Should bankers be concerned with Intellectual capital? A study of the Thai banking sector

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Abstract

Purpose – The purpose of this paper is to examine the causal effect of intellectual capital (IC) performance on financial performance at Thai listed banks.

Design/methodology/approach – Data are collected from 16 listed banks in Thailand for the period 1997–2016. This paper uses the value-added intellectual coefficient methodology suggested by Pulic (1998, 2004) to measure IC. This study employs a fixed-effects and random-effects model and generalized method of moments (GMM) estimator to investigate the causal effect of IC on financial performance.

Findings – The results show that bank profitability is driven mainly by capital employed efficiency to make a profit. However, human capital efficiency marginally reduces bank profitability in the current period but has positive effects on future profitability.

Research limitations/implications – First, this study does not cover data on foreign banks, which reduces the generalizability of the results. Second, financial statements can be manipulated through accounting adjustments. Lastly, subsequent research should control for more bank characteristics, such as bank ownership, the non-performing loan ratio and R&D expenditure.

Practical implications – To achieve higher future profitability, banks should not only manage their physical and financial capital effectively but also improve employee efficiency.

Originality/value – This paper contributes to the literature on IC in the banking sector in emerging countries. Moreover, this paper is the first to employ the GMM method in the banking context to address possible endogeneity problems.

Keywords Financial performance, VAIC, Thailand, Intellectual capital, Banking sector

Paper type Research paper

1. Introduction

Before the advent of the information society, people traditionally focused on input factors, such as labor, capital and raw materials, and other, intangible factors were gradually added and gained priority in companies' operations and survival. Now, knowledge, information technology and intellectual skills are the principal resources that organizations need to be effective and to gain a sustainable competitive advantage (Gogan *et al.*, 2016).

Despite the emerging recognition of intellectual capital (IC), the accounting profession has not addressed the problem of how to measure and report the results of knowledge-based firms (Eckstein, 2004). In this knowledge era, in which IC is considered a significant part of the value of products manufactured by companies, the regular reporting systems show only a portion of IC, such as the value of intangible assets (royalty fees, licenses and trademarks). It is widely understood that financial statements do not attempt to represent the actual value of companies and thus underestimate the value of intangible factors. Moreover, the current accounting standards rarely recognize intangible investment (Zéghal and Maaloul, 2010). Therefore, stakeholders have clamored for the introduction of comprehensive information on IC in company reports.

To satisfy this demand, many methods have been developed to measure the impact of IC on creating value and increasing firm financial performance (Edvinsson, 1997; Edvinsson and Sullivan, 1996; Kaplan and Norton, 1996; Roos *et al.*, 1997). Pulic (1998, 2004) developed a model to analyze the value-added intellectual coefficient (VAIC) in order to measure the efficiency of IC.

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In general, VAIC is an analytical procedure designed to enable management, shareholders and other relevant stakeholders to effectively monitor and evaluate the efficiency of value added by a firm's total resources and each major resource component (Firer and Williams, 2003, p. 352). Most recent studies use this model to measure the relationship between IC and financial performance (e.g. Al-Musali and Ku Ismail, 2014; Meles *et al.*, 2016; Ozkan *et al.*, 2017).

The banking system is an ideal environment in which to perform research about IC because it is one of the most knowledge-intensive industries (Firer and Williams, 2003). First, banking operations are highly dependent on customers to create competitive advantages. Second, bank products are not manufactured goods but, rather, services whose value is based on IC. Finally, to provide clients with the best services, banks have to invest in human resources, brand names, systems and processes. Thus, it is essential for banks to manage their IC as efficiently as possible.

The Thai banking system is an interesting subject for IC research. Young *et al.* (2009) compares the IC performance of commercial banks in eight Asian economies from 1996 to 2001. Using the VAIC method, they indicate that Thailand has the greatest improvement in IC performance. However, Thailand was the first country to suffer from the Asian financial crisis in 1997. Although it happened a long time ago, research on the Thailand banking system is still needed to clarify the importance of IC and maintaining its sustainability. Moreover, because of globalization, competition in the banking industry has become fiercer than ever, increasing pressure on bank performance. Before the 2008 financial crisis, most banks made a profit through risky investments, but this precipitated a global crisis. Afterward, governments tried to control the banking sector through greater regulation of mergers and acquisitions as well as the adoption of policies such as the Basel framework. Therefore, banks now seek to establish effective and sustainable operations and increase profitability.

This paper aims to fill these gaps in the literature on the existing debates, with mixed findings on the causal effects between VAIC, its components and financial performance. First, we adopt the VAIC model developed by Pulic (1998, 2004) to measure the IC performance of 16 listed banks in Thailand over the period 1997–2016. Then, we investigate the relationship between IC and financial performance to determine which components contribute most to profitability in Thailand.

This study contributes to the literature in that it provides understanding on how to evaluate IC performance in the Thai banking sector. Moreover, it also identifies the potential role of IC in bank financial performance in Thailand. This paper also contributes to the ongoing literature on the determinants of banking profitability (e.g. Garcia and Guerreiro, 2016; Menicucci and Paolucci, 2016; Petria *et al.*, 2015). It not only helps banks to improve their profitability but also supports policy makers in reaching their financial stability goals. Finally, in consideration of possible endogeneity problems and the dynamic characteristics of banking profitability, we employ the generalized method of moments (GMM) model, which has not been widely used before, to ensure that our estimation results are robust.

The results provide evidence of a relationship between IC's components and financial performance. In particular, the efficiency of physical and financial capital significantly drives bank profitability. Human capital efficiency (HCE) slightly reduces the return on assets (ROA) in the same period but increases profitability after three quarters on average. In this sense, it is necessary to pay special attention to the capital employed by managing it effectively. Moreover, this suggests that, to improve future profitability, banks should consider employee efficiency.

The remainder of this study is structured as follows. Following this introduction, Section 2 provides the theoretical basis for our research. In Section 3, we present the data, definitions of the variables and methodology used to analyze the mechanism by which IC improves profitability. Section 4 offers empirical results, related discussion and a robustness check, followed by concluding remarks in Section 5.

2. Literature review

The concept of IC is still a subject of ongoing debate for several reasons. It has no universally accepted definition, as it is discussed in various disciplines and from different perspectives, including economics, strategy, finance, accounting, human resources, reporting and disclosure, marketing and communication. Additionally, the concept of IC is not only often ill-defined but also has a lack of agreement across various definitions (Marr and Moustaghfir, 2005). For example, Edvinsson and Sullivan (1996, p. 358) define IC simply as "knowledge that can be converted into value." Stewart (1997, p. x) adds more details and defines IC as "intellectual material – knowledge, information, intellectual property, experience – that can be put to use to create wealth" whereas Marr and Moustaghfir (2005, p. 1116) state: "Intellectual capital embraces any valuable intangible resource gained through experience and learning that can be used in the production of further wealth." As a consequence, researchers and industrial experts struggle to measure IC and its components.

This study employs the VAIC method, which was proposed by Pulic (1998, 2004) to measure IC because of its advantages. Iazzolino and Laise (2013) address the conceptual and methodological aspects of VAIC. In evaluating Pulic's proposed contribution to the literature, they critically review and clearly explain what Pulic means and then identify the conceptual misunderstanding of the terms used in the VAIC model. They compare Pulic's approach with those of his critics and find that his method does not modify or contradict any of the fundamental accounting principles from a methodological point of view. In a nutshell, they indicate that Pulic's model is innovative, both theoretically and methodologically.

Empirically, the VAIC model is widely employed to measure the relationship between IC and financial outcomes and confirm a positive correlation between them. For example, Meles *et al.* (2016) use a sample of 5,749 banks from 2005 to 2012 in the USA to prove that VAIC positively affects banking financial performance. Moreover, this study also finds that human capital – a component of VAIC efficiency – has a larger impact on bank performance than other elements. Al-Musali and Ku Ismail (2014) show that VAIC performance is positively associated with banking financial performance and that HCE has a significant impact on ROA and the return on equity (ROE), using data on listed banks in Saudi Arabia. Joshi *et al.* (2013) use the VAIC method to investigate IC performance in the Australian financial sector over the period 2006–2008. They find that human capital highly influences the value creation capability of the financial sector in Australia. Moreover, the results show that the performance of VAIC and its components differs across all subsectors. In particular, investment companies rely on a high level of human capital to earn a higher VAIC value, whereas insurance companies focus on physical capital that lowers their VAIC level. Ting and Lean (2009) examine IC performance and its relationship with performance at financial institutions in Malaysia from 1999 to 2007. They reveal that VAIC is positively correlated with ROA in the Malaysian financial sector. In addition, they show that variance in HCE, capital employed efficiency (CEE) and structural capital efficiency (SCE) helps to explain 71.6 percent of the variance in ROA. Kamath (2007) focuses on Indian banks from 2000 to 2004. The results indicate that foreign banks are clearly the top performers in HCE while public sector banks are the top performers in CEE. Furthermore, foreign banks are the top performers in value creation efficiency. He also explains that public sector banks seem to have a large and inefficient workforce, which does not contribute anything to overall value creation.

Regarding the context of Thailand, some previous studies investigate the causal effect of IC on financial performance using the VAIC model approach. Phusavat *et al.* (2011) use data on leading manufacturing firms listed on the Thai stock exchange. They find that IC positively and significantly affects firm performance. Appuhami (2007) studies a sample of 33 banking, insurance, and finance companies in Thailand in 2005. Using the VAIC approach, the empirical research finds that IC has a significant, positive association with investors' capital gains.

Using half-year bank-level data, including commercial banks registered in Thailand (Thai banks) and foreign bank branches, from 2000 to 2007, Saengchan (2007) estimates the relationship between VAIC, its components, and financial performance, including ROA and the ratio of costs to assets, using a linear multiple regression analysis. The results show a strong association between IC efficiency and bank financial performance.

Although the literature shows that IC performance should have positive effects on profitability, some studies have results that disprove this hypothesis. Using the VAIC method to examine this relationship, Ozkan *et al.* (2017) show that IC (measured by VAIC) has no statistically significant correlation with financial performance, using data from the Turkish banking sector. However, when they break down the components of VAIC, HCE is the most crucial factor that drives profit in the banking sector in Turkey. However, Chang and Hsieh (2011), using a sample of 367 Taiwanese semiconductor companies, discover that IC has an adverse impact on financial and market performance. Morariu (2014) examines a sample of 72 Romanian firms listed on the Bucharest Stock Exchange in 2010. His paper suggests a significant association between VAIC and market value but no relationship between VAIC and ROE and the asset turnover ratio.

As for the econometric aspect, we suspect that VAIC and its components can be endogenous because of omitted variables and reverse causality. Omitted variables can cause estimation bias through the discrepancies in unobserved individual characteristics across banks, as well as time-varying factors that have an impact on both financial performance and VAIC (e.g. financial crisis). Reverse causality is more problematic when financial performance affects VAIC. For instance, highly profitable banks can offer higher bonuses to their employees, which has an impact on HCE, or banks can use their retained earnings to reinvest in physical and financial assets, which drives CEE.

Turning to the estimation method, many papers use a simple regression method to estimate the causal effect of IC on financial performance. For example, Joshi *et al.* (2013) use a multiple linear regression on ROA (dependent variable) and components of VAIC. Similarly, Al-Musali and Ku Ismail (2014) employ a linear regression to estimate the relationship between VAIC, its components and financial performance. However, the potential endogeneity problem, as mentioned above, can make ordinary least squares (OLS) estimation results bias and inconsistent. Thus, Ozkan *et al.* (2017) use a fixed- and random-effects model to control for individual specific bank characteristics. Although a fixed-effects model controls for time-invariant unobserved characteristics, it cannot control for unobserved variables that change over time (Allison, 2009). It is argued that this method can produce a consistent estimation when we assume no correlation between idiosyncratic errors and independent variables. However, this assumption can be violated by time-varying unobservable variables (e.g. financial shock) or reverse causality (VAIC affects financial performance). Taking into account potential endogeneity problems, Meles *et al.* (2016) use OLS estimation and check for their estimation's robustness by using one-time lagged independent variables. However, we use another approach, such as GMM, to tackle the endogeneity problem as well as consider the dynamic nature of bank profit. The GMM method has been used in VAIC analyses because of its advantages, such as addressing endogeneity problems. For example, Kehelwalatenna and Premaratne (2014) employ the GMM method to estimate the impact of IC on the performance of US banking from 2000 to 2011. Nadeem *et al.* (2016) use the same estimation method in the case of listed firms in the UK for the period 2005–2014. Zheng *et al.* (2018) examine the bidirectional relationship between HCE and risk-taking behavior and capital regulation in Bangladesh.

3. Methodology and data

3.1 Overview of the Thai banking system

In emerging countries, the banking sector plays a crucial role in the economy because most companies are financed by bank loans. Thailand is no exception: commercial banks

accounted for around 46 percent of the total assets of financial institutions at the end of the third quarter in 2016. At the same time, they were the source of approximately 73 percent of corporate loans and 41 percent of consumer loans (Bank of Thailand, 2016).

After the Asian financial crisis in 1997, which first started in Thailand, the government implemented two policies to restructure the banking sector, in particular, to allow mergers and acquisitions among Thai banks and foreign banks. For example, DBS Bank acquired 50.3 percent of Thai Danu Bank in 1998, 75 percent of Radanasin Bank was acquired by United Overseas Bank Limited in 1999 and Standard Chartered Bank acquired 75 percent of Nakornthon Bank in 1999. In addition, the government wanted to attract capital inflows, so under the new Financial Institution Business Act (implemented in August 2008), it adjusted the maximum limit on foreign shareholdings at Thai commercial banks from 25 percent to more than 49 percent. Foreign banks were expected to help attract new capital, management experience and bank products while addressing the high level of non-performing loans from the crisis.

As a consequence, Thai banks gradually recovered in term of loans, deposits and total assets. For example, in 2016, the total assets of all Thai commercial banks steadily increased from THB6tn in 2001 to approximately THB18tn. A similar increasing trend is also found for loans and deposits. However, net profit fluctuates over the period, increasing from THB20bn in 2002 to THB100bn in 2005, before dropping significantly in the financial crisis in 2007 and then recovering to around THB200bn in 2016 (Bank of Thailand, 2018).

3.2 Measurement of IC

The VAIC model uses items on balance sheets and income statements to calculate IC performance. VAIC is measured as follows:

$$VAIC_i = CEE_i + HCE_i + SCE_i$$

where $VAIC_i$ is the value-added intellectual coefficient of bank *i*. CEE_i (capital employed efficiency) indicates the marginal contribution of each unit of physical and financial capital to value added. HCE_i (human capital efficiency) shows the marginal contribution of human capital of each unit of human capital to value added. SCE_i (structural capital efficiency) measures the contribution of structural capital to value added (Meles *et al.*, 2016). In general, this method tries to measure the contribution of physical and financial, human and structural resources to create value added for banks. Thus, these components are defined, respectively, as follows:

$$CEE_i = \frac{VA_i}{CA_i},$$

$$HCE_i = \frac{VA_i}{HC_i},$$

$$SCE_i = \frac{SC_i}{VA_i} = \frac{VA_i - HC_i}{VA_i}.$$

In these computations, VA_i is defined as the value added to the banks. In other words, it is the subtraction of all input from the output in bank operations. In particular, the income statement structure shows a similar concept. It reports the total revenue generated by banks and then subtracts all the related costs to arrive at the profit before tax. In this paper, we use the sum of profit before tax and payroll expenses to proxy for value added because profit before tax indicates the residual value after eliminating all the costs from revenues.

Moreover, we need to add back payroll expenses because they are excluded from profit before tax. CA_i is banks' physical and financial capital. This concept is similar to tangible assets, so it is calculated by total assets minus intangible assets (including goodwill). Thus, CEE is equivalent to VA divided by CA to indicate the efficiency of banks' use of physical and financial capital. According to Iazzolino and Laise (2013), Pulic defines HC (human capital) as the amount of capital invested in knowledge workers, such as wages, salaries and training, while SC means the conditions that enable human resources to produce VA, which is, in other words, the share of VA that remains after investments in IC obtained by SC holders are deducted. Therefore, we use payroll expenses to proxy for HC because they comprise employee wages and salaries, as widely used in previous studies (Kehelwalatenna and Premaratne, 2014; Meles *et al.*, 2016; Ozkan *et al.*, 2017). However, training expenses may not be perfectly captured in this account because it may be recorded under various sections in current accounting systems, depending on the purpose and how the training is set up. Thus, this information is not available in financial statements. Conceptually, the ratio of VA and HC indicates the efficiency of human capital in creating value added. SC is measured as the value of VA that remains after HC is deducted, while SC divided by VA indicates the efficiency of structural capital.

By analyzing the relationship between the efficiency of IC and financial performance at banks, VAIC and its components are used as indicators of IC efficiency. As such, VAIC and its components CEE, SCE and HCE are independent variables employed in the model. ROA is used as an indicator of financial performance, measured as the ratio of profit before tax to total assets. This measure of profitability is used in many similar studies (Al-Musali and Ku Ismail, 2014; Meles *et al.*, 2016; Ozkan *et al.*, 2017).

Like Meles *et al.* (2016), we control for three variables that proxy for bank characteristics: bank size, measured as the natural logarithm of total bank assets; credit risk is calculated by dividing the allowance for doubtful debt by total loans which shows the level of bank provisions relative to its total loans; and liquidity risk, indicating the percentage of bank assets tied up in loans, is calculated as total loans over total assets. A summary of the variables used in this paper is in Table I.

We test the relationship between VAIC performance and financial performance (ROA) and then identify the components with the most severe impact on ROA at Thai banks.

Thus, we propose four models, as follows:

$$\text{Model 1}: ROA_{it} = \beta_0 + \beta_1 VAIC_{it} + \varepsilon_{it},$$

Variables	Description
ROA (return on assets)	A measurement of financial performance of banks
VAIC (value-added intellectual coefficient)	IC efficiency measure. The ratio is the sum of SCE, CEE and HCE
SCE (structural capital efficiency)	Measure of marginal contribution of structural capital to the value added, calculated by the sum of value-added − payroll expenses/value added
CEE (capital employed efficiency)	Marginal contribution per each unit of physical and financial capital to the added value, measured by value added/tangible fixed assets
HCE (human capital efficiency)	Marginal contribution per each unit of employee expenses to the added value, measured by value added/payroll expenses
ALOAN	An indicator of credit risk, calculated as allowance of doubtful debt/total loans. This ratio shows how much provisions relative to its total loans
LOANTA	A measure of liquidity – a ratio of total loans/total assets. The ratio indicates what percentage of the assets of the bank are tied up in loans
SIZE	The natural logarithm of the total assets of the bank

Table I.
Variable description

$$\text{Model 2}: ROA_{it} = \beta_0 + \beta_1 VAIC_{it} + \beta_2 ALOAN_{it} + \beta_3 LOANTA_{it} + \beta_4 SIZE_{it} + \varepsilon_{it},$$

$$\text{Model 3}: ROA_{it} = \beta_0 + \beta_1 CEE_{it} + \beta_2 HCE_{it} + \beta_3 SCE_{it} + \varepsilon_{it},$$

$$\text{Model 4}: ROA_{it} = \beta_0 + \beta_1 CEE_{it} + \beta_2 HCE_{it} + \beta_3 SCE_{it} + \beta_4 ALOAN_{it} + \beta_5 LOANTA_{it} + \beta_6 SIZE_{it} + \varepsilon_{it},$$

where: $ALOAN_{it}$ is the credit risk of bank i at time t ($ALOAN_{it}$ = allowance for doubtful debt/total loans). $LOANTA_{it}$ is the liquidity risk of bank i at time t ($LOANTA_{it}$ = total loans/total assets). $SIZE_{it}$ is the size of bank i at time t (natural logarithm of total assets)

These models are used to test the following four hypotheses:

H1. IC performance (VAIC) has a positive causal effect on financial performance (ROA) at listed banks in Thailand.

H2. CEE has a positive causal effect on financial performance (ROA) at listed banks in Thailand.

H3. HCE has a positive causal effect on financial performance (ROA) at listed banks in Thailand.

H4. SCE has a positive causal effect on financial performance (ROA) at listed banks in Thailand.

3.3 Data

This paper uses an unbalanced panel data set of quarterly financial information on 16 listed banks in Thailand from 1997 to 2016. After the 1997 crisis, many regulations were imposed to control banks. Thus, the number of banks varies over these years in unbalanced panel data. Moreover, we use only separated financial statements because consolidated reports may include some subsidiaries, such as real estate or securities companies, which may create bias in the nature of banks. The data are collected from banks' official websites. Table II shows that the data used in this research represent the majority of the Thai banking system, covering approximately 77.91 percent of total assets at commercial banks in Thailand at the end of 2016.

4. Empirical results

The descriptive statistics are summarized in Table III.

Table III shows the average value of the VAIC variables and its components of listed banks in Thailand from 1997 to 2016. During this period, Thailand has 16 banks, many of which were newly established or ended operations. The table indicates that LH Financial Group (LHBANK) and Thanachart Bank (TCAP) have the highest VAIC among all banks, whereas the banks with the lowest VAIC are Industrial Finance Corporation of Thailand and Tisco Financial Group (TISCO). Among the three components of VAIC, HCE accounts for the highest proportion of VAIC. This result is consistent with other countries, such as Saudi Arabia and Turkey (Al-Musali and Ku Ismail, 2014; Ozkan *et al.*, 2017).

Table III also lists some negative VAIC values. To understand this phenomenon, we need to trace back to each component of VAIC and its computation. As mentioned, HCE plays a major role in VAIC, and, not surprisingly, negative VAIC is driven by negative HCE. HCE is calculated by dividing value added by personnel expenditure, which represents the ratio of profit that a bank makes per unit of staff cost. However, negative HCE means that banks

Bank's name	Total assets	Shares (%)	Data's ending period	Data's starting period
Bangkok Bank (BBL)	2,838,799	16.02		
The Siam Commercial Bank (SCB)	2,661,442	15.02		
Krung Thai Bank (KTB)	2,614,798	14.75		
Kasikorn Bank (KBANK)	2,467,252	13.92		
Bank of Ayudhya (BAY)	1,805,967	10.19		
TMB Bank (TMB)	820,172	4.63		
Siam City Bank (SCIB)	385,195	2.17	Quarter 3/2010	
CIMB Thai Bank (CIMBT)	295,623	1.67		
Kiatnakin Bank (KKP)	220,312	1.24		Quarter 4/2005
United Overseas Bank – Thai (UOBT)	206,184	1.16	Quarter 1/2006	
The Industrial Finance Corporation (IFCT)	179,548	1.01	Quarter 2/2004	
DBS Thai Danu Bank (DTDB)	102,952	0.58	Quarter 1/2004	
UOB Radanasin Bank (UOBR)	52,221	0.29	Quarter 3/2005	
Thanachart Capital (TCAP)	37,989	0.21		Quarter 2/2009
Tisco Financial Group (TISCO)	27,536	0.16		Quarter 4/2008
LH Financial Group (LHBANK)	17,027	0.10		Quarter 4/2010
Total assets of all commercial banks[a]	17,721,617			

Note: [a]Bank of Thailand
Source: The authors' own calculation

Table II.
The shares of commercial banks by asset size in December 2016 (in THB million)

Bank's name	CEE	HCE	SCE	VAIC
LH Financial Group (LHBANK)	0.012	67.875	0.687	68.574
Thanachart Capital (TCAP)	0.013	13.707	0.865	14.585
Krung Thai Bank (KTB)	0.002	0.829	3.399	4.231
Kiatnakin Bank (KKP)	0.009	3.367	0.637	4.013
The Siam Commercial Bank (SCB)	0.005	2.439	0.764	3.208
Kasikorn Bank (KBANK)	0.005	1.979	0.622	2.605
Bangkok Bank (BBL)	0.004	1.789	0.670	2.462
Bank of Ayudhya (BAY)	0.003	1.258	0.525	1.785
TMB Bank (TMB)	0.000	−0.406	1.825	1.419
Siam City Bank (SCIB)	−0.002	−1.238	0.598	−0.643
United Overseas Bank – Thai (UOBT)	−0.002	−1.477	0.715	−0.764
UOB Radanasin Bank (UOBR)	−0.006	−1.923	0.452	−1.477
CIMB Thai Bank (CIMBT)	−0.003	−2.534	0.308	−2.229
DBS Thai Danu Bank (DTDB)	−0.009	−5.082	0.334	−4.758
The Industrial Finance Corporation (IFCT)	−0.003	−7.618	0.784	−6.837
Tisco Financial Group (TISCO)	0.032	−75.879	0.591	−75.255
Average of all 16 Thai-listed banks	0.004	−0.182	0.861	0.683

Table III.
Descriptive statistics

make a loss while still paying salaries. In conclusion, if VAIC measures utilize profitability as an indicator, making a loss will show a negative VAIC measure.

We also see some abnormal ratios, such as the HCE of LHBANK and TISCO. In further investigation, we find that these cases are caused by significant fluctuations in payroll expenses in some quarters perhaps because of a huge change in the headcounts at newly established banks. An alternative explanation is that in some periods, financial statements contain accounting adjustments. Thus, the average value is affected by these abnormal figures. However, these numbers do not frequently show up in the data, and they are all audited as listed banks at year's end. Therefore, we capture all the values to obtain a picture of the entire banking system in Thailand.

However, the approximate value of VAIC can be obtained by not including these extreme values in the descriptive statistics, so we ignore the top and bottom 1 percent of the data to eliminate the extreme value problem in this data set. Then, Thanachart Capital (17.3832), Tisco Financial Group (4.9256) and LH Financial Group (4.5976) are the banks with the highest average VAIC in the Thai banking system, and the banks with the negative average VAIC are the Industrial Finance Corporation (−3.3072), DBS Thai Danu Bank (−2.1070), United Overseas Bank (−0.7031) and UOB Radanasin Bank (−0.3972). Overall, the average VAIC in the Thai banking system is estimated at 2.4079.

4.1 Diagnostic tests

Pearson's correlation analysis in Table IV illustrates a statistically significant positive correlation between ROA and VAIC, CEE and HCE. Among the independent variables, CEE is the variable with the highest correlation with ROA. SCE has a negative but statistically insignificant relationship with ROA. No substantial correlation is found between the independent variables. This result suggests that multicollinearity problem between independent variables is weak or nonexistent. Moreover, it is confirmed by the variance inflation factor among variables. All the recorded figures are lower than the rule of thumb by a factor of 10.

First, it is necessary to perform a unit-root test because of the long time-series data. A unit root causes the time series to have a systematic pattern that is unpredictable. Therefore, the Im–Pesaran–Shin unit-root test (Im *et al.*, 2003) for key variables including the dependent variable ROA, independent variable VAIC and its components is performed with the null hypothesis that all panels contain unit roots. The results indicate that all the *p*-values are zero, so the null hypothesis is rejected. Thus, the data set used in this study is stationary. Moreover, we also check for autocorrelation by performing the Wooldridge test for autocorrelation in panel data. The results show no first-order autocorrelation in Models 1, 3 and 4 while Model 2 has this problem.

Second, we perform a modified Wald test for group-wise heteroskedasticity to test for heteroskedasticity in the four models. The result shows that the *p*-value of all four models is below the significant level of 1 percent. Thus, the heteroskedasticity problem exists, so we use heteroskedasticity-consistent standard errors. Results from all the related tests are in Table V.

Because of the autocorrelation in Model 2 and the heteroskedasticity in all four models, we apply heteroskedasticity-consistent standard errors, known as the robust standard errors option (specifying the vce(robust) option) in Stata, which can produce a consistent variance-covariance matrix estimator (Stata, 2013, p. 372).

Third, we do not apply pooled OLS because unobserved effects, such as managerial bank efficiency, will result in inefficient estimators. Thus, we employ both random- and fixed-effects models to account for differences across the banks (see Ozkan *et al.*, 2017). Then, we conduct a Hausman test to identify whether the random- or fixed-effects model is preferred. The result shows that the Models 1 and 2 are estimated using a random-effects model while Models 3 and 4 use a fixed-effects model.

4.2 Fixed-effects and random-effects models

Table VI demonstrates the relationship between the profitability of the banks operating in Thailand and their IC. A comparison of the explanatory power of the models indicates that R^2 values (0.9948 and 0.9947, respectively) of Models 3 and 4 are higher than those of Models 1 and 2 (0.0062 and 0.1685, respectively). This result shows that the components of VAIC are better at explaining the profitability of banks than VAIC alone. This conclusion is consistent with the results in Turkey's banking system (Ozkan *et al.*, 2017). However, no strong

Table IV.
The pairwise correlation coefficients and variance inflating factor among variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	VIF	
(1) ROA	1.00								–	–
(2) VAIC	0.08 (0.0196)	1.00							1.01	–
(3) CEE	1.00 (0.0000)	0.08 (0.0185)	1.00						–	1.22
(4) HCE	0.08 (0.0181)	1.00 (0.0000)	0.08 (0.0170)	1.00					–	1.01
(5) SCE	−0.01 (0.7391)	0.08 (0.0143)	−0.01 (0.7158)	0.00 (0.9673)	1.00				–	1.01
(6) ALOAN	−0.15 (0.0000)	0.03 (0.4665)	−0.16 (0.0000)	0.02 (0.5865)	0.07 (0.0309)	1.00			1.06	1.13
(7) LOANTA	−0.31 (0.0000)	−0.01 (0.8158)	−0.31 (0.0000)	−0.01 (0.7521)	0.03 (0.3230)	−0.19 (0.0000)	1.00		1.27	1.50
(8) SIZE	−0.05 (0.1141)	0.03 (0.4077)	−0.06 (0.0565)	0.03 (0.4519)	0.03 (0.3557)	−0.21 (0.0000)	0.55 (0.0000)	1.00	1.28	1.30

Note: Significant level is reported in parentheses

correlation is found among VAIC components using a Pearson's correlation analysis; therefore, including all three components may not bias the estimation results.

It can be inferred from Models 1 and 2 that a positive statistically insignificant relationship exists between VAIC and the financial performance indicator (ROA) from 1997 to 2016. In other words, VAIC does not affect bank profitability. When we decompose VAIC into HCE, CEE and SCE, Models 3 and 4 illustrate that CEE has a high positive correlation with ROA. In contrast, HCE shows a weak negative relationship with financial performance. Finally, no statistically significant association is found between SCE and ROA.

At the same time, credit risk (*ALOAN*) has a negative relationship with financial performance in Model 2 while Model 4 shows that this correlation is insignificant. Similarly, high liquidity risk (*LOANTA*) reduces profitability in Models 2 and 4. However, bank size is proven to have a positive impact on bank profitability, but this result is inconsistent because of a statistical insignificance coefficient in Model 4.

4.3 Dynamic panel data estimation: GMM

In the context of the relationship between IC and performance, an increasing number of studies use the GMM approach because of its ability to deal with the endogeneity problem (e.g. Anifowose *et al.*, 2018; Kehelwalatenna and Premaratne, 2014; Sardo and Serrasqueiro, 2017). In this section, we use the dynamic-GMM estimation in the Arellano–Bond model (Arellano and Bond, 1991). In general, the GMM estimator utilizes

	Im–Pesaran–Shin unit-root test		Wooldridge test			Modified Wald test		
	p-value	Presence of unit-root	*F*-test	*p*-value	Presence of autocorrelation	χ^2	*p*-value	Presence of heteroskedasticity
Model 1	0.0000	X	1.478	0.2429	X	10,090.76	0.0000	✓
Model 2	0.0000	X	8.601	0.0109	✓	16,644.86	0.0000	✓
Model 3	0.0000	X	1.841	0.1949	X	8,948.45	0.0000	✓
Model 4	0.0000	X	2.527	0.1342	X	1.9e+35	0.0000	✓

Note: The Im–Pesaran–Shin unit-root test is performed on all key variables: ROA, VAIC, HCE, CEE and SCE

Table V. Unit-root test, heteroskedasticity and autocorrelation test

	Model 1	Model 2	Model 3	Model 4
VAIC	0.0223	0.0130		
CEE			1.0000***	1.0000***
HCE			−0.0027***	−0.0029***
SCE			0.0016	−0.0002
ALOAN		−0.0472**		0.0027
LOANTA		−0.0445***		−0.0012**
SIZE		0.0026***		0.0000
Constant	0.0015	−0.0185	−0.0022***	−0.0012
R^2	0.0062	0.1685	0.9948	0.9947

Notes: ROA is the return on assets; VAIC is the value-added intellectual coefficient: VAIC components include SCE (structural capital efficiency), CEE (capital employed efficiency) and HCE (human capital efficiency); control variables: ALOAN is an indicator of credit risk, LOANTA is a measure of liquidity and SIZE is the natural logarithm of the total assets of the bank. After applying the Hausman test, Models 1 and 2 are estimated using Random effect model, and Models 3 and 4 are estimated by Fixed effect model. To deal with heteroskedasticity for all four models, heteroskedasticity-consistent standard errors are used. Coefficients followed by **,***Significant at 5 and 1 percent, respectively

Table VI. Regression results of fixed-effect and random-effect model

lagged dependent variables as instruments in a two-stage least squares procedure. The first advantage of this estimator technique is its ability to control for potential endogeneity by using internal instruments. Second, this method also contributes to understanding the dynamic nature of profitability, which means profit in the current period can be influenced by the previous period.

Two requirements need to be met for the GMM's results to be valid: second-order autocorrelation should not exist in the model; and overidentification restrictions are created by the instruments used. Thus, related tests are conducted and shown in Table VII, which indicate that our results survive the autocorrelation test AR(2) because we fail to reject the null hypothesis of "no autocorrelation." At the same time, the Sargan (1958) and Hansen (1982) tests of overidentification restrictions show an inconsistent conclusion about the over-identification in the model. However, because autocorrelation and heteroskedasticity (non-spherical errors) are suspected in the previous section, the Sargan statistic is inconsistent (Roodman, 2009). Thus, we follow the results from the Hansen test and conclude that we fail to reject the null hypothesis that "the instrumental variables are uncorrelated to the residuals." Thus, the instruments are exogenous, which ensures the validity of the GMM model.

Overall, as shown in Table VII, the results are in line with those in Table VI. Once again, VAIC is not significantly associated with ROA while HCE and CEE show a similar conclusion with fixed- and random-effects models, as mentioned above. However, the one-quarter lagged ROA shows insignificant correlation with current ROA. Although the dynamic nature of bank profitability has been confirmed in the literature (e.g. Pervan *et al.*, 2015; Sinha and Sharma, 2015), it is likely that a quarter is too short for past profit to have an effect on current profit. In reality, retained earnings in the past year must be approved at a shareholder meeting to decide how much to distribute as dividends or reinvest in business, which can improve profit in the current year. Thus, the dynamic effect of profitability may exist in longer periods.

4.4 Robustness check

We conduct a sensitivity analysis by excluding the period from 1997 to 1999 from our estimation. We suspect that this timeframe includes the impact of the Asian financial crisis that started in 1997 and its lagged effects afterward. Thus, we re-estimate our model by excluding 1997–1999 to avoid the effects of the crisis. Another approach is that we add

	Model 1	Model 2	Model 3	Model 4
ROA_{t-1}	0.0081	−0.0257	−0.0021	−0.0027
VAIC	0.0212	0.0090		
CEE			1.0019***	1.0011***
HCE			−0.0030***	−0.0032***
SCE			−0.0003	−0.0003
ALOAN		−0.2400		0.0004
LOANTA		−0.0479		−0.0003
SIZE		0.0803		0.0019
AR(1) test	0.075	0.013	0.003	0.002
AR(2) test	0.193	0.536	0.294	0.277
Sargan test	0.000	0.000	0.071	0.216
Hansen test	0.139	0.375	0.224	0.134

Notes: ROA is the return on assets; VAIC is the value-added intellectual coefficient: VAIC components include SCE (structural capital efficiency), CEE (capital employed efficiency) and HCE (human capital efficiency); control variables: ALOAN is an indicator of credit risk, LOANTA is a measure of liquidity and SIZE is the natural logarithm of the total assets of the bank. To deal with heteroskedasticity for all four models, heteroskedasticity-consistent standard errors are used. Coefficients followed by ***Significant at 1 percent

Table VII.
Regression results of GMM method

dummy variables to control for both crisis periods, 1997–1998 and 2007–2009. We find that the results reported are very similar to those reported earlier (Tables VIII and IX).

The crisis period does not influence our core results about the VAIC, its components and financial performance in the Thai banking sector significantly. As mentioned above, we also analyze our model with trimmed data of 1 percent of the highest and the lowest value for key variables (HCE, SCE, CEE and VAIC). The results are still robust when we remove the outliers in data (see Table X).

4.5 The dynamic aspect of IC on performance

The dynamic aspect of IC is considered in the previous literature because researchers suspect that the effects of IC on financial performance exist not only in the current period

	Model 1	Model 2	Model 3	Model 4
ROA_{t-1}	0.0081	−0.0295	−0.0021	−0.0062
VAIC	0.0212	0.0089		
CEE			1.0019***	0.9990***
HCE			−0.0030***	−0.0032***
SCE			−0.0003	0.0001
CRISIS		−0.0018		−0.0017
ALOAN		−0.2400		−0.0005
LOANTA		−0.0476		−0.0001
SIZE		0.0796		0.0014
AR(1) test	0.075	0.019	0.003	0.002
AR(2) test	0.193	0.153	0.294	0.283
Sargan test	0.000	0.000	0.071	0.721
Hansen test	0.139	0.532	0.224	0.119

Notes: ROA is the return on assets; VAIC is the value-added intellectual coefficient: VAIC components include SCE (structural capital efficiency), CEE (capital employed efficiency) and HCE (human capital efficiency); control variables: ALOAN is an indicator of credit risk, LOANTA is a measure of liquidity and SIZE is the natural logarithm of the total assets of the bank; CRISIS are dummies for crisis periods (1997–1998, 2007–2009). Heteroskedasticity-consistent standard errors are used. Coefficients followed by ***Significant at 1 percent

Table VIII. Robustness check by GMM method with crisis period control (dummies for crisis period)

	Model 1	Model 2	Model 3	Model 4
ROA_{t-1}	−0.1600*	−0.1180	−0.0072	−0.0054
VAIC	0.0038	−0.0057		
CEE			0.9990***	1.0010***
HCE			−0.0030***	−0.0032***
SCE			−0.0002	−0.0012
ALOAN		−0.0038		0.0017
LOANTA		0.0308		0.0000
SIZE		0.0296		0.0010*
AR(1) test	0.030	0.043	0.179	0.176
AR(2) test	0.241	0.309	0.296	0.315
Sargan test	0.000	0.000	0.000	0.000
Hansen test	0.342	0.205	0.644	0.501

Notes: ROA is the return on assets; VAIC is the value-added intellectual coefficient: VAIC components include SCE (structural capital efficiency), CEE (capital employed efficiency) and HCE (human capital efficiency); control variables: ALOAN is an indicator of credit risk, LOANTA is a measure of liquidity and SIZE is the natural logarithm of the total assets of the bank. To deal with heteroskedasticity for all four models, heteroskedasticity-consistent standard errors are used. Coefficients followed by *,***Significant at 10 and 1 percent, respectively

Table IX. Robustness check by GMM method with crisis period control (omitting 1997-1999 period)

	Model 1	Model 2	Model 3	Model 4
ROA_{t-1}	0.0081	−0.0257	−0.0034	−0.0041
VAIC	0.0212	0.0090		
CEE			1.0014***	0.9975***
HCE			−0.0030***	−0.0032***
SCE			0.0000	−0.0005
ALOAN		−0.2400		0.0011
LOANTA		−0.0479		0.0002
SIZE		0.0803		0.0020
AR(1) test	0.075	0.013	0.009	0.008
AR(2) test	0.193	0.536	0.741	0.578
Sargan test	0.000	0.000	0.004	0.047
Hansen test	0.139	0.375	0.268	0.142

Notes: ROA is the return on assets; VAIC is the value-added intellectual coefficient: VAIC components include SCE (structural capital efficiency), CEE (capital employed efficiency) and HCE (human capital efficiency); control variables: ALOAN is an indicator of credit risk, LOANTA is a measure of liquidity and SIZE is the natural logarithm of the total assets of the bank. To deal with heteroskedasticity for all four models, heteroskedasticity-consistent standard errors are used. Coefficients followed by ***Significant at 1 percent

Table X.
Robustness check by GMM method trimming the top and bottom 1 percent of data

but also in the future. Empirically, the lagged value of VAIC is confirmed to benefit current profitability (e.g. Clarke *et al.*, 2011; Meles *et al.*, 2016; Sardo and Serrasqueiro, 2017). To avoid multicollinearity, we step-by-step consider one, two and three lag-steps of VAIC and its components in our models. In particular, we use one-quarter lagged VAIC in Models 1 and 2 and one-quarter lagged HCE, CEE and SCE in Models 3 and 4. Afterward, we repeat the estimation using two-quarter lags and then three-quarter lags separately. The results of the one lag-step and two lag-step VAIC and its components indicate that IC has no impact on current profitability. However, Table XI illustrates that three-quarter lag VAIC and HCE are positively associated with current ROA, suggesting that VAIC and HCE have a positive effect on future bank profitability.

	Model 1	Model 2	Model 3	Model 4
ROA_{t-1}	0.0041	−0.0284	−0.0001	−0.0447
$VAIC_{t-3}$	0.0118**	0.0105***		
CEE_{t-3}			−0.0187	−0.0950*
HCE_{t-3}			0.0131***	0.0134***
SCE_{t-3}			0.0505*	0.0199
ALOAN		−0.2440*		−0.2400*
LOANTA		−0.0466		−0.0577
SIZE		0.0836		0.0772
AR(1) test	0.086	0.014	0.091	0.015
AR(2) test	0.488	0.374	0.778	0.281
Sargan test	0.000	0.000	0.000	0.000
Hansen test	0.104	0.288	0.103	0.141

Notes: ROA is the return on assets; VAIC is the value-added intellectual coefficient: VAIC components include SCE (structural capital efficiency), CEE (capital employed efficiency) and HCE (human capital efficiency); control variables: ALOAN is an indicator of credit risk, LOANTA is a measure of liquidity and SIZE is the natural logarithm of the total assets of the bank. To deal with heteroskedasticity for all four models, heteroskedasticity-consistent standard errors are used. Coefficients followed by *,**,***Significant at 10, 5 and 1 percent, respectively

Table XI.
Regression results of GMM method using lagged three-quarter of IC variables

4.6 Discussion

As Thailand is still a developing country, and its banking system has not fully developed yet, the findings of this study suggest that profitability in the Thai banking sector is primarily driven by CEE, which is in line with previous studies (Ozkan *et al.*, 2017; Ting and Lean, 2009). Additionally, SCE is proven to be statistically insignificant with ROA. Al-Musali and Ku Ismail (2014), Joshi *et al.* (2013), Meles *et al.* (2016), Ozkan *et al.* (2017) and Ting and Lean (2009) also show that SCE is not correlated with financial performance in Malaysia, Australia, Turkey, the USA and Saudi Arabia, respectively.

HCE seems to illustrate that human capital marginally reduces profitability. This result is consistent with previous research (Saengchan, 2007). Similarly, Morariu (2014) also finds that HCE is negatively correlated with market value (measured by the market-to-book value) and productivity (measured by the asset turnover ratio). One possible explanation for this result is the occurrence of mergers and acquisitions throughout the period in Thailand, as mentioned earlier. In this procedure, downsizing is likely to result in a significant increase in the cost of employees because of severance payments and other compensation.

Because of the mixed results of VAIC components in financial performance, VAIC is shown to have a statistically insignificant relationship with financial performance. This outcome is consistent with that of several previous studies, such as Joshi *et al.* (2013) in Australia and Ozkan *et al.* (2017) in Turkey.

Another interesting result we obtained from the estimations is that HCE and VAIC are positively related to bank profitability in a three-quarter period. This finding is consistent with the fact that investments in human capital are likely to bring future benefits (e.g. Clarke *et al.*, 2011; Meles *et al.*, 2016; Sardo and Serrasqueiro, 2017). The delayed effect of human capital investment on profitability may be caused by the management style or processes within banks. Thus, HCE appears to take longer to have an effect on bank performance.

5. Conclusions

A new line of research examines the emerging trend of employing IC in business, and it is becoming more extensive than ever. Many approaches have been proposed to provide insights, understanding and even measurement methods. This paper provides an overview of IC in a knowledge-intensive industry, such as banking in Thailand, which is an emerging country, particularly its measurement and its connection with financial performance. In this study, the IC efficiency of 16 banks operating in Thailand between 1997 and 2016 is estimated using the VAIC approach. Then, this paper focuses on how IC and its components affect financial performance at these banks using the GMM method. The result reveals that VAIC is not correlated with banking financial performance. Among VAIC components, CEE makes the highest contribution to bank profitability. However, HCE shows a slightly opposite effect on bank performance in the current period but yields positive effects on future profitability. Therefore, CEE can be considered the main driver of commercial banks in Thailand.

This research has some limitations. First, this study only considers listed banks in Thailand, which does not involve foreign banks, which are likely to employ more IC from developed countries. The results obtained from those banks in comparison with Thai banks offer great understanding of IC as a competitive advantage. Second, because banks are a special institution with their own characteristics, it is necessary to include more control variables, such as bank ownership, the non-performing loan ratio and R&D expenditures, to isolate the contribution of IC to bank profitability. Third, accounting manipulation and adjustments can be included, as we use items from financial statements.

Several practical implications are suggested by this study. As the results imply that the Thai banking sector still operates based on traditional resources, such as financial and physical capital, to make a profit, so bank managers should focus on how to use and manage its financial and physical resources effectively to achieve a higher level of profitability.

Although HCE marginally reduces bank profitability in the current period, it is necessary to strengthen the personnel structure and employee efficiency to improve future profitability. In order for human capital to have a positive effect on future profitability, managers should invest in human capital, such as continuous training to improve employee performance. Although the beneficial outcomes of HCE are not likely to have immediate effects, employees are valuable assets that should not be neglected if banks wish to maintain competitiveness in the market. In addition, SCE has not shown a favorable effect yet, and only a small proportion of HCE affects profitability, which indicates that IC has not yet been fully exploited as a driver of profit. A new field of research has emerged on the industry, which suggests that managers should focus on using IC to create competitive advantages over their competitors. In other words, IC is still a new determinant of bank profitability, and it needs to be investigated to maximize bank profit. As the Thai banking system is still in the process of recovering and developing, it needs major innovation not only to maintain sustainability but also to grow steadily in this competitive industry. The results of this research help to clarify the role of IC and its importance in the Thai banking system. Thus, IC should be a consideration in planning future strategy.

In further research, more components of VAIC should be considered, such as relational capital, including the relationship with internal and external stakeholders and R&D potential in the IC development. These approaches can capture more aspects to create a broad overview of IC. At the same time, here we use items from financial statements (based on accounting profit), which can be easily affected by accounting manipulation and adjustments. Instead, it is better to use the market-to-book ratio or value-based measures, such as economic value added or shareholder value added, as complements to traditional accounting performance measures.

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