Joint Stock Commercial Bank (SACOMBANK)	SBS
16	Southeast Asia Joint Stock Commercial Bank	SSB
17	Tien Phong Joint Stock Commercial Bank	TPB
18	Vietnam Export Import Joint Stock Commercial Bank (EXIMBANK)	EIB
19	VietNam International Joint Stock Commercial Bank (VIB)	VIB
20	Vietnam Maritime CS Bank	MSB
21	Vietnam Prosperity Joint Stock Commercial Bank	VPB
22	Vietnam Public Joint Stock Commercial Bank (PVCom)	PVCOM
23	Vietnam Technological and Joint Stock Commercial Bank (Techcombank)	TCB
	Foreign banks including joint-venture banks (FB)	
24	Hong Leong Bank Vietnam Limited	HLBVN
25	Standard Chartered Bank (Vietnam)	SCBV
26	Woori Bank Vietnam	WB
27	Indovina Bank*	IVB
	State-owned commercial bank (SOCB)	
28	Commercial Bank for Foreign Trade of Vietnam (Vietcombank)	VCB
29	Vietnam Bank for Agriculture and Rural Development (Agribank)	VBARD
30	Vietnam CSJ Bank for Industry and Trade (VietinBank)	VIETIN

Notes: * indicates a joint venture bank. The joint-venture partners are Vietnam Joint Stock Commercial Bank for Industry and Trade (Vietinbank) and Cathay United Bank in Taiwan (CUB).

Appendix 3

Table 10 Pearson correlation matrix

	MVAIC	*HCE*	*SCE*	*CEE*	*RCE*	*EFF*	*ROA*	*CAP*	*LIQ*	*SIZE*	*SOLV*	*IncDiv*	*INDcon*	*GPD*
MVAIC	1													
HCE	0.9861	1												
SCE	0.9022	0.8964	1											
CEE	0.5491	0.4441	0.4408	1										
RCE	–0.2999	–0.3775	–0.4776	–0.2562	1									
EFF	0.0214	0.093	0.105	–0.5223	0.0273	1								
ROA	0.7058	0.6878	0.6167	0.4929	–0.2546	–0.2058	1							
CAP	0.4589	0.3934	0.4071	0.5919	–0.127	–0.3323	0.3553	1						
LIQ	–0.2562	–0.2608	–0.234	–0.1785	0.1793	0.0309	–0.1246	–0.115	1					
SIZE	0.3882	0.3197	0.3714	0.6303	–0.2023	–0.2917	0.2309	0.9339	–0.1309	1				
SOLV	–0.1175	–0.1006	–0.1885	–0.3449	0.3589	0.0225	0.019	–0.2797	0.0538	–0.5593	1			
IncDiv	–0.0742	–0.0787	–0.0758	0.0277	–0.0094	0.1044	0.0106	–0.0343	0.0215	0.0286	–0.0884	1		
INDcon	0.0666	0.0642	0.0504	0.0335	0.0048	0.2115	0.1065	0.0502	0.1738	0.0279	0.0038	0.0428	1	
GPD	0.0613	0.069	0.063	0.1318	–0.1997	–0.3757	0.0339	–0.0416	–0.2105	0.0078	–0.0399	0.0258	–0.3082	1
INFL	0.06	0.0417	0.0454	0.0423	0.1003	0.1348	0.1856	0.1398	0.1244	0.1115	–0.0463	0.0208	0.498	–0.7375

Appendix 4

Table 11 Panel data unit root tests

Variable	*ADF test*	*PP test*
	Coefficient	*Coefficient*
MVAIC	138.4573***	190.4383***
HCE	140.21***	248.0993***
SCE	126.7264***	215.105***
CEE	91.5262***	137.4847***
RCE	153.9157***	277.9537***
EFF	183.532***	876.1046***
ROA	108.5915***	243.8303***
CAP	81.0876****	71.9289***
LIQ	47.8572***	23.1300
SIZE	78.4718***	216.2405***
SOLV	97.9411***	62.3734
IncDiv	134.7758***	58.3118
INDcon	193.6112***	115.0619***
GDP	88.1515***	140.2971***
INFL	209.1783***	41.1732

Notes: ADF and PP are the augmented Dickey-Fuller unit root test and the Phillips-Perron test, respectively. ***1% level of significance.

Appendix 5

Table 12 Changes in outputs and inputs

Year		*Input*			*Output*	
		w1	*w2*	*w3*	*y1*	*y2*
2011	Value	686,441.9	76,603.7	43,218.5	1,317,827.4	7,693,897.0
2012	Value	818,913.6	120,048.4	43,803.7	1,589,265.8	9,170,211.0
	Growth (2011–2012)	19.3%	56.7%	1.4%	20.6%	19.2%
2013	Value	364,394.8	57,568.5	31,333.3	1,106,919.1	4,888,911.5
	Growth (2011–2012)	–55.5%	–52.1%	–28.5%	–30.4%	–46.7%
2014	Value	337,486.8	60,520.0	30,289.2	1,468,776.8	5,684,163.5
	Growth (2012–2013)	–7.4%	5.1%	–3.3%	32.7%	16.3%
2015	Value	328,189.1	70,090.1	26,068.6	1,585,348.0	6,414,992.0
	Growth (2013–2014)	–2.8%	15.8%	–13.9%	7.9%	12.9%
2016	Value	359,855.6	79,405.7	25,683.7	1,823,188.1	6,965,977.0
	Growth (2014–2015)	9.7%	13.3%	–1.5%	15.0%	8.6%
2017	Value	450,641.9	102,026.7	35,866.1	1,946,671.2	8,854,689.0
	Growth (2016–2017)	25.2%	28.5%	39.7%	6.8%	27.1%
2018	Value	565,225.8	126,222.6	37,396.4	2,109,644.5	10,453,126.0
	Growth (2017–2018)	25.4%	23.7%	4.3%	8.4%	18.1%

Notes: Inputs *w1*, *w2*, *w3* are the price of physical capital, salary expenditures, and interest expenditures, respectively. Outputs *y1* and *y2* total securities and net loans.

Appendix 6

Table 13 Variance inflation factor results

Variable	*VIF*	*1/VIF*	*Variable*	*VIF*	*1/VIF*
MVAIC	-	-	MVAIC	2.48	0.40
HCE	6.36	0.16	HCE	-	-
SCE	6.24	0.16	SCE	-	-
CEE	3.01	0.33	CEE	-	-
RCE	1.56	0.64	RCE	-	0.64
ROA	2.9	0.35	ROA	2.4	0.42
LIQ	1.17	0.85	LIQ	1.16	0.86
SIZE	2.29	0.44	SIZE	1.82	0.55
SOLV	1.95	0.51	SOLV	1.65	0.60
IncDiv	1.03	0.97	IncDiv	1.03	0.97
Bank_Type	1.77	0.57	Bank_Type	1.21	0.83
INDcon	1.41	0.71	INDcon	1.4	0.72
GDP	2.55	0.39	GDP	2.52	0.40
INFL	3.11	0.32	INFL	3.09	0.32
Mean VIF	2.72		Mean VIF	1.88	

Notes: Truncated regression was used to generate VIF statistics. These VIF results are comparable to the other models; thus, only this model is provided.