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Navigating Complexity: Uncovering the Intricate Dynamics Between Intellectual Capital, Efficiency, and Performance in Taiwan's Banking Sector

Wil Martens[a]

[a] *College of Management, National Sun Yat-sen University, Kaohsiung, Taiwan*

Abstract

As the global landscape places greater emphasis on intangible assets, the role of intellectual capital (IC) in adding value has gained heightened importance. This study examines the role of IC, technical efficiency, and income diversity in shaping the performance of Taiwan's banks. Using the resource-based view of the firm, it investigates the relationship between IC and firm performance, the impact of well-organized technical efficiency on bank performance, and the influence of income diversity on bank performance. This paper employs Fixed Effects regression and Generalized Method of Moments models to analyze the research questions. The findings reveal a complex landscape wherein it is shown that IC has a limited impact on profitability, but technical and intellectual capital efficiency can positively influence bank performance. Implications for both theory and practice are discussed.

Keywords: Bank efficiency, Intellectual capital, Taiwan banks, Systems Generalized Method of Moments (SGMM), Income Diversity

JEL Classification: M41, F30, D89

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1. Introduction

In an era where globalization has amplified the significance of intangible assets, the role of intellectual capital (IC) in value creation has become increasingly crucial. This is especially pertinent for the banking sector, which serves as the linchpin for economic development and financial stability (Karacan and Ergin 2011). The focus on IC is not merely academic but has tangible implications for the performance and competitiveness of banks. In the context of Taiwan, an emerging economy[1] that has shown resilience amid global disruptions (KPMG 2022), understanding the impact of IC on banking efficiency becomes imperative. This study aims to fill the empirical gap by evaluating the role of IC in firm efficiency in Taiwan's banking sector, thereby offering insights for firms on ways to improve innovation, knowledge management, employee productivity, customer satisfaction, and competitive advantage (Lewis and Mazvancheryl 2011).

In Taiwan, the banking system is a critical component of the financial structure, functioning differently than developed nations' banking systems. Taiwan's financial system is essentially bank-based (Chen et al. 2023), with the volume of banking business being considerably larger than the level of stock market activities (Luu and Luong 2020). This characteristic is generally true for financial systems in emerging countries, contrasting with the market-based approaches typically found in developed countries (Yadav and Pathak 2013). The banking sector, an integral part of Taiwan's service sector, forms the backbone of its economy, contributing significantly to the country's Gross Domestic Product[2]. Over the years, Taiwan's banking sector has undergone significant changes due to many reforms, including the introduction of prudential norms, interest rate deregulation, digitalization of operations, and opening up of the sector for new private entities, including foreign banks. However, the industry faces a declining trend in competition and profitability, despite the increased competition witnessed in the early 2000s. Given Taiwan's aspiration to remain competitive and its banking sector's crucial role, there is an ardent need for a study to examine the factors affecting bank performance in Taiwan. Such a study is not only timely but also essential in light of Taiwan's economic goals of globally oriented development and the recent changes in its banking sector.

Building on the resource-based view of the firm, it is posited that companies can achieve superior performance through the effective organization and deployment of strategic resources, such as IC. In the banking sector, where knowledge and relationships are key assets, IC becomes a cornerstone for achieving sustainable competitive advantage. This perspective is particularly relevant for Taiwan's banking industry, which has been adopting a conservative approach due to regional geopolitical risks, yet aims to remain competitive on a global scale. The resource-based view thus provides a theoretical framework for this study, guiding the examination of how well-organized IC contributes to banking efficiency and overall performance in Taiwan.

In light of the increasing importance of IC in the globalized banking sector (Boostan et al. 2014), this study aims to address critical gaps and as such formulates three key research questions to explore the relationship between IC, technical efficiency, and income diversity in shaping the performance of Taiwan's banks. First, we investigate the relationship between IC and firm performance. Second, we delve into the impact of well-organized technical efficiency on bank performance. Lastly, we examine the influence of income diversity on bank performance. These research questions seek to offer invaluable insights for policymakers, investors, and bank managers in Taiwan and could serve as a blueprint for other emerging economies experiencing similar growth patterns.

In its examination of the research questions, this study employs Fixed Effects regression and Generalized Method of Moments models for robustness. The findings of these analyses reveal a complex landscape wherein it is shown that IC has a limited impact on profitability. When examining performance indicators against efficiency calculations derived through the Malmquist method, Total Factor Productivity Change (TFPCH) and Technological Change (TECCH) show mixed results. This study further supports the positive relationship between income diversification on Earnings Per Share (EPS). Grounded in Resource-Based Theory (RBT), this study challenges conventional wisdom by revealing nuanced relationships between IC components, efficiency and income diversity in affecting bank profitability.

This paper systematically examines technical and intellectual capital efficiency in Taiwan's banking sector. Section 2 reviews literature and poses research questions. Section 3 outlines our methodology. Section 4 interprets findings and compares them to existing studies. Section 5 concludes by summarizing implications for both theory and practice.

[1] Emerging country classification as per MSCI (2023)

[2] Taiwan' s 2021 banking-system assets accounted for 292% of nominal GDP, higher than the ratio of most regional peers (Ratings 2023).

2. Review of literature and formulation of hypothesis

2.1. Definition and Components of Intellectual Capital and Its Global Impact

Intellectual capital (IC) is a conceptual framework that encompasses a firm's productive knowledge assets and has garnered substantial scholarly attention (Bayraktaroglu et al. 2019). The primary components of IC are human capital, organizational capital, and social capital, which are key in understanding and valuing an organization's diverse knowledge resources as assets in specific contexts. Empirical research in this area has grown extensively, consistently showing that these components significantly enhance firm performance (Mention and Bontis 2013; Youndt and Snell 2004). Traditional models for measuring IC, such as Pulic (1998)'s VAIC^{TM} model, focus mainly on three efficiency components: human capital efficiencies (HCE), capital employed efficiencies (CEE), and structural capital efficiencies (SCE). This model is popular for its simplicity and its utility in enabling effective comparisons across enterprises or countries. However, it has been criticized for its narrow focus on labour and capital investment efficiency, neglecting IC efficiency and excluding relational and innovation capital (Ståhle et al. 2011; Smriti and Das 2018). To address these limitations, Ulum et al. (2017) amended the original VAIC model to include relational capital efficiency (RCE), resulting in the modified VAIC (MVAIC) method.

Global studies corroborate the importance of IC in enhancing firm performance. Research in Asia, Australia, and the Middle East has shown a positive correlation between IC and performance metrics like ROA and ROE (Ting and Lean 2009; Clarke et al. 2011; Joshi et al. 2013; Al-Musali and Ismail 2014). However, the relationship is nuanced, influenced by factors such as income diversification in East Africa and human capital efficiency in South Korean manufacturing (Githaiga 2020; Xu and Wang 2020). Despite geographical variances, the overarching consensus is that IC positively correlates with firm success, although its effective management, especially of human capital, remains a challenge (Garc'ıa Castro et al. 2021; Cindiyasari et al. 2022). Below is an outline of the four IC components and their individual association with performance.

2.2. Components of Intellectual Capital

2.2.1. Human Capital Efficiency (HCE)

The efficiency of human capital, encapsulating employees' collective knowledge, skills, education, and experience, is vital for an organization's competitive advantage and serves as an internal driver of economic growth (Lanfang et al. 2021). The OECD stresses that HCE propels economic activity, competitiveness, and prosperity (Anaduaka et al. 2014). Research shows mixed results - some Taiwan-based studies found no significant impact of HCE on performance (Tsao and Hung 2014; Xìnpú 2012), while others revealed a significant positive impact in the Taiwan banking context (Zheng et al. 2018). Studies in China (Xiaopeng et al.) and Asia (Zheng et al. 2018) also present mixed findings, underscoring geographical differences.

2.2.2. Capital Employed Efficiency (CEE)

Capital Employed Efficiency (CEE), a metric quantifying value generated per dollar of asset investment, has diverse regional impacts. It boosts performance in Indonesia, Pakistan, and Bahrain, and in Saudi Arabia (Esti Damayanti et al. 2021; Rehman et al. 2013; Ismail and Karem 2011; Hamdan et al. 2017), but shows low scores in Kuwait (Abdulsalam et al. 2011) and negative post-crisis effects in Turkey (Nassar 2018). Notably, there is a research gap regarding CEE's influence on Taiwanese banks.

2.2.3. Structural Capital Efficiency (SCE)

Structural capital efficiency (SCE) refers to the effective utilization and management of an organization's tangible and intangible assets, such as processes, technologies, patents, and organizational culture (Ismail and Karem 2011). It involves creating a supportive environment that encourages experimentation, learning, and the integration of knowledge. SCE is a component of intellectual capital and has been found to impact organizational performance and financial outcomes. Research on SCE has shown mixed results, with some studies indicating a positive relationship between structural capital and corporate performance (Saleem et al. 2022; Olarewaju and Msomi 2021), while others report negative or inconclusive findings (Ting and Lean 2009).

2.2.4. Relational Capital Efficiency (RCE)

Relationship Capital Efficiency (RCE), a vital intangible asset derived from an organization's external interactions, influences metrics like customer loyalty and market image (Kaplan and Norton 2004; Buallay 2018). Its strategic cultivation theoretically enhances competitiveness and efficiency (Nimtrakoon 2015). However, research shows mixed results; while multivariate regression found no significant link between RCE and financial performance, fuzzy regression indicated a positive relationship (Salehi et al. 2013).

2.3. Insights on Efficiency and Bank Performance

The literature provides a multifaceted view of the factors that contribute to bank efficiency and performance, particularly in Taiwan. Various methodologies, such as non-parametric approaches and chance-constrained data envelopment analysis (DEA), have been employed to measure and improve these metrics (Chen and Yeh 2000; Chen 2002). The Malmquist index is another tool that has been globally employed to measure productivity growth in banking sectors. It has been particularly useful in identifying shifts in productivity post-deregulation and in assessing efficiency-driven growth patterns (Berg et al. 1993; Leightner and Lovell 1998; Isik and Hassan 2003). This index provides an additional perspective for understanding and improving banking efficiency and performance.

Research in other regions, such as Indonesia and India, also focuses on operational strategies for improving banking efficiency and performance (Anik et al. 2021; Suardi and Chandra 2014). In Indonesia, financial performance has been found to mediate the relationship between IC and Good Corporate Governance (GCG), thereby enhancing performance (Anik et al. 2021). In India, foreign banks have been shown to outperform domestic banks, suggesting that different operational strategies can lead to performance improvements (Kamath 2004). Mergers generally enhance cost efficiency, although the gains are not uniform across all cases (Chiou 2009).

Improving bank efficiency and performance is a complex but achievable objective. Various methodologies and tools, such as the Malmquist index, offer ways to measure and improve these metrics (Berg et al. 1992, 1993). While traditional factors like mergers and size often contribute to efficiency gains, the role of IC and external factors adds complexity to the landscape of performance improvement (Ting et al. 2021a; Kweh et al. 2021).

2.4. Income diversity and bank performance

The question of how bank income diversification influences financial performance is gaining substantial academic attention. Central to this debate is whether expanding revenue sources beyond traditional interest income positively or negatively impacts bank performance. This discussion is closely related to the broader conversation on the effect of market concentration on bank performance, which is tied to two main theories: the Structure-Conduct-Performance (SCP) hypothesis and the Efficient-Structure Hypothesis (ESH). The SCP hypothesis posits that higher profits are achievable in a highly concentrated banking structure, whereas the ESH argues that profitability reflects individual bank efficiency, regardless of market concentration (Lelissa and Kuhil 2018; Samad 2008).

2.5. Income Diversity in the Literature

The literature on income diversification's impact on bank performance is complex and influenced by geographical and economic factors. Studies from Kenya, Pakistan, and India show a positive correlation with profitability (Kiweu et al. 2012; Shahzad et al. 2016; Vidyarthi 2019), whereas other findings suggest limited or no positive effects (Ho 2020; Nguyen et al. 2021; Wulandari et al. 2021). This highlights the necessity for context-specific understanding, especially in Taiwan where such data may be sparse yet crucial.

Moderating factors like bank size and business model can significantly shape the effects of income diversification (Marshall and Elzinga-Marshall 2017). This is particularly pertinent for Taiwan, given its diverse banking sector. There is a consensus on the need to explore the conditions for positive outcomes, including risk management and tailored diversification strategies (Nguyen et al. 2019; Wulandari et al. 2021). With recent research shedding light on the efficiency implications of non-traditional banking (Tariq et al. 2021; Najam et al. 2022), there's a growing imperative for targeted research on the diversification-performance relationship in Taiwan's evolving banking sector.

2.6. Theoretical Framework

The Resource-Based Theory (RBT) serves as this study's cornerstone for understanding how banks can achieve long-term success and profitability. This theory posits that a firm's unique resources and capabilities, both tangible and intangible, are pivotal for gaining a sustainable competitive advantage and thereby enhancing performance (Dubey et al. 2019). Barney (1991) further argues that the heterogeneity of these resources among firms explains the variations in their profitability, which is particularly relevant for assessing bank performance.

In the context of a knowledge-based economy, IC has been identified as a significant driver of sustained competitive advantages (Theriou et al. 2009). Studies have emphasized the role of IC, characterized by its scarcity, value, and non-replicability, in achieving lasting competitive advantage and thereby influencing bank performance (Massaro et al. 2018; Mikalef and Gupta 2021; Isola et al. 2020). The RBT framework underscores the importance of effectively organizing these strategic resources, including IC, for maximizing bank value and performance (Akter et al. 2016; Fischer et al. 2020).

2.7. Research Questions

In light of the literature surveyed, this paper establishes three central research questions:

1. There is a positive relationship between the Modified Value-Added Intellectual Coefficient (MVAIC) and bank performance in Taiwan.
   (a) Relational capital efficiency (RCE), an intellectual capital component, is positively correlated with bank performance in Taiwan.
   (b) Structural capital efficiency (SCE), an intellectual capital component, is positively correlated with bank performance in Taiwan.
   (c) Capital employed efficiency (CEE), an intellectual capital component, is positively correlated with bank performance in Taiwan.
   (d) Human capital efficiency (HCE), an intellectual capital component, is positively correlated with bank performance in Taiwan.
2. Bank efficiency, as measured by the Malmquist DEA, is positively associated with bank performance in Taiwan.
3. Income diversity is positively associated with bank performance in Taiwan.

3. Data and methodology

3.1. Data and study period

This study draws upon the BankFocus database to examine secondary data related to 44 Taiwanese commercial banks operating between 2010 and 2022, inclusive of both domestic and foreign entities. As shown in Table 1, due to data unavailability, the sample was pruned to 39 banks. The final sample consists of 33 domestic banks (84.6%) and six foreign banks (15.4%). Despite excluding some banks to maintain balanced panel data for efficiency score calculation, this selection still significantly represents the Taiwanese banking sector in terms of total assets. Table 2 outlines the banks involved in the study over the study's time frame.

Table 1: Data Sample

Description	No. of Banks	Percent
Initial Sample	44	111.4%
Companies with unavailable annual reports or data	5	11.4%
Final Sample	39	100.00%
Domestic Banks	33	84.6%
Foreign Banks	6	15.4%
Full Sample	39	100.00%

Table 2: Descriptive Statistics of Key Variables

No.	DMU (Bank Name)	2010 - 2011	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018	2018 - 2019	2019 - 2020	2020 - 2021	2021 - 2022	2022 - 2023
1	AGRICULTURAL BANK OF TAIWAN	AGBT	AGBT	AGBT	AGBT	AGBT	AGBT	AGBT	AGBT	AGBT	AGBT	AGBT	AGBT	AGBT
2	BANCO BILBAO VIZCAYA ARG, TPE BRANCH†		BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA	BBVA
3	BANK OF COMMUNICATIONS. TAIPEI BRANCH†			BOCC	BOCC	BOCC	BOCC	BOCC	BOCC	BOCC	BOCC	BOCC	BOCC	BOCC
4	BANK OF KAOHSIUNG	BOKW	BOKW	BOKW	BOKW	BOKW	BOKW	BOKW	BOKW	BOKW	BOKW	BOKW	BOKW	BOKW
5	BANK OF PANHSIN PUBLIC COMPANY	BOPC	BOPC	BOPC	BOPC	BOPC	BOPC	BOPC	BOPC	BOPC	BOPC	BOPC	BOPC	BOPC
6	BANK OF TAIWAN	BOTA	BOTA	BOTA	BOTA	BOTA	BOTA	BOTA	BOTA	BOTA	BOTA	BOTA	BOTA	BOTA
7	BANK SINOPAC	BSPC	BSPC	BSPC	BSPC	BSPC	BSPC	BSPC	BSPC	BSPC	BSPC	BSPC	BSPC	BSPC
8	CATHAY UNITED BANK	CUBC	CUBC	CUBC	CUBC	CUBC	CUBC	CUBC	CUBC	CUBC	CUBC	CUBC	CUBC	CUBC
9	CHANG HWA COMMERCIAL BANK	CHCB	CHCB	CHCB	CHCB	CHCB	CHCB	CHCB	CHCB	CHCB	CHCB	CHCB	CHCB	CHCB
10	CHUNGHWA POST CO LTD	CHPO	CHPO	CHPO	CHPO	CHPO	CHPO	CHPO	CHPO	CHPO	CHPO	CHPO	CHPO	CHPO
11	CITIBANK TAIWAN LIMITED†	CTBT	CTBT	CTBT	CTBT	CTBT	CTBT	CTBT	CTBT	CTBT	CTBT	CTBT	CTBT	CTBT
12	COTA COMMERCIAL BANK	CCBK	CCBK	CCBK	CCBK	CCBK	CCBK	CCBK	CCBK	CCBK	CCBK	CCBK	CCBK	CCBK
13	CTBC BANK CO LTD		CTBC	CTBC	CTBC	CTBC	CTBC	CTBC	CTBC	CTBC	CTBC	CTBC	CTBC	CTBC
14	DBS BANK (TAIWAN)†			DBST	DBST	DBST	DBST	DBST	DBST	DBST	DBST	DBST	DBST	DBST
15	E. SUN COMMERCIAL BANK			ESUN	ESUN	ESUN	ESUN	ESUN	ESUN	ESUN	ESUN	ESUN	ESUN	ESUN
16	ENTIE COMMERCIAL BANK PUBLIC	ENCB	ENCB	ENCB	ENCB	ENCB	ENCB	ENCB	ENCB	ENCB	ENCB	ENCB	ENCB	ENCB
17	FAR EASTERN INTERNATIONAL BANK	FEIB	FEIB	FEIB	FEIB	FEIB	FEIB	FEIB	FEIB	FEIB	FEIB	FEIB	FEIB	FEIB
18	FIRST COMMERCIAL BANK		FCBK	FCBK	FCBK	FCBK	FCBK	FCBK	FCBK	FCBK	FCBK	FCBK	FCBK	FCBK
19	HSBC BANK (TAIWAN)†	HSBC	HSBC	HSBC	HSBC	HSBC	HSBC	HSBC	HSBC	HSBC	HSBC	HSBC	HSBC	HSBC
20	HUA NAN COMMERCIAL BANK LTD.	HNCB	HNCB	HNCB	HNCB	HNCB	HNCB	HNCB	HNCB	HNCB	HNCB	HNCB	HNCB	HNCB
21	HWATAI BANK	HWBK	HWBK	HWBK	HWBK	HWBK	HWBK	HWBK	HWBK	HWBK	HWBK	HWBK	HWBK	HWBK
22	JIH SUN INTERNATIONAL BANK	JSIB	JSIB	JSIB	JSIB	JSIB	JSIB	JSIB	JSIB	JSIB	JSIB	JSIB	JSIB	JSIB
23	KGI BANK	KGIB	KGIB	KGIB	KGIB	KGIB	KGIB	KGIB	KGIB	KGIB	KGIB	KGIB	KGIB	KGIB
24	KING'S TOWN BANK	KBWT	KBWT	KBWT	KBWT	KBWT	KBWT	KBWT	KBWT	KBWT	KBWT	KBWT	KBWT	KBWT
25	LAND BANK OF TAIWAN	LBOT	LBOT	LBOT	LBOT	LBOT	LBOT	LBOT	LBOT	LBOT	LBOT	LBOT	LBOT	LBOT
26	MEGA INTERNATIONAL COMMERCIAL BANK	MICB	MICB	MICB	MICB	MICB	MICB	MICB	MICB	MICB	MICB	MICB	MICB	MICB
27	O-BANK CO., LTD.	OBCL	OBCL	OBCL	OBCL	OBCL	OBCL	OBCL	OBCL	OBCL	OBCL	OBCL	OBCL	OBCL
28	SHANGHAI COMMERCIAL & SAVINGS BANK	SCSB	SCSB	SCSB	SCSB	SCSB	SCSB	SCSB	SCSB	SCSB	SCSB	SCSB	SCSB	SCSB
29	STANDARD CHARTERED BANK TAIWAN†	SCBT	SCBT	SCBT	SCBT	SCBT	SCBT	SCBT	SCBT	SCBT	SCBT	SCBT	SCBT	SCBT
30	SUNNY BANK	SNBK	SNBK	SNBK	SNBK	SNBK	SNBK	SNBK	SNBK	SNBK	SNBK	SNBK	SNBK	SNBK
31	TAICHUNG BANK LTD	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL
32	TAIPEI FUBON COMMERCIAL BANK	TFCB	TFCB	TFCB	TFCB	TFCB	TFCB	TFCB	TFCB	TFCB	TFCB	TFCB	TFCB	TFCB
33	TAIPEI STAR BANK	TSBK	TSBK	TSBK	TSBK	TSBK	TSBK	TSBK	TSBK	TSBK	TSBK	TSBK	TSBK	TSBK
34	TAISHIN INTERNATIONAL BANK	TIBK	TIBK	TIBK	TIBK	TIBK	TIBK	TIBK	TIBK	TIBK	TIBK	TIBK	TIBK	TIBK
35	TAIWAN BUSINESS BANK	TBBK	TBBK	TBBK	TBBK	TBBK	TBBK	TBBK	TBBK	TBBK	TBBK	TBBK	TBBK	TBBK
36	TAIWAN COOPERATIVE BANK	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL	TCBL
37	TAIWAN SHIN KONG COMMERCIAL BANK	TSKB	TSKB	TSKB	TSKB	TSKB	TSKB	TSKB	TSKB	TSKB	TSKB	TSKB	TSKB	TSKB
38	UNION BANK OF TAIWAN	UBOT	UBOT	UBOT	UBOT	UBOT	UBOT	UBOT	UBOT	UBOT	UBOT	UBOT	UBOT	UBOT
39	YUANTA COMMERCIAL BANK	YUCB	YUCB	YUCB	YUCB	YUCB	YUCB	YUCB	YUCB	YUCB	YUCB	YUCB	YUCB	YUCB

Foreign banks noted by †

3.1.1. Descriptions and measurement of variables

In this study, the dependent variable is bank performance, traditionally measured by Return on Assets (ROA), Return on Equity (ROE), and Net Interest Margin (NIM) (Liu and Wilson 2010; Seenaiah et al. 2015; Ghosh et al. 2019). To provide a more comprehensive view, this study examines performance via the following five metrics: Operating Ratio (*Oper_Ratio*), Earnings Per Share (*EPS*), ROE, Revenue Growth (*Rev_Growth*), and Profit Margin (*Profit_Margin*). These metrics evaluate operational efficiency, profitability, shareholder returns, growth trends, and cost management, each influenced by unique factors. This multifaceted approach allows for a nuanced understanding of a bank's financial health, avoiding unwarranted assumptions of interdependency among these measures. Figure 1 illustrates bank performance measures by domestic and foreign banks in addition to the MVAIC.

3.1.2. Bank-specific explanatory variables

Data Envelopment Analysis (DEA) is employed as the frontier analysis method, chosen for its straightforwardness and minimal assumptions. Within this framework, the Malmquist Productivity Index (MPI) is utilized to assess efficiency changes over time for each decision-making unit (DMU), specifically banks in this study. The study applies an input-oriented model, aligning with the control banks typically have over inputs like interest expenses and operating expenses (Banker et al. 1996).

The MPI is a composite measure, calculated as the product of the technical change index (TCI) and the efficiency change index (ECI). TCI and ECI measure shifts in the best-practice frontier's output-to-input ratio and the DMU's distance from this frontier, respectively. In the context of the MPI approach, a set of DMUs is selected to establish an optimal performance benchmark through input-output combinations. The aim is to measure the distance between individual observations and this benchmark, following methodologies proposed by Shephard (1970) and Caves et al. (1982). The output distance function at time t, denoted as $D_0{}^t$, is defined as per Equation 1. This study adopts the intermediation approach, viewing banks as intermediaries that convert deposits into loans using labour and other resources. Output variables include diverse revenue streams, making MPI a robust tool for longitudinally evaluating DMU performance and pinpointing the sources of efficiency change.

$$D_0^t(X_tY_t) = \left\{\theta : (X_t, Y_t/\theta) \in T^t\right\} \qquad (Eq.\ 1)$$

where

T^t denotes the production technology, which is represented as $T^t = \{X_t, Y_t\}$,
X_t can produce Y_t at time t.
X_t is a vector of inputs at time t
Y_t is a vector of outputs at time t

It is important to note that $D_0^t \leq 1$ indicates that the pair (X_t, Y_t) belongs to the production technology T^t and lies on the best-practice frontier when $D_0^t = 1$. The Malmquist productivity index for an individual decision-making unit (DMU) or bank, spanning from period t to period t + 1, is established by employing the distance function as specified in Equation 2

$$M_0(X_{t+1}, Y_{t+1}, X_t, Y_t) = \left[\frac{D_0^t(X_{t+1}, Y_{t+1})}{D_0^t(X_t, Y_t)} \frac{D_0^{t+1}(X_{t+1}, Y_{t+1})}{D_0^{t+1}(X_t, Y_t)}\right]^{1/2} \qquad (Eq.\ 2)$$

A Malmquist productivity index (M_0) value greater than 1 signifies an enhancement in input-output efficiency from period t to period $t+1$, whereas a value less than 1 symbolizes a decline in efficiency. Following Färe et al. (1994), Equation 2 can be re-expressed as Eq. 3

$$M_0(X_{t+1}, Y_{t+1}, X_t, Y_t) = \frac{D_0^{t+1}(X_{t+1}, Y_{t+1})}{D_0^t(X_t, Y_t)} \times \left[\frac{D_0^t(X_{t+1}, Y_{t+1})}{D_0^{t+1}(X_{t+1}, Y_{t+1})} \times \frac{D_0^t(X_t, Y_t)}{D_0^{t+1}(X_t, Y_t)}\right]^{1/2} \qquad (Eq.\ 3)$$

Equation 3 divides the Malmquist index into "technical change" and "efficiency change." The geometric mean of shifts in the best-practice frontier between periods t to period $t+1$ represents "technical change." In contrast, "efficiency change" is captured by the first ratio in Eq.3, indicating whether a DMU is moving closer to or farther from the existing frontier between t to period $t+1$. A value over 1 for "efficiency change" implies a reduced efficiency gap relative to the current best practice.

3.2. Measurement of intellectual capital

Following the methodologies of Tran et al. (2020); Soetanto and Liem (2019), this study employs the MVAIC model as a proxy for Intellectual Capital (IC), serving as the independent variable. The MVAIC is computed as the sum of four key components: Human Capital Efficiency (HCE), Structural Capital Efficiency (SCE), Capital Employed Efficiency (CEE), and Relational Capital Efficiency (RCE), as defined by Equation 4.

$$MVAIC_{i,t} = HCE_{i,t} + SCE_{i,t} + CEE_{i,t} + RCE_{i,t} \qquad (Eq.\ 4)$$

Each component is calculated in a specific manner. HCE is determined by dividing Value Added (VA) by Human Capital, which is proxied by the funds spent on employee compensation. SCE is calculated as Structural Capital (SC) divided by VA. CEE is the ratio of VA to Capital Employed, which is the net of total assets less total liabilities. RCE is derived from expenditures associated with maintaining relationships with customers, suppliers, shareholders, and the government, divided by VA. Higher values in these components indicate greater efficiency in IC value creation.

Value Added itself is defined as the difference between output and input. Output comprises total bank revenue, including both interest and non-interest income, such as fees and commissions. Input is calculated as operational costs, which include interest, administration, and other expenses, but excludes personnel costs.

3.3. Macro and Firm Control Variables

This study integrates macro-specific control variables such as Population Change, GDP Growth, Gross Domestic Savings, and Inflation to isolate the impact of potential confounders on the hypotheses. Population Change accounts for demographic shifts affecting economic dynamics, while GDP Growth serves as an indicator of overall economic health. Gross Domestic Savings assesses a nation's saving behaviour and its influence on economic stability and investment opportunities. Inflation is included to reflect the broader economic context that could affect corporate strategies and financial outcomes. Year effects are also controlled for through dichotomous variables to capture temporal trends. Additionally, leverage is incorporated as a control variable to isolate its impact on bank performance from other predictors. A quadratic term for leverage is included to account for potential non-linear relationships between leverage and performance.

4. Results and Discussion

4.1. Bank Performance, Efficiency, and Intellectual Capital

Figure 1 illustrates the performance metrics and IC as measured by the MVAIC variable, for domestic and foreign banks in Taiwan from 2010 to 2022. The data reveals consistent IC performance, peaking in 2022. While ROE shows a minor decline, EPS indicates domestic banks outperforming their foreign counterparts. Revenue growth, operational efficiency, and profit margin exhibit significant fluctuations in 2015 and 2020 but stabilize towards the end of the period, suggesting resilience in domestic banks and volatility in foreign entities.

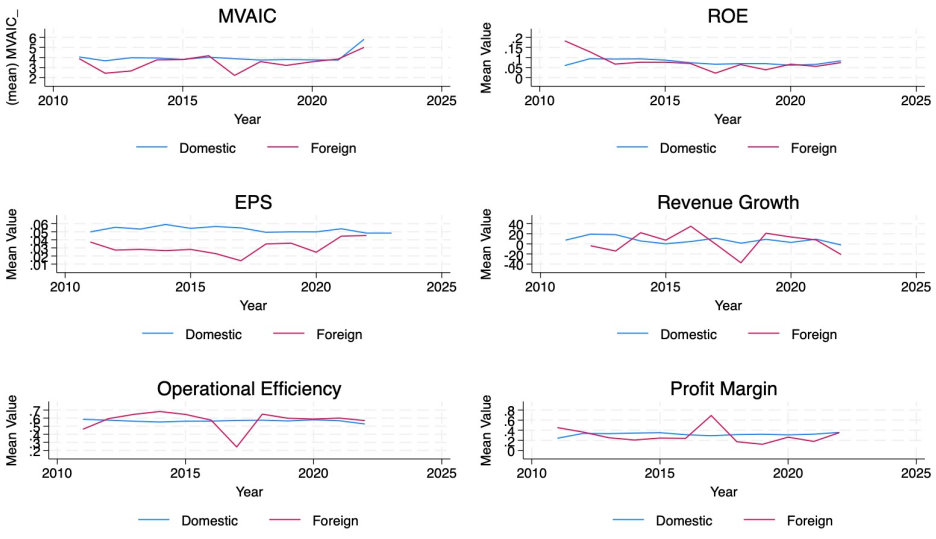

Figure 1: Performance measures by domestic and foreign Banks

The descriptive statistics of the five performance variables are presented in Table 3 (Panel A). The average *Oper_Ratio* is around 0.57, with a standard deviation of 0.18, indicating moderate variability across firms. *EPS* and *ROE* have averages of 0.05 and 0.075, respectively, with slightly higher variability seen in *ROE*. The aggregated and individual IC variables (*MVAIC*, *HCE*, *SCE*, *CEE*, and *RCE*) show means ranging from 0.18 to 3.88, these variables present diverse profiles, with the highest variation observed in *RCE*. Panel B of the table presents efficiency results for local and foreign banks. The local and foreign Malmquist Productivity Index (MPI) means are roughly equal at 1.01 and 1.02, indicating comparable productivity levels, however, the standard deviations show greater variability for the foreign banks, Technical Change (TECCH), and Techincal Efficiency (TECH). exhibit similar mean values yet slightly higher variability for the foreign variables.

An examination of efficiency values over an annual basis can be seen via Table 4. Panel A of the table summarizes the annual efficiency scores. From 2011 to 2022, there have been fluctuations in efficiency scores, with TECH achieving a high of 1.07 between the years 2021–2022. TFPCH peaked at 1.11 in 2020–2021, showing a period of productivity growth. The data in Panel B, showcases the top eight firms with *TFPCH* greater than 1, with JSIB leading with a TFPCH of 1.0713.

Table 3: Descriptive Statistics

Variables	**Obs**	**Mean**	**Std. Dev**	**Median**
Panel A				
Performance Indicators				
Oper_Ratio	411	0.568	0.188	0.548
EPS	195	0.045	0.038	0.036
ROE	411	0.075	0.044	0.076
Rev_Growth	399	7.318	38.026	5.072
Profit_Margin	411	0.314	0.203	0.331
Efficiency Variables -Inputs				
Interest Exp (1)	466	274292.40	325108.80	141767.400
Fee & Commission Exp (2)	377	28887.78	35081.35	19693.68
Operating Exp (3)	466	481188.60	936289.60	207354.30
Provisions (4)	466	752687.10	3766823.00	0.00
Efficiency Variables -Outputs				
Interest Income (1)	411	780331.60	763997.90	405921.200
Fee Commission Income (2)	466	153060.10	215893.50	83203.770
Intellectual Capital				
MVAIC	411	3.846	2.552	3.139
HCE	411	2.788	1.413	2.616
SCE	411	0.380	0.275	0.420
CEE	411	0.587	0.316	0.645
RCE	411	1.719	3.084	0.775
Income Diversity				
Inc_Diversity	410	6.114	50.018	2.674
Macro Control Variables				
Population Change	466	0.128	0.201	0.200
GDP Growth	466	3.123	1.296	2.800
Gross Domestic Savings	466	34.181	3.172	33.840
Inflation	466	1.152	0.880	1.300
Firm Control Variables				
Size	411	17.090	1.235	17.043
ROA	411	0.054	0.038	0.052
Capitalization	411	14.345	1.313	14.401
Panel B				
Firm Efficiency Results -Domestic				
Local MPI (TFPCH)	–	1.009289	0.0911398	1.009289
Tech Change (Local) (TECCH)	–	1.010425	0.0871156	1.010425
Tech Efficiency (Local) (TECH)	–	1.004923	0.0688093	1.004923
Firm Efficiency Results -Foreign				
Foreign MPI (TFPCH)	–	1.018431	0.1553367	1.018431
Tech Change (Foreign) (TECCH)	–	1.009239	0.1375266	1.009239
Tech Efficiency (Foreign) (TECH)	–	1.012164	0.0761907	1.012164

Note: Macroeconomic data, including population changes and gross domestic savings, were obtained from the Asian Development Bank (ADB). GDP growth rates and inflation statistics were sourced from the International Monetary Fund (IMF). The variable of bank size was operationalized as the natural logarithm of total assets. Capitalization was quantified as the natural logarithm of total equity.

Table 4: The Malmquist index summary of annual means in terms of intellectual capital efficiency

Panel A				*Panel B - Top eight firms (TFPCH > 1*			
Year(s)	TFPCH	TECH	TECCH	Abbrev.	TFPCH	TECH	TECC
2010–2011	.	.	.	JSIB	1.0713	1.0125	1.0567
2011–2012	0.9889	0.9652	1.0325	BOPC	1.0593	1.0210	1.0364
2012–2013	1.0233	1.0128	1.0348	ENCB	1.0514	1.0000	1.0514
2013–2014	1.0085	0.9806	1.0319	CTBT	1.0481	1.0000	1.0481
2014–2015	1.0059	1.0015	1.0039	KTBK	1.0430	1.0000	1.0430
2015–2016	1.0277	1.0038	1.0113	OBCK	1.0366	1.0196	1.0392
2016–2017	0.9822	1.0214	0.9722	CCBK	1.0298	1.0000	1.0298
2017–2018	0.9865	0.9918	0.9961	HSBC	1.0273	1.0028	1.0251
2018–2019	0.9921	1.0094	0.9910				
2019–2020	1.0303	1.0088	1.0411				
2020–2021	1.1069	1.0114	1.1000				
2021–2022	0.8219	1.0727	0.7333				

Note: TFPCH measures total productivity change, where $TFPCH > 1$ indicates growth and $TFPCH < 1$ indicates decline. TECH measures efficiency change, where $TECH > 1$ indicates improvement and $TECH < 1$ indicates decline. TECCH measures technological change, where $TECCH > 1$ indicates progress and $TECCH < 1$ indicates regress.

4.2. Correlation Analysis

An examination of the correlation matrix (Table 5) reveals positive and negative interrelationships of varying strengths between key financial and operational metrics. Notably, *Oper_Ratio* positively correlates with *RCE*. *EPS* shows moderate positive correlation with *RCE* but strong negative correlation with *SCE*. *ROE* demonstrates strong positive correlations with *CEE* and *HCE* yet moderate negative correlation with *RCE*. *Profit_margin* is strongly negatively tied to *RCE*. *MVAIC* has strong positive correlations with *RCE* and *HCE*, while *HCE* itself positively correlates with *ROE*, *CEE*, and *MVAIC*. *RCE* is strongly positively associated with *EPS* but strongly negatively with *Profit_margin*. The interrelationships reveal nuances in how the financial and operational metrics are associated, with correlation strength and direction varying across variable pairs.

Table 5: Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Oper_Ratio	1.00													
(2) EPS	0.11	1.00												
	(0.14)													
(3) ROE	-0.24***	0.01	1.00											
	(0.00)	(0.92)												
(4) Rev-Grwth	0.00	-0.00	0.27***	1.00										
	(0.96)	(0.95)	(0.00)											
(5) Profit_margin	-0.81***	-0.09	0.41***	0.02	1.00									
	(0.00)	(0.21)	(0.00)	(0.66)										
(6) MVAIC_	0.01	0.08	0.19***	0.29***	-0.07	1.00								
	(0.85)	(0.28)	(0.00)	(0.00)	(0.17)									
(7) HCE_	-0.59***	-0.06	0.48***	0.17***	0.31***	0.35***	1.00							
	(0.00)	(0.46)	(0.00)	(0.00)	(0.00)	(0.00)								
(8) CEE_	-0.07	0.15	0.79***	0.21**	0.06	0.04	0.40***	1.00						
	(0.40)	(0.25)	(0.00)	(0.01)	(0.48)	(0.60)	(0.00)							
(9) SCE_	0.00	-0.44***	0.33***	-0.03	0.13	0.07	-0.08	0.27***	1.00					
	(0.98)	(0.00)	(0.00)	(0.74)	(0.11)	(0.37)	(0.34)	(0.00)						
(10) RCE_	0.54***	0.40**	-0.22**	0.20*	-0.34***	0.81***	-0.37***	-0.29***	0.00	1.00				
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.96)					
(11) Leverage	0.13**	-0.05	-0.15**	0.06	-0.21***	0.04	-0.18***	0.16*	-0.11	0.21**	1.00			
	(0.01)	(0.52)	(0.00)	(0.25)	(0.00)	(0.47)	(0.00)	(0.05)	(0.15)	(0.01)				
(12) TFPCH	-0.03	0.01	0.03	-0.07	0.05	-0.11	0.05	0.01	-0.07	-0.08	-0.12*	1.00		
	(0.61)	(0.93)	(0.64)	(0.22)	(0.39)	(0.05)	(0.33)	(0.96)	(0.49)	(0.41)	(0.03)			
(13) TECH	0.00	0.08	-0.04	0.01	-0.04	-0.02	-0.03	-0.06	-0.07	-0.02	-0.01	0.34***	1.00	
	(0.98)	(0.38)	(0.45)	(0.88)	(0.49)	(0.77)	(0.61)	(0.51)	(0.43)	(0.85)	(0.89)	(0.00)		
(14) TECCH	0.01	-0.04	0.02	0.00	0.03	-0.04	0.05	-0.00	-0.09	-0.00	-0.12*	0.65***	-0.27***	1.00
	(0.90)	(0.67)	(0.73)	(0.98)	(0.54)	(0.44)	(0.37)	(1.00)	(0.36)	(0.96)	(0.02)	(0.00)	(0.00)	

Note: P-values in parentheses = "* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$".

4.3. Random Effects Regression

To account for variations both within and between banks, this study employs random effects regression. This model allows for differing intercepts across the sampled banks, capturing intrinsic variations in factors such as

efficiency, capital, and diversity. Statistical support for this choice comes from the Hausman test ($\chi^2 = 3.37$, p-value $= 0.3382$) favouring the random effects model. This methodology enables a robust, flexible, and efficient analysis of both time-invariant and time-variant factors affecting bank performance. Equation 5 focuses on collective IC value, while Equation 6 examines individual IC components, both serving to outline the models used for assessing bank performance.

$$\pi_{i,t} = \beta_1 \pi_{i,t-1} + \beta_2 \text{Eff}_{i,t}(\text{MPI}_{i,t}, \text{TECH}_{i,t}, \text{TECCH}_{i,t}) + \beta_3 \text{MVAIC}_{i,t} + \beta_4 \text{IncDiversity}_{i,t} + \beta_3 \text{IncDiversity}_{i,t} + \beta_4 \text{Leverage}_{i,t} + \beta_5 \text{Leverage}_{i,t}^2 + \mu_{i,t} \sum \text{Macro Control}_{i,t} + \sum \text{Firm Control}_{i,t} + \varepsilon_{i,t} \quad (Eq.\ 5)$$

$$\pi_{i,t} = \beta_1 \pi_{i,t-1} + \beta_2 \text{Eff}_{i,t}(\text{MPI}_{i,t}, \text{TECH}_{i,t}, \text{TECCH}_{i,t}) + \gamma_1 \text{HCE}_{i,t} + \gamma_2 \text{SCE}_{i,t} + \gamma_3 \text{CEE}_{i,t} + \gamma_4 \text{RCE}_{i,t} + \beta_3 \text{IncDiversity}_{i,t} + \beta_4 \text{Leverage}_{i,t} + \beta_5 \text{Leverage}_{i,t}^2 + \mu_{i,t} \sum \text{Macro Control}_{i,t} + \sum \text{Firm Control}_{i,t} + \varepsilon_{i,t} \quad (Eq.\ 6)$$

where i and t denotes bank and year, respectively. π is the performance indicator. The inclusion of a one-period lagged variable of π serves dual purposes: it captures the persistence and path dependence in bank performance and mitigates potential endogeneity between performance and key predictors like efficiency, capital, and diversity. Consequently, this methodological choice enhances the robustness and accuracy of the estimates. *Eff* represents the efficiency scores via (MPI) and *EFFCH* (the the catch-up effect of efficiency changes) and *TECHCH* (the technical changes of frontier shift). The IC variable is captured via *MVAIC* in Eq.5 and via its four components in Eq.6. *IncDiversity* is the distribution of a bank's income across different sources. μ represent the macro and firm control variables as outlined in Section 3.3

Random Effects regression analysis reveals π_{t-1} consistently shows a significant positive association with *Oper_ratio*, *EPS*, and *ROE*, and a significant negative one with *Rev_Growth*. *TFPCH*, a measure of total productivity change, exhibits a mixed effect, positively influencing *EPS* but negatively influencing *Oper_ratio*. *Leverage* and its quadratic form have contrasting impacts on performance indicators, indicating a non-monotonic relationship. The variable *MVAIC* also shows consistent significance across different metrics, positively affecting *Oper_ratio* and *Rev_Growth* but negatively impacting *EPS*, *ROE*, and *Profit_margin*. This finding suggests IC aids in operational efficiency and revenue growth but is not as good a predictor of profitability. Income Diversity has a statistically significant positive effect on EPS across the three models as indicated by the z-scores of (3.85, 3.32, 3.55). This suggests that a diversified income stream can enhance a bank's per-share profitability. However, the variable does not show a significant impact on the other performance metrics with z-scores for these metrics ranging from non-significant to mildly negative, indicating that the benefits of income diversity may be confined to enhancing EPS. Therefore, while income diversity appears to contribute to per-share profitability, its influence on overall bank performance in Taiwan seems limited.

Table 6: Random Effects Regression Of Performance Indicators On Combiner Intellectual Variables

	Oper_ratio			EPS			ROE			Rev_Growth			Profit_margin		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
π_{t-1}	0.722***	0.704***	0.715***	0.346**	0.269	0.302	0.076*	0.075*	0.075*	-0.154	-0.168	-0.162	0.157**	0.151*	0.160**
	(16.45)	(15.80)	(15.76)	(2.59)	(1.66)	(1.90)	(2.20)	(2.18)	(2.17)	(-1.45)	(-1.62)	(-1.55)	(2.59)	(2.51)	(2.66)
TFPCH	-0.089*			0.079**			0.007			-28.090			-0.002		
	(-2.40)			(3.07)			(0.86)			(-0.54)			(-0.03)		
TECH		-0.065			0.030			0.003			13.990			-0.098	
		(-1.23)			(0.94)			(0.28)			(0.19)			(-1.22)	
TECCH			-0.047			0.051			0.003			-39.350			0.077
			(-0.96)			(1.31)			(0.30)			(-0.61)			(1.06)
MVAIC	0.013***	0.013***	0.013***	-0.001	0.007	0.004	-0.002***	-0.002***	-0.002***	5.438*	5.453*	5.299*	-0.017***	-0.017***	-0.017***
	(5.41)	(5.56)	(5.20)	(-0.07)	(0.71)	(0.40)	(-5.46)	(-5.44)	(-5.38)	(2.10)	(2.10)	(2.04)	(-5.48)	(-5.52)	(-5.37)
IncDiversity	-0.000	-0.000	-0.000	0.003***	0.004***	0.004***	-0.000	-0.000	-0.000	-0.006	-0.004	-0.006	-0.000	-0.000	-0.000
	(-1.42)	(-1.54)	(-1.37)	(3.85)	(3.32)	(3.55)	(-1.52)	(-1.49)	(-1.52)	(-0.11)	(-0.07)	(-0.11)	(-0.50)	(-0.63)	(-0.48)
Leverage	-144.200	-168.500	-146.000	0.000	0.000	0.000	38.490*	39.850*	38.630	25961.60	21139.60	36792.200	387.200**	393.200**	354.300**
	(-1.70)	(-1.96)	(-1.63)	(0.00)	(0.00)	(0.00)	(1.96)	(2.03)	(1.92)	(0.23)	(0.18)	(0.31)	(2.89)	(2.97)	(2.61)
Leverage^2	92.59	107.7*	93.41	-3.497**	-2.133	-2.141	-23.40	-24.23*	-23.46	-16470.6	-13594.3	-23349.0	-239.0**	-242.5**	-218.4**
	(1.75)	(2.01)	(1.67)	(-3.07)	(-1.69)	(-1.75)	(-1.92)	(-1.99)	(-1.87)	(-0.23)	(-0.19)	(-0.32)	(-2.87)	(-2.95)	(-2.58)
_cons	59.87	70.14	60.73	0.553	-0.00949	0.0407	-16.71*	-17.29*	-16.78*	-10369.3	-8321.2	-14849.8	-164.6**	-167.1**	-150.8**
	(1.67)	(1.93)	(1.61)	(1.02)	(-0.02)	(0.07)	(-2.01)	(-2.08)	(-1.97)	(-0.21)	(-0.17)	(-0.30)	(-2.90)	(-2.99)	(-2.63)
N	102.0000	102.0000	102.0000	29.0000	29.0000	29.0000	102.0000	102.0000	102.0000	100.0000	100.0000	100.0000	102.0000	102.0000	102.0000
R^2 within	0.3686	0.3285	0.3032	0.8028	0.6955	0.7214	0.9113	0.9113	0.911	0.1711	0.1671	0.1701	0.7546	0.7603	0.7555
R^2 between	0.9939	0.9938	0.9944	0.9985	0.9971	0.9957	0.9954	0.9951	0.9952	0.9061	0.9173	0.9129	0.9533	0.9535	0.9536
R^2 overall	0.9685	0.967	0.9667	0.9697	0.9544	0.9566	0.9682	0.968	0.968	0.2254	0.2231	0.2261	0.9105	0.912	0.9116
Wald Chi2	2702.83 ***	2575.65 ***	2558.48 ***	.	.	.	2683.26 ***	2662.83 ***	2663.17 ***	25.02 **	24.70 **	25.12 **	895.01 ***	911.71 ***	907.51 ***

Note: z-scores in parenthesis. TFPCH measures total productivity change, where $TFPCH > 1$ indicates growth and $TFPCH < 1$ indicates decline. TECH measures efficiency change, where $TECH > 1$ indicates improvement and $TECH < 1$ indicates decline. TECCH measures technological change, where $TECCH > 1$ indicates progress and $TECCH < 1$ indicates regress. SECH measures scale efficiency change, where $SECH > 1$ indicates improvement and $SECH < 1$ indicates decline. Wald Chi^2 H0: coefficients of the random effects being tested are equal to zero simultaneously

Table 7: Random Effects Regression Of Performance Indicators On Combiner Intellectual Variables

	Oper_ratio			EPS			ROE			Rev_Growth			Profit_margin		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
π_{t-1}	0.525***	0.496***	0.507***	0.308**	0.320**	0.261*	0.072	0.068	0.068	-0.154	-0.168	-0.161	0.149**	0.143**	0.144**
	(-10.070)	(-9.650)	(-9.390)	(-3.050)	(-2.590)	(-2.580)	(-1.780)	(-1.670)	(-1.700)	(-1.420)	(-1.580)	(-1.510)	(-3.210)	(-3.050)	(-3.110)
TFPCH	-0.066*			0.075**			0.006			-29.380			0.053		
	(-2.000)			(-2.700)			(-0.740)			(-0.550)			(-1.300)		
TECH		-0.089			0.022			-0.000			11.490			0.008	
		(-1.930)			(-0.700)			(-0.000)			(-0.150)			(-0.130)	
TECCH			-0.007			0.110**			0.007			-42.000			0.047
			(-0.160)			(-2.820)			(-0.650)			(-0.620)			(-0.880)
RCE	0.021***	0.022***	0.021***	-0.005	0.028	0.034	-0.002***	-0.002***	-0.002***	6.651	6.501	6.131	-0.032***	-0.032***	-0.031***
	(-7.120)	(-7.500)	(-6.770)	(-0.110)	(-0.530)	(-0.840)	(-3.590)	(-3.470)	(-3.380)	(-1.730)	(-1.660)	(-1.560)	(-10.370)	(-10.160)	(-9.960)
SCE	-0.042	-0.034	-0.044	-0.090	-0.089	-0.014	-0.019	-0.019	-0.018	9.837	10.300	2.991	-0.044	-0.046	-0.036
	(-1.010)	(-0.820)	(-1.030)	(-0.950)	(-0.750)	(-0.140)	(-1.730)	(-1.730)	(-1.590)	(-0.150)	(-0.150)	(-0.040)	(-0.860)	(-0.890)	(-0.700)
HCE	-0.016**	-0.018***	-0.018***	-0.003	0.001	-0.004	-0.003**	-0.003**	-0.003**	0.403	0.170	0.636	-0.012*	-0.011	-0.012*
	(-3.290)	(-3.730)	(-3.440)	(-0.830)	(-0.420)	(-1.200)	(-2.710)	(-2.640)	(-2.700)	(-0.060)	(-0.020)	(-0.090)	(-2.000)	(-1.860)	(-1.960)
CEE	0.366**	0.398**	0.342**	0.396	0.376	0.425	0.044	0.049	0.051	93.650	74.120	67.140	-1.667***	-1.644***	-1.627***
	(-2.860)	(-3.040)	(-2.590)	(-1.300)	(-1.000)	(-1.410)	(-1.140)	(-1.250)	(-1.340)	(-0.450)	(-0.350)	(-0.320)	(-10.570)	(-10.230)	(-10.310)
IncDiversity	-0.000	-0.000	-0.000	0.003	0.002	0.002	-0.000	-0.000	-0.000	-0.002	0.000	-0.001	-0.000	-0.000	-0.000
	(-1.190)	(-1.440)	(-1.110)	(-1.720)	(-0.990)	(-0.860)	(-1.170)	(-1.170)	(-1.180)	(-0.040)	(-0.010)	(-0.020)	(-0.090)	(-0.100)	(-0.120)
Leverage	-272.400***	-296.600***	-295.900***	0.000	0.000	0.000	32.400	34.370	31.910	19791.100	13299.100	27761.800	236.200*	251.900*	235.900*
	(-3.440)	(-3.790)	(-3.570)	(0.000)	(0.000)	(0.000)	(-1.580)	(-1.680)	(-1.540)	(-0.170)	(-0.110)	(-0.230)	(-2.420)	(-2.560)	(-2.370)
Leverage^2	170.900***	186.000***	185.300***	-3.563***	-2.235*	-2.492**	-19.550	-20.730	-19.210	-12921.900	-9049.600	-18019.300	-146.100*	-155.600*	-145.600*
	(-3.480)	(-3.830)	(-3.600)	(-3.400)	(-1.970)	(-2.870)	(-1.540)	(-1.630)	(-1.500)	(-0.180)	(-0.120)	(-0.240)	(-2.410)	(-2.560)	(-2.360)
Macro Control	included	included	included	included	included	included	included	included	included	included	included	included	included	included	included
Firm Control	included	included	included	included	included	included	included	included	included	included	included	included	included	included	included
_cons	114.900***	125.300***	124.900***	0.110	-0.383	0.140	-14.210	-15.050	-14.020	-7553.700	-4778.100	-10858.900	-100.700*	-107.400**	-100.700*
	(-3.43)	(-3.79)	(-3.56)	(-0.19)	(-0.57)	(-0.25)	(-1.63)	(-1.73)	(-1.60)	(-0.15)	(-0.10)	(-0.21)	(-2.43)	(-2.58)	(-2.39)
N	102	102	102	29	29	29	102	102	102	100	100	100	102	102	102
R^2 within	0.4383	0.4323	0.4008	0.8535	0.7772	0.8524	0.9108	0.9105	0.9109	0.1784	0.1744	0.1773	0.797	0.7916	0.7938
R^2 between	0.9955	0.9954	0.9951	0.9997	0.9993	0.9998	0.9968	0.9967	0.9967	0.932	0.9409	0.942	0.9942	0.9944	0.9944
R^2 overall	0.9769	0.9768	0.9758	0.9783	0.9674	0.979	0.9694	0.9692	0.9693	0.232	0.2295	0.2328	0.9571	0.9563	0.9567
Wald Chi^2	3587.95 ***	3576.65 ***	3423.71 ***	.	.	.	2691.83 ***	2674.24 ***	2688.00 ***	25.08 *	24.72 *	25.19 *	1897.62 ***	1859.56 ***	1876.92 ***

Note: z-scores in parenthesis. TFPCH measures total productivity change, where $TFPCH > 1$ indicates growth and $TFPCH < 1$ indicates decline. TECH measures efficiency change, where $TECH > 1$ indicates improvement and $TECH < 1$ indicates decline. TECCH measures technological change, where $TECCH > 1$ indicates progress and $TECCH < 1$ indicates regress. SECH measures scale efficiency change, where $SECH > 1$ indicates improvement and $SECH < 1$ indicates decline. Wald Chi^2 H0: coefficients of the random effects being tested are equal to zero simultaneously

The examination of individual IC variables, as shown in Table 7, reveals that RCE and HCE are negatively associated with profitability measures such as ROE and profit margin. This indicates that while IC may enhance growth in operational efficiency and revenue growth, it does not significantly boost overall profitability. Furthermore, CEE demonstrates a dual impact: it positively influences the operating ratio, suggesting that better capital utilization enhances operational efficiency, but negatively affects profit margin, revealing a trade-off between operational efficiency and profitability. Income diversity, which can reduce risk, was expected to show a positive impact on profitability measures. However, income diversity only had a positive impact on EPS when the IC variables were examined collectively. The analysis also uncovers the nuanced role of leverage effects on various outcomes, emphasizing the complexity of capital structure in shaping firm performance.

In a focus on efficiency variables, *TFPCH* demonstrates a positive effect on *EPS*, implying that efficiency gains can lead to higher earnings. However, its impact on the operating ratio is adverse, suggesting that overall operational performance might not see commensurate improvements despite enhanced efficiency. Conversely, *TECCH* showcases a positive influence on *EPS*, underscoring its significance in bolstering profitability. These findings underscore the importance of understanding the nuanced relationships between different performance dimensions and the role of IC and technological advancements in shaping a bank's financial performance.

Implications of these findings highlight the significance of past profitability in driving current and future financial performance. Banks should consider leveraging their past success while recognizing the potential trade-offs between improved efficiency and profit margins. Furthermore, the impact of intellectual capital factors, such as *RCE*, on different performance metrics requires careful consideration. To achieve sustained growth and success, banks must explore strategies that harness their IC potential while adapting to the complexities of the banking industry. These findings underscore the need for a nuanced understanding of the relationships between financial performance variables, which can guide banks in formulating effective strategies and achieving long-term profitability and competitiveness.

Concerning this study's research questions, the relationship between *MVAIC* and bank performance in Taiwan yielded mixed results. Mixed support was found for *RCE*'s positive relationship with bank performance, indicating inconsistent effects across different contexts. There was no support for the hypothesis that *SCE* positively correlates with bank performance, hinting that structural aspects might not translate into improved performance. The relationship between *CEE* and bank performance also showed mixed support. Additionally, the study partially supported the positive association between bank efficiency, as measured by the Malmquist DEA, and bank performance, implying other influencing factors. The hypothesis that income diversity is positively associated with bank performance was weakly supported and partially supported in detail. Far from a simplistic portrait, the results reveal an intricate web of interactions between diverse facets of IC and bank performance in Taiwan, emphasizing the contextual sensitivities and complexities inherent in enhancing competitiveness. Unexpected findings, such as the reverse relationship with *HCE*, and partial support for relationships between bank efficiency and *IncDiversity*, emphasize the need for further research to understand the intricate dynamics shaping bank performance in Taiwan.

4.4. Additional Analysis

The one-step System-GMM (SGMM) estimator is employed to rigorously assess the sensitivity of bank performance, effectively addressing issues of endogeneity and heterogeneity (Shahzad et al. 2020; Blundell and Bond 1998). This estimator yields more precise and asymptotically efficient estimates compared to alternative methods (Bond 2002). The validity of the SGMM approach is contingent on two key conditions: the relevance of the instruments and the absence of second-order serial correlation in the errors. These conditions are verified through the Sargan and Arellano-Bond tests. Instrumental variables such as *Income Diversity* and *Gross Domestic Savings* are selected to mitigate endogeneity bias, while GMM variables including *Size*, *Solvency*, and *Leverage* are incorporated to directly model their impacts on performance. This methodological framework ensures both robustness and relevance.

Table 8: SGM Regression Of Performance Indicators On Combined Intellectual Variables

	Oper_ratio			EPS			ROE			Rev_Growth			Profit_margin		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
π_{t-1}	0.725***	0.713***	0.732***	0.346***	0.269	0.302*	0.163*	0.158*	0.160*	-0.154***	-0.167***	-0.161***	0.201	0.199	0.192
	(-8.22)	(-7.83)	(-8.82)	(-3.66)	(-1.68)	(-2.18)	(-2.17)	(-2.04)	(-2.2)	(-13.93)	(-12.17)	(-19.68)	(-1.48)	(-1.39)	(-1.43)
TFPCH	-0.0488			0.0787***			0.00739			-27.73			0.0481		
	(-1.36)			(-10.38)			(-1.01)			(-0.66)			-0.89		
TECH		-0.0717			0.0299**			-0.0146			14.07			-0.0244	
		(-1.10)			(-3.02)			(-1.11)			(-0.51)			(-0.26)	
TECCH			-0.0874**			0.0505			-0.00409			-37.28			0.104*
			(-2.66)			(-1.81)			(-0.45)			(-0.69)			(-2.16)
MVAIC	0.00899***	0.00929***	0.00907***	-0.000551	0.00652	0.00366	-0.00211***	-0.00210***	-0.00210***	5.568***	5.563***	5.487***	-0.0146***	-0.0146***	-0.0151***
	-3.91	-3.83	-4.11	(-0.21)	-1.23	-0.77	(-5.29)	(-5.09)	(-4.76)	-12.28	-13.12	-13.83	(-4.31)	(-4.09)	(-4.72)
IncDiversity	-0.0000549**	-0.0000658**	-0.0000553**	0.00333***	0.00351***	0.00364***	-0.0000093	-0.0000120*	-9.83E-06	-0.0062	-0.00391	-0.00632	-0.0000358	-0.0000427	-0.0000314
	(-2.77)	(-2.59)	(-3.08)	-8.15	-4.37	-4.8	(-1.70)	(-2.13)	(-1.67)	(-0.61)	(-0.34)	(-0.58)	(-0.80)	(-0.93)	(-0.73)
Leverage	-0.442	-0.41	-0.352	0.000	0.000	0.000	-0.385***	-0.345***	-0.362***	14099.4	11201.7	19666	-0.222	-0.0804	-0.354
	(-1.22)	(-1.47)	(-1.14)	(0.00)	(0.00)	(0.00)	(-8.25)	(-4.88)	(-6.02)	(-0.46)	(-0.42)	(-0.57)	(-0.66)	(-0.26)	(-0.98)
Leverage^2	0.830*	0.843***	0.808***	-3.497***	-2.133*	-2.141*	0.486***	0.473***	0.479***	-9093.1	-7412.2	-12693.4	-0.322	-0.373	-0.312
	(-2.28)	(-3.32)	(-3.83)	(-7.10)	(-2.16)	(-2.03)	(-4.99)	(-5.03)	(-5.01)	(-0.48)	(-0.44)	(-0.59)	(-0.99)	(-1.24)	(-0.74)
Macro Control	included	included	included	included	included	included	included	included	included	included	included	included	included	included	included
Firm Control	included	included	included	included	included	included	included	included	included	included	included	included	included	included	included
_cons	0.000	0.000	0.000	0.553**	-0.00948	0.0407	0.000	0.000	0=0.000	-5358.7	-4123.8	-7620.2	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	-2.59	(-0.02)	-0.1	(0.000)	(0.000)	(0.000)	(-0.42)	(-0.37)	(-0.54)	(0.000)	(0.000)	(0.000)
N	102	102	102	29	29	29	102	102	102	100	100	100	102	102	102
AR(1)[1]	-2.53 **	-2.48 **	-2.35 **	-1.43	-1.04	-1.83 *	-1.88 *	-1.88 *	-1.91 *	0.96	0.94	0.98	-1.95 *	-1.91 *	-2.13 **
AR(2)[2]	1.21	1.05	0.65	-0.97	-1.01	-0.66	-2.41 **	-2.04 **	-2.08 **	-0.99	-0.93	-1.1	-1.57	-1.04	-1.3
Sargan[3]	115.81 *	115.28 *	110.95 *	33.86 ***	47.19 ***	39.72 ***	116.48 **	128.05 ***	120.77 **	188.47 ***	188.67 ***	187.30 ***	162.17 ***	162.56 ***	163.14 ***
Hansen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	0.00	0.00	0.00	0.00	0.00
Wald chi^2[4]	5.30e+06 ***	2.36e+07 ***	4.82e+06 ***	660.47 ***	216.96 ***	327.46 ***	264956.67 ***	28563.94 ***	75241.33 ***	3.90e+06 ***	658193.75 ***	2.45e+06 ***	9832.01 ***	16196.22 ***	55078.47 ***

Note: z-score in parenthesis. [1]Arellano-Bond first-order autocorrelation test (Ho: no autocorrelation); [2]Arellano-Bond second-order autocorrelation test (Ho: no autocorrelation); [3]Test for overidentifying restrictions in GMM dynamic model estimation; Wald Chi^2 (Ho: estimated parameters not significantly different from the true values).

Table 9: SGM Regression Of Performance Indicators On Individual Intellectual Variables

	Oper_ratio			EPS			ROE			Rev_Growth			Profit_margin		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
π_{t-1}	0.560***	0.550***	0.579***	0.308***	0.320***	0.261***	0.114**	0.0915	0.110**	-0.153***	-0.167***	-0.160***	0.204***	0.195***	0.194***
	(-6.08)	(-5.84)	(-5.56)	(-5.02)	(-3.68)	(-5.72)	(-2.75)	(-1.84)	(-3.19)	(-16.92)	(-12.89)	(-20.86)	(-4.4)	(-4.45)	(-3.95)
TFPCH	-0.0647*			0.0749***			0.007			-29.04			0.0857**		
	(-2.33)			-6.58			-0.9			(-0.68)			-3.13		
TECH		-0.0748			0.0215*			-0.0272			11.71			-0.0197	
		(-1.42)			(-2.31)			(-1.44)			(-0.49)			(-0.35)	
TECCH			-0.0824**			0.110***			0.00643			-40.6			0.0721*
			(-3.02)			(-3.52)			(-0.98)			(-0.80)			(-1.96)
RCE	0.0125***	0.0131***	0.0120***	-0.00469	0.0276	0.0344	0.000186	0.000208	0.000191	6.731***	6.558***	6.257***	-0.0208***	-0.0213***	-0.0210***
	(-5.15)	(-4.22)	(-4.43)	(-0.13)	(-1.3)	(-1.15)	(-0.13)	(-0.15)	(-0.16)	(-5.95)	(-6.2)	(-7.62)	(-5.21)	(-5.21)	(-4.86)
SCE	-0.144	-0.126	-0.139	-0.0903	-0.0892	-0.0139	0.0489	0.0489	0.0487	9.651	10.13	2.995	0.137	0.111	0.131
	(-0.99)	(-0.83)	(-1.42)	(-0.88)	(-0.87)	(-0.13)	(-0.76)	(-0.84)	(-0.93)	(-0.42)	(-0.43)	(-0.16)	(-1.05)	(-0.85)	(-1.01)
HCE	-0.0148**	-0.0146*	-0.0136**	-0.00271	0.00149	-0.00419*	-0.00709	-0.0064	-0.00709	0.426	0.191	0.656	-0.0215	-0.0198	-0.0213
	(-2.61)	(-2.38)	(-2.87)	(-1.57)	(-1.06)	(-2.45)	(-1.77)	(-1.57)	(-1.79)	(-0.12)	(-0.05)	(-0.19)	(-1.69)	(-1.45)	(-1.80)
CEE	0.438	0.406	0.382	0.396	0.376**	0.425	0.0347	0.046	0.0399	92.04	72.96	65.57	-1.528***	-1.476***	-1.481***
	(-1.29)	(-1.24)	(-1.48)	(-1.86)	(-2.73)	(-1.75)	(-0.36)	(-0.56)	(-0.51)	(-0.83)	(-0.76)	(-0.75)	(-4.82)	(-4.88)	(-5.01)
IncDiversity	-0.0000222	-0.0000362	-0.0000206	0.00327*	0.00227***	0.00158	-0.0000193	-0.0000237	-0.0000193	-0.00215	0.000414	-0.00111	-0.0000274	-0.0000291	-0.0000273
	(-0.62)	(-0.97)	(-0.83)	-2.55	-3.55	-1.5	(-0.80)	(-0.97)	(-0.87)	(-0.22)	-0.04	(-0.11)	(-0.43)	(-0.42)	(-0.41)
Leverage	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10200.6	6332.5	14238.7	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	-0.28	-0.2	-0.38	(0.00)	(0.00)	(0.00)
Leverage^2	-0.0229	0.0758	0.0414	-3.563***	-2.235***	-2.492***	0.295	0.318	0.29	-6966.7	-4722.3	-9619.6	0.931	0.905	0.857
	(-0.04)	(-0.11)	(-0.1)	(-6.38)	(-3.67)	(-6.73)	(-1.03)	(-1.19)	(-1.17)	(-0.31)	(-0.25)	(-0.42)	(-1.53)	(-1.46)	(-1.59)
Macro Control	included	included	included	included	included	included	included	included	included	Included	Included	Included	Included	Included	Included
Firm Control	included	included	included	included	included	included	included	included	included	Included	Included	Included	Included	Included	Included
_cons	0.000	0.000	0.000	0.11	-0.383	0.14	0.000	0.000	0.000	-3499.3	-1833.8	-5143.4	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	-0.33	(-1.39)	-0.33	(0.00)	(0.00)	(0.00)	(-0.23)	(-0.14)	(-0.33)	(0.00)	(0.00)	(0.00)
N	102	102	102	29	29	29	102	102	102	100	100	100	102	102	102
AR(1)[1]	-1.38	-1.46	-1.71 *	-1.59	-1.64	-1.64	-1.96 **	-2.87 ***	-2.12 **	1.02	1	1.03	-1.29	-1.3	-1.46
AR(2)[2]	0.44	0.36	0.25	-0.64	-1.5	0.8	-0.62	-1.04	-0.77	-0.9	-0.84	-1.02	-2.26 **	-1.66 *	-2.67 ***
Sargan[3]	141.71 ***	141.18 ***	128.78 ***	30.91 ***	40.55 ***	28.39 ***	126.19 ***	131.77 ***	139.22 ***	189.87 ***	190.23 ***	188.50 ***	121.51 ***	126.08 ***	142.08 ***
Hansen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wald chi^2[4]	164724.79 ***	52208.92 ***	8.03e+10 ***	2322.98 ***	115.75 ***	65.69 ***	221939.75 ***	323158.46 ***	2.12e+10 ***	1.14e+08 ***	5.03e+06 ***	1.43e+09 ***	75576.54 ***	95691.89 ***	89471.78 ***

Note: z-score in parenthesis. [1]Arellano-Bond first-order autocorrelation test (Ho: no autocorrelation); [2]Arellano-Bond second-order autocorrelation test (Ho: no autocorrelation); [3]Test for overidentifying restrictions in GMM dynamic model estimation; Wald Chi^2 (Ho: estimated parameters not significantly different from the true values.

The SGMM analysis, detailed in Table 8, reveals intricate relationships among key variables. Specifically, *TFPCH* exhibits a negative correlation with *Oper_ratio* and *Rev_Growth*, but a positive one with *EPS*. This suggests a nuanced trade-off between profitability and operational efficiency. Additionally, *TECH* positively influences *EPS*, but negatively impacts *ROE* and *Rev_Growth*. This implies that while technical efficiency may boost EPS, it could potentially inhibit revenue growth and ROE. *TECCH* shows mixed effects, highlighting the need for strategic planning to harness its benefits effectively.

MVAIC has a widespread influence on all performance metrics, underlining the critical role of IC. *IncDiversity* generally shows a negative impact on performance metrics but has a positive correlation with *EPS*. The data underscores the pivotal role of Information Communication (IC) in shaping performance outcomes. For a more robust performance, companies may want to allocate more resources to strengthen their IC initiatives, all while carefully navigating the potential pitfalls of income diversification.

Further insights from Table 9 indicate that *TFPCH* positively affects Profit Margin but negatively impacts *Oper_ratio*. This underscores the need for a balanced approach to productivity initiatives. *TECH* and *EPS* share a positive relationship, reinforcing the value of technical efficiency in enhancing earnings.

TECCH positively correlates with both *Oper_ratio* and Profit Margin, advocating for technology-focused strategies. *RCE* presents mixed results, emphasizing the need for nuanced management of relational capital. *SCE* and *HCE* show mixed outcomes, highlighting the complex interplay between these variables and financial performance, and suggesting that optimal strategies must be carefully calibrated.

Addressing the study's research questions, *MVAIC*'s influence on Taiwanese bank performance yielded nuanced outcomes. RQ 1 found *RCE* to be positively correlated with performance, emphasizing the role of relational capital, while *SCE* and *HCE* received partial support, indicating complex dynamics in structural and human capital. In contrast, RQ 3's hypothesis about the positive impact of income diversity on performance was not substantiated, challenging traditional views in Taiwan's banking sector. RQ 2 confirmed the positive correlation between bank efficiency, as gauged by the Malmquist DEA, and performance, underscoring efficiency's pivotal role. Overall, the findings present a complex landscape with confirmed relationships between *RCE* and *CEE* and performance, partial support for *SCE* and *HCE*, and mixed results concerning income diversity.

5. Conclusion

This research investigates the influences of technical efficiency and MVAIC on Taiwanese banks' performance, considering bank-specific, industry-specific, and macroeconomic variables. Initially, a Fixed Effects regression model assesses the impact of technical efficiency and MVAIC at different performance levels. Subsequently, a one-step SGMM model is employed to confirm the results and address endogeneity, heterogeneity, and persistence concerns. This dual-method approach provides intricate insights into the factors governing banks' performance in Taiwan, contributing novel insights to the empirical literature.

The findings weave a multifaceted picture of banking performance in Taiwan. Intellectual capital enhances efficiency and revenue growth but has negligible effects on profitability. The finding Total factor productivity change (TFPCH) positively influences earnings per share but may undermine the operational ratio. Technological change (TECCH) exhibits mixed results on profitability metrics, improving profit margins but varying in its impact on ROE and revenue growth. Income diversification significantly impacts EPS positively, while the complex nonlinear associations of leverage with performance indicators call for careful calibration. Challenges were revealed with RCE and HCE, both negatively correlated with profitability metrics such as ROE. This finding is partially supported by Nazir et al. (2021), who also find HCE is not significant in its contribution to profitability and that RCE negatively impacts profitability in the Taiwan bank setting. These findings are, however, in opposition to Ting et al. (2021b)'s and Young et al. (2009) work in a Taiwan setting which suggests the time period and evaluation method may confer alternative findings. Capital-employed efficiency shows a double-edged effect, improving the operational ratio but reducing the profit margin. Lastly, past profitability and performance (lagged π) consistently underpin current operational and financial success. This is supported by Shiu (2006), who had similar findings in a non-bank Taiwan setting.

5.1. Practical Implications

The findings from this study elucidate multifaceted strategies and have important policy implications for regulatory authorities, bank managers, and investors to enhance bank performance in Taiwan. Banks must work to increase technical efficiency, allowing more institutions to operate on the efficient production frontier. Recognizing that MVAIC is foundational to organizational success and consists of a continuous knowledge acquisition, creation, and dissemination cycle, banks should invest in acquiring experienced staff and providing

ample training opportunities. Given the importance of IC in value creation, banks should provide transparent disclosure about the intellectual resources they possess in annual or other relevant reports, and regulatory authorities should foster an environment that encourages detailed reporting. Banks should also seek to diversify their activities, as this has been shown to impact performance significantly. Overall, this research underscores the need for a comprehensive, nuanced approach for banking practitioners in Taiwan. The interplay of factors such as IC and efficiency, coupled with the complexities of leverage levels and the delicate balance between CEE and profitability, necessitates careful, tailored strategies—the overarching message advocates for a holistic perspective that acknowledges and navigates the multifaceted nature of modern banking.

5.2. Theoretical Implications

Anchored in RBT, the study elevates academic discourse by dissecting the nuanced relationships between assets such as IC and banking performance. The findings reveal a mixed picture: while some components of IC positively correlate with profitability metrics, others show negative associations, challenging traditional RBT assumptions. These complex and occasionally paradoxical outcomes underscore the importance of contextual factors in shaping competitive advantages. They enrich the theoretical understanding of the multifaceted drivers behind bank performance, efficiency, and sustainability. Overall, the research transcends simplistic narratives to spotlight the intricate and subtle roles that IC plays in shaping a bank's competitiveness.

5.3. Limitations and Direction for Future Research

The study's contributions are tempered by its limitations, including its specific focus on Taiwan's banking sector and the challenges of measuring IC precisely. These constraints suggest caution when applying the findings to different sectors or regulatory environments. Future studies should aim to broaden the scope, possibly incorporating banks into other regions, to test the findings' generalizability. Additional methods for measuring IC and surveys exploring causality could enrich the research. A focus on corporate governance and other mediating factors could provide a more comprehensive understanding of bank performance

This document contains 1 Figures, 9 Tables, 6 Equations and 90 References.

3674 (errors:17) words

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