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6

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FINANCIAL ECONOMICS | RESEARCH ARTICLE

Does intellectual capital efficiency matter for banks' performance and risk-taking behavior?

Changjun Zheng¹, Md Nazmul Islam¹²*, Najmul Hasan³ and Md. Abdul Halim⁴

Abstract: The aim of this study is to investigate whether a bank's intellectual capital (IC) efficiency impacts its performance and risk-taking behavior in an emerging economic country. The study used panel data (unbalanced) of 30 commercial banks in Bangladesh during 2002–2019. Data were analyzed through the use of the generalized method of moments (GMM) by Eviews-10. The pragmatic results demonstrate that IC efficiency (HCE), RCE and SCE have significant positive (negative) impacts both on the bank's performance and risk-taking behavior, this finding is similar to resource-based theory. Moreover, adequate capital and liquidity position improves bank performance, but leverage, size, and non-performing loans to total loan have a significant negative impact on bank performance. In addition, the macro-economic variable growth (i.e., gross domestic product) rate of inflation and financial crisis year negatively impacts both bank performance and risk-taking

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behavior. The panel dataset in this research is restricted to the Bangladeshi banking sector, which restricts the study's generalizability. Bank performance in Bangladesh is unaffected by leverage, loan size, and the proportion of non-performing loans to total loans. Regulatory authorities, managers and policymakers should step up their surveillance of banks and other financial institutions when the GDP inflation rate and financial crisis year have a negative impact on both bank performance and risktaking behavior.

Subjects: Economics; Econometrics; Business, Management and Accounting

Keywords: Intellectual capital; bank performance; risk; commercial banks; Bangladesh

1. Introduction

Economic development and the stability of a nation largely depend on the performance of its financial sector (Zaidi, 2004). Due to globalization, the banking sector has experienced a competitive and dynamic atmosphere that directs the banks to grow as a knowledge-intensive sector, and this globalization process has increased the necessity of innovative industries, such as banking, finance, and information technology (Mavridis, 2004). P. Drucker (1993) stated that "Knowledge is superior to land, labour, and capital as a meaningful factor of production." Again, knowledge is regarded as a long-term strategic asset that may be used to achieve and preserve competitive advantages (P. F. P. F. Drucker, 1985), and in a knowledge-based economy, intellectual capital (IC) is the most valuable asset a company can have (Nassir Shaari et al., 2011). A study mentions that "Knowledge is like light. Weightless and intangible, it can easily travel the world, enlightening the lives of people everywhere" (Bank, 1998).

The significance of IC has increased for the growing demand of knowledge economy (Cabrita, 2006). IC is the knowledge, experience, intellectual resources, and information that are used to generate wealth (T. A. Stewart, 1997). The performance of the banking sector is important for the economy as banks serve as an instrument for economic growth (Mohiuddin et al., 2006). It is very much essential to have better performance from IC investments as the firms' long-term competitive advantages depend on it (Alhassan & Asare, 2016; Pradita & Solikhah, 2017), and in achieving sustainable growth, firms' should emphasize their IC (Edvinsson, 1997). Therefore, it is essential to focus more on the effect of IC capability on firm performance to justify whether firm performance growth will increase or decrease in relation to the performance of IC (Ting et al., 2020). According to El-Bannany (2008), the percentage of intangible assets acts as a proxy for future performance depending on the risky assets owned by the company. The global financial crisis of 2007–2008, as well as recent political insecurity, shattered confidence and disrupted the region's capital flow. The impact of this crisis created a threat to the region's banking and directed banking behavior towards risk (Mrad & Mateev, 2020).

The necessity of bank peril management has been raised due to the recent economic calamity. Interestingly, banks encourage durable capital flows, protect investors' interests, and reduce credit risk by enforcing better corporate governance standards in borrowing firms (S. Ghosh, 2017). Banking business is mainly a business of risk management (Alhassan, 2015) and high credit risk causes many problems such as inefficiency, low growth, and reduction of cost efficiency. of financial sectors affecting the whole economy (Karim et al., 2010). So, the important task of banks in the changing environment is to manage all kinds of risks in an efficient and effective way to safeguard against being insolvent. In spite of its increasing importance in a new economy, knowledge-base sector-like banks, the role of IC in handling risk has not been recognized by the Basel Committee (S. K. Ghosh & Maji, 2014).

Numerous studies (Buallay et al., 2019b; Chan, 2009; Guerrini et al., 2014; Gupta & Raman, 2021; Innayah et al., 2020; Kaupelytė & Kairytė, 2016; Makki & Lodhi, 2008; Mohapatra et al., 2019;

Muhammad & Ismail, 2009; Ting et al., 2020; Urbanek, 2016) on the association of IC with firms' performance and profitability have been done in recent past. Although (Alrashidi & Alarfaj, 2020; S. K. Ghosh & Maji, 2014) show the relationship between IC efficiency and bank risk, they did not show the effect on performance. The vast majority of studies found an ambiguous relationship between IC and risk, performance, and ownership structure. The banking industry has been facing a competitive environment in recent times (Alhassan & Asare, 2016; Mondal & Ghosh, 2012), and the banking sector is being forced to have sustainable performance due to cross-border competition (Mondal & Ghosh, 2012). Bangladeshi financial sectors have faced several key challenges and conflicts relating to political issues, refuse problems, revenue decline, terrorism, and economic crisis over the past few years and are still trying to recover from these issues. Due to the above constraints financial growth has flowed down, and the banking segment of Bangladeshi is facing several problems, such as low investment, low-interest revenue, and increased non-performing loans.

As emerging countries face challenges, reforms are essential to boost long-term economic growth. Hence, continuous research needs to be done on how to overcome these issues to recover the economy. While IC is a crucial issue in the banking sector in developing countries like Bangladesh, the regional impact differences in the inter-country context highlight the need for further investigation. As a part of IC, human capital and structural capital help in achieving the stability and insolvency of banks in the complex competitive setting (Nawaz et al., 2019) and as a driver for credit risk, investment in IC can reduce credit risk that ultimately ensures growth and sustainability of banks and the economy. Value addition of the financial organization not only depends on physical capital but also depends on intangible assets (intellectual assets/capital). This study will focus on evaluating the IC's contribution to the firm's value addition process (performance) as well as assessing whether the risks are associated or not with the investment in IC by various owners. The findings may also aid investors in making investment decisions and strategies, as well as economic analysts in developing strategies to improve bank efficiency and potential value creation. In this study, we addressed the following research questions to justify our research objectives: (i) Does IC efficiency beneficial to bank performance? (ii) If and how does the bank's IC efficiency directly affect current and future financial performances? (iii) Is there any relation between ICE and risk taking behavior? iv) Is there any effect of IC efficiency in reducing or increasing firms' risk taking behavior? But in the case of Bangladesh, these researches are absent. No empirical study examines the relationship between IC efficiency with bank performance and risk-taking behavior of the Bangladeshi banking sector as a whole. Given this background, this research seeks to expand the literature on intellectual capital and performance along with risk from the perspective of emerging banking market of Bangladesh. Hence, this study delves into the effects of IC efficiency on bank's performance as well as risk-taking behavior of Bangladeshi commercial banks, which is clearly missing in the previous outcomes of the study.

Despite the arguments of (Chalermchatvichien et al., 2014; Innayah et al., 2020) that IC significantly impacts on bank's risk-taking behavior taking into consideration bank level and industry-level variables, significantly absent in this literature is how IC and macro-level variable inflation affect the bank's risk along with IC. Hence, it is important to examine IC effects on bank performance and risk. This study takes responsibility to fill this important gap.

However, this study mainly contributes to the theoretical and practical aspects. Theoretically, it contributes to the existing literature by incorporating macro-economic factors and income diversity (ID) factors that impact along with IC. First and foremost, the present study evaluates the efficiency of 30 Bangladeshi banks from 2002 to 2020 by employing macroeconomic factors rather than traditional variables that do not consider the underlying structure of decision-making divisions. Second, despite the fact that the previous literature seems to have a limited number of researches devoted to the association between IC and bank performance, these studies have verified that IC efficiency has a considerable favorable influence on the performance of banks as well as their risk-taking behavior. Improved IC efficiency is indicative of the bank's long-term

success in the country of Bangladesh. In at least one developing nation like Bangladesh, this is likely to become the first research to investigate the influence of ICs on the performance of banks. Finally, all commercial and public sector banks are integrated into the given dataset and the factors that impact bank performance and risk-taking are identified. Moreover, practically, it was revealed via this study that greater investments in IC would lead to improved bank performance over time. Liquidity, loan size, and the percentage of nonperforming loans to total loans have no effect on the performance of Bangladesh's commercial banks. In the future, these results will be useful to stakeholders, policymakers, and academics in their consideration of the elements indicated above in order to increase investor confidence.

The remaining of the study is organized as follows: literature review and development of hypothesis have been described in section 2, and data and methodology has been presented in section 3. The model specification, empirical results and analysis are detailed in section 4. Finally, section 5 represents the conclusions and policy implications.

2. Literature review and hypothesis development

2.1. Theoretical review

According to "resource-based theory," an individual's ability to get and use resources is a valued and irreplaceable asset. According to the resource-based theory, businesses should look within themselves to identify areas where they may gain a competitive edge by better utilizing their own resources. The competitive advantage of a company is derived from the resources it has. The RBT discusses how resources can be leveraged to gain a competitive edge over the competition (Amit & Schoemaker, 1993; Black & Boal, 1994; Mahoney & Pandian, 1992).

According to Wernerfelt (1984) defines resources as anything that either strengthens or diminishes a company's position in the market. A resource is useful if it takes advantage of opportunities and/or lowers dangers in the environment of a firm, according to J. B. J. B. Barney (2001) and J. J. Barney (1991). Alternatively, if a resource meets the needs of customers, it has been deemed valuable (Verdin & Williamson, 1994).

A model called resource-based theory says that resources play a big role in helping businesses improve their organizational performance and become more competitive¹. If it helps a company thinks of or uses strategies that make it more efficient and effective (J. J. Barney, 1991). Grant (1996) says that IC is the most important strategic asset for businesses that want to be more successful in the market and make more money. So, it makes sense to think that IC, both as a whole and for each of its parts, has a positive effect on a company's performance.

2.2. Relationship between IC efficiency and risk

Various studies have been carried out with ongoing and counterfactual conflicts on whether efficiency takes precedence over risks and whether this has a substantial impact on the efficiency of financial institutions (Altunbas et al., 2007). As very few studies address IC efficiency in risk taking, we bring up some previous literature on the relationship between overall efficiency and risk. The normally expected association of IC efficiency is negative with bank risk. It indicates that increased IC efficiency will help to manage risk. Therefore, in this study, we can expect a negative correlation, but different outcomes have also been found in the past literature regarding this relationship. Several prior studies, such as (Alrashidi & Alarfaj, 2020; S. K. Ghosh & Maji, 2014; Innayah et al., 2020; Nawaz et al., 2019; Zheng, Gupta, Moudud-Ul-Huq et al., 2018); found a negative association between IC efficiency and risk. (S. K. Ghosh & Maji, 2014), using the Value Added Intellectual Coefficient (VAIC) model and analyzing regressions of the

Indian banking sector found that IC is inversely associated with credit risk and that the influence of IC efficiency and human capital efficiency (HCE) on the credit risk of public banks is greater than that of private banks. The study fails to draw any conclusions on measuring the effect of IC on

insolvency risk. However, the opposite result was also found in studies by (Guimón, 2005; Sarmiento & Galán, 2014; Sun & Chang, 2011); and they claimed that IC could have a positive effect on credit risk as it helps in evaluating the organizational competitiveness and provides a fine image of the firm's management team. Again, (Zheng, Gupta, Moudud-Ul-Huq et al., 2018) discovered that there is no statistically significant association between risk and HCE and that well-capitalized banks are better able to absorb risk while also boosting HCE.

(Berger & DeYoung, 1997; Deelchand & Padgett, 2009; Fiordelisi et al., 2011; Kwan & Eisenbeis, 1997); and others found a negative association between efficiency and risk. Whereas positive relationships are also found in some prior studies, such as (Isaac et al., 2010; Tan & Floros, 2013). Risk is increased due to reduced monitoring and screening of loans, but that technical efficiency increases the volume of loans a bank can make (Tan & Floros, 2013). Again, (Altunbas et al., 2007) found an insignificant relationship between efficiency and risk.

There is no correlation between the efficiency of the IC and the risk-taking and stability of the bank. The findings do not provide any evidence in favor of the resource-based theory. The system GMM estimation provides more evidence of the robustness of this conclusion (Dalwai et al., 2021). The authors demonstrated that the value-added intellectual coefficient (VAIC) of a bank had a positive influence on bank insolvency, whereas the inverse was true for credit risk (Nguyen et al., 2021). Although statistics do not indicate a short-term effect for ICE in this regard, research has shown that it plays a significant role in bank stability over the long run. In the near run, there is evidence of a positive influence from efficiency ratios, risk-based capital, leverage, and overall bank size. In the long run, the risk-based capital and leverage both have a definitively beneficial influence, whereas the bank size and efficiency ratio both show a negative effect (Ullah, Pinglu, Ullah, Qian, & Zaman).

These studies tried to measure the impact of a particular component of IC on risk, but the impact of the overall efficiency of IC on risk taking behavior was absent. In this study, we will try to fill the gap by showing the impact of the overall efficiency of IC calculated using Stochastic Frontier Analysis (SFA) on the risk-taking behavior of banks. According to the literature, the vast majority of the work is carried out on banks in industrialized countries. There have been few, if any, studies conducted on the banking sector in Bangladesh. Thus, we construct the following hypothesis:

 ${\bf H_1}\!\!:$ There is a positive relationship between IC efficiency and the risk-taking behavior of Bangladeshi banks.

2.3. Relationship between IC efficiency & performance

Bank performance plays a momentous role in the economy as being a vehicle of economic growth (Mohapatra et al., 2019). (Kaplan et al., 1987) argued that IC might play a significant role in the process of company performance. Several empirical studies have been conducted in relation to the IC and firm performance and found a positive relationship (Alhassan & Asare, 2016; Bitar et al., 2016; Buallay et al., 2019a; Guerrini et al., 2014; Gupta & Raman, 2021; Innayah et al., 2020; Joshi et al., 2010; Maditinos et al., 2011; Makki & Lodhi, 2008; Mohiuddin et al., 2006; Urbanek, 2016; Wang et al., 2013). Using the VAIC model to determine efficiency of IC, ROA, ROE, TQ, profitability, along with market value, those studies concluded that components of IC have a strong effect on bank performance in Pakistan, Ghana, Poland, India, Malaysia, ASEAN, and Taiwan, respectively. Similar results were found by (Mondal & Ghosh, 2012; Ozkan et al., 2017). Similarly, (Alhassan & Asare, 2016) stated that efficiency enlarges the growth of productivity compared to technological changes and found HC and SC as a driving force for productivity. On the other hand, (Muhammad & Ismail, 2009; Ting et al., 2020) in their studies, found significant negative affiliation between ICE and risk.

Ur Rehman et al. (2022) demonstrated that the key factors in achieving good performance at Islamic banks are structural capital efficiency (SCE) and relational capital efficiency (RCE). They also demonstrate how human capital efficiency (HCE) has a detrimental impact on IBs' performance. These results were obtained using the GMM estimator (Ur Rehman et al., 2022). Salehi et al. (2022) found that there is not just a negative but also a significant relationship between social capital and intellectual capital (Salehi et al., 2022). According to the findings of the study, there is a positive and statistically significant connection between intellectual capital and social capital and knowledge management. The management of knowledge did not have a substantial impact on the innovative process (Salehi et al., 2021). The research indicates that there is a detrimental and statistically significant connection between IC and its constituents, such as the efficacy of HC, SC, RC, and CC, and fraudulent activity in financial statements. This indicates that decreasing the quantity of fraud in business firms' financial statements can be accomplished by investments in the IC and its component parts (Lotfi et al., 2022). According to the findings of another study, intellectual capital can have a beneficial effect on the readability of financial statements (Moghadam et al., 2022). The intellectual capital of the boards of directors in companies that are traded on the Tehran Stock Exchange has no bearing whatsoever on the companies' actual levels of performance (Salehi et al., 2020).

In the literature, there exist results that are in conflict with one another. For example, (Kaupelytė & Kairytė, 2016) provided mixed opinions on the connection between IC and the achievements of banks. They mentioned that in spite of the influence of IC on bank achievement; it differs from large banks to small banks in Europe. (Mohapatra et al., 2019) used the DEA approach to find efficiency as a performance measure and a truncated regression model to test the relationship of IC with the performance of banks in India during 2011–2015. They conclude that HC positively impacts on bank performance, but SC and CEE have negative impact on bank efficiency. Our present study is aimed at measuring the efficiency of the IC and its components through SFA in relation to the Bangladeshi banks. Thus, IC is deemed an essential strategic tool for banking business; the current study expects IC efficiency to be positively related to the performance of the bank. Therefore, we assume the following hypothesis:

 $\mathbf{H}_{\mathbf{2}}$: There is a positive relationship between IC efficiency and the performance of Bangladeshi banks.

2.4. Relationship between risk & performance

The link between risk & performance is an important consideration in the context of bank risk evaluation. However, it has been found that there are relatively few research in the literature that examine the relationship between risk and performance, which is somewhat surprising. The authors Kwan and Eisenbeis (1997) used a simultaneous equation framework to examine the interrelationships between risk, capitalization, and operating efficiency in a financial institution. According to their findings, there is a positive relationship between inefficiency and risk taking. It has been demonstrated by Lin et al. (2005) that there is a statistically significant negative relationship between insolvency risk and financial performance. It is also suggested that banks with a lower degree of risk outperform banks with a higher level of risk. Based on the extensive literature reviewed above, it is clear that very few studies have taken into account the link between risktaking and profitability. The researchers demonstrate that IC has been able to maintain its favorable influence on bank profitability in China and Pakistan even during the COVID-19 pandemic that has been going on (Xu, Xu et al., 2022). Value-added intellectual coefficient (VAIC) and its components (human capital efficiency (HCE), capital employed efficiency (CEE), and structural capital efficiency (SCE)) were shown by the authors to have a favorable effect on the profitability of banks. In order to arrive at these findings, they used a GMM estimator (Le et al., 2020). (Guidara et al. (2013); C.-C. Lee and Hsieh (2013); Lin et al. (2005), risk-based capital, bankruptcy risk, and financial performance are their primary concerns. (Guidara et al., 2013) focused on Canadian banking and looked at capital buffers, risk, and performance. Thus, we formulate the following hypothesis:

H₃: There is a significant negative relationship between risk-taking behavior and the performance of Bangladeshi banks.

3. Methodology

3.1. Data & its sources

The data retrieved from 32 Bangladeshi commercial banks between 2002 and 2019. This study excludes 30 banks due to the complexity and lack of data availability, as well as their heterogeneity. In addition to annual reports, banks' websites, and certain information from banks' scope database, secondary data has been gathered from these sources (www.bvdinfo.com). The data for micro-economic variables is collected from the World Bank's database (http://data.worldbank.org). It had first been log normalized for analyzing the stochastic frontier.

3.2. Dependent variables

In this study, two dependent variables were used: the ratio of non-performing loans to total loans (NPLTA) as the primary measure of risk and the return on assets (ROA) as the primary indicator of performance. In contrast to the previous measure of risk, which was the ratio of nonperforming loans to total loans, credit risk is evaluated by the ratio of nonperforming loans to total loans (NPLTL), and the higher ratio points to a risk of losses from loan defaults (Chaibi & Ftiti, 2015; Niţoi & Spulbar, 2015; Zheng, Gupta, Moudud-Ul-Huq et al., 2018). This ratio is also used by (Berger & DeYoung, 1997; Syed; Moudud-Ul-Huq et al., 2021; Zheng, Gupta, Moudud-Ul-Huq et al., 2018). Based on previous literature, three metrics can be used to evaluate a bank's performance: operational performance (ROA), financial performance (ROE), and market performance (TQ). We consider ROA as the main measure of performance. ROA considers the assets used in supporting business functions. It is also calculated by dividing net income by total assets, which is how it is done. The return on assets (ROA) measures net profits as a percentage of total assets. ROA is the most important way to figure out how profitable a business is, and it is the only (Halim et al., 2020; Majumder & Uddin, 2017; Syed; Moudud-Ul-Huq et al., 2021; Syed, 2020; San & Heng, 2013). In this study, we will look at the bank's ROA to see how well it does.

3.3. Independent variables

The independent variables are utilized to explain the risk and performance of the bank, which can be further classified as bank-specific qualities and macro-economic factors, respectively. We have used ICE and income diversity as primary explanatory variables (Table 1). The bank-specific variables are risk weighted assets to total assets (RWATA), size (natural logarithm of total assets), liquidity, capital (CAP), and leverage. Following (Chaibi & Ftiti, 2015; Zheng et al., 2017) this study also used two macroeconomic variables, such as the growth of gross domestic product (GGDP) & rate of inflation (INF). Some studies in the literature have utilized risk weighted assets as a proportion of total assets (RWATA) as a measure of risk. The size of a bank has an impact on a variety of activities, including investment opportunities, portfolio diversity, reputation, and the ability to raise equity financing (Zheng, Gupta, Moudud-Ul-Huq et al., 2018). Liquidity (LIQUIDITY) has been used in the equation of risk to show the impact of liquidity on risk. LIQUIDITY can be measured by the ratio of total loans to total deposits. The capital (CAP) of banks consists from fund the collected by issuing shares as well as retaining earnings. Income diversification (ID) is included in the equation of profitability as it is an important factor of banks' profitability (Fiordelisi et al., 2011; C.-C. C.-C. Lee & Hsieh, 2013; Meslier et al., 2014). Banks are assumed to have higher burden of risk due to higher level of leverage ratio (LEVERAGE). The percentage of non-interest revenue to total income is used to calculate income diversification at a financial institution. The assumption is that GGDP is crucial because, as a result of cyclical causes, the credit risk and capital have a tendency to be established. This study also uses the Financial Crisis Year (FCY) 2007-2009 as independent variable for year dummy. FCY is used as a Dummy Variable 1 for the period 2007-2009, and otherwise 0 (Fiordelisi & Mare, 2014; Fu et al., 2014; J. Zhang, Jiang, Qu, Wang et al., 2013).

3.4. Intellectual capital

Intellectual assets (IA) also intellectually termed as Intellectual Capital (IC) are the most significant resources of today's organization and most of the institutions cannot define what makes an IA (Andreou et al., 2007). Simply, creativeness of human brain or mind is called intellectual capital. IC is related to the value and intangible nature of assets. (Edvinsson, 1997) define IC as "knowledge that can be converted into value." (Sullivan, 2000) define intangibles as "knowledge that can be converted into profit." Non-accounting researcher defines "intellectual is the difference between the firm's market value and its book value of entity" ((Berger & DeYoung, 1997; Mouritsen et al., 2001; Sveiby, 1997). Many researchers and analysts have tried to categorize IC. At first (Sveiby, 1997) categorized IC as 3 types from a non-accounting perspective, namely, l) employee (individual) competence; 2) internal structure; & 3) External structure. In accordance with Sveiby's findings, (Stewart, 1997) designated these assets as follows: human capital; structural; and consumer capital, respectively. Again, three categories of ICs were proposed by (Bontis (1996); Edvinsson & Sullivan, 1996; Bontis, 1996; Edvinsson & Sullivan, 1996): people's knowledge (human capital); an entity's routines, procedures, processes, and databases (structural capital); and the firm's ability to interface to markets and stakeholders (relational capital) suggested for three types of IC: people's know-how (human capital); entity's routines, procedures, processes, and databases (structural capital); and the firm's ability to relate to markets and stakeholders (relational capital). (Gu & Lev, 2001) divided IA into five subgroups of focusing on measurement issues and the persuade of intangibles on capital market and investors. These five components are as follows: research and development, capital expenditures, information systems, advertising, and technology acquisition. The researchers of IC opinioned for including the human capital and structural capital as the components of IC (Andriessen & O'Donnell, 2006; Bontis, 2004; Edvinsson, 1997). In this study, we will calculate the efficiency of IC by taking into consideration of HC and SC as the parts of IC (Customer/relational capital will also include in SC through SFA). Human capital consists of skills, knowledge, and experiences of employees, which can be enriched through training (Sveiby, 1997) defined HC as "the capacity to act in a wide variety of situations to create both tangible and intangible assets." Efficient plus effective utilization of entity's employees' knowledge, experiences, skill, creativeness, etc., ensure the proper utilization of HC and it is used to solve business problems (Mondal & Ghosh, 2012). Structural capital can be termed as supportive capital consisting of everything from a firm that assists employees and enables human capital to function properly (Mondal & Ghosh, 2012). The structural capital of a firm is formed with structures, systems, organizational cultures, procedures, routines, hardware, and databases, and it also includes inventions, process, copyright, patents, technology, strategy (Joshi et al., 2010). Structural capital is the difference between value added and human capital (SC = VA-HC; Pulic, 1998; 2000; 2004). According to Pulic (A. Pulic, 2000) Value Addition of current year resources is called VA, which is calculated as VA = Output (total sales)—Input (cost of materials, components, and services). Pulic (2000) also proposed another way of calculating VA, which is as follows:

$VA = OP(Operating \ profit + EC(Employee \ Cost) + D(Depreciation) + A(Amortization))$

(Bontis, 2001) mentioned Economic Value-added (EVAe) as a comprehensive gauge for studying the achievement of the whole business and proposed the following equation for calculating EVAe: EVAe = Net sales—operating expenses—taxes—capital charges. The relational capital of a firm is termed as the relationships with all its interested groups (Choong, 2008). Again, the value of a company's ties with the individuals with whom it does business be defined by (Mondal & Ghosh, 2012) as relational capital.

The descriptive statistics are shown in Table 2. During the study period, the average value of risk (NPLTL) was 7.30%, and the mean value of ROA was around 124.3%, but the minimum value was negative. This means that during the study period, the sample banks did not earn the required minimum return on assets. The mean value of intellectual capital efficiency is 89.2%, and minimum is 75.1%. All other independent variables have positive mean, maximum, and minimum

Table 1. Contains deta	ails about the source of	variables and possible s	igns
Variables	Symbol	Definition	Sources
Risk	NPLTL	Ratio of nonperforming loans to total loans	(Chaibi & Ftiti, 2015; Niţoi & Spulbar, 2015; J. Zhang, Jiang, C., Qu, B., & Wang et al., 2013; Zheng, Gupta, Moudud-Ul-Huq et al., 2018)
Performance (PERF)	ROA	Return on Assets (ROA) for Operational performance	(Aebi, Sabato & Schmid, 2012; Farooque et al., 2007; Halim et al., 2020; Hoque et al., (2013); S. Moudud-Ul-Huq, 2015; Peni & Vähämaa, 2012)
Intellectual Capital Efficiency	ICE	Intellectual Capital Efficiency	(Alrashidi & Alarfaj, 2020; Buallay et al., 2019b; Chan, 2009; S. K. Ghosh & Maji, (2014); Guerrini et al., 2014; Urbanek, 2016)
Income diversification	ID	Ratio of non-interest income to total income	(Fiordelisi et al., 2011; C C. CC. Lee & Hsieh, 2013; Meslier et al., 2014)
Bank size	SIZE	Natural logarithm of total assets	(Bougatef & Mgadmi, 2016; Chaibi & Ftiti, 2015; Deelchand & Padgett, 2009; Zheng, Gupta, Moudud-Ul-Huq et al., 2018)
Liquidity	LIQ	Ratio of total loans to total deposits	(Altunbas et al., 2007; Bougatef & Mgadmi, 2016; T. Lee & Chih, 2013; Tan & Floros, 2013; Zheng et al., 2017)
Risk weighted assets to total assets	RWATA	Ratio of risk weighted assets to total assets	(Gropp & Heider, 2007; Schaeck & Cihak, 2007; Zheng, Gupta, Moudud-Ul -Huq et al., 2018)
Capital Regulation	САР	Regulatory capital to risk weighted assets, i.e. Capital Adequacy Ratio (CAR)	(Altunbas et al., 2007; Laeven & Levine, 2009; Lin et al., 2005; Rime, 2001; Zheng et al., 2017)
Leverage	LEV	Ratio of total debt to total assets	(Chalermchatvichien et al., 2014; Zheng, Gupta, Moudud-Ul-Huq et al., 2018; Zheng et al., 2017)
Inflation rate	INFR	Annual inflation rate	(Chaibi & Ftiti, 2015; Hussain & Hassan, 2005; Jokipii & Milne, 2008; Stolz & Wedow, 2011; Zheng et al., 2017)
Growth in GDP	GGDP	Annual growth in real gross domestic product	(Chaibi & Ftiti, 2015; Jokipii & Milne, 2008; Stolz & Wedow, 2011; Zheng et al., 2017)
Financial Crisis Year	FCY	FCY uses as Dummy Variable 1 for the period 2007–2009, and otherwise 0	(Fiordelisi & Mare, 2014; Fu et al., 2014; J. Zhang, Jiang, Qu, Wang et al., 2013)

Table 2. Shows the descriptive statistics (BDT- million where applicable)					
Variables	N	Minimum	Maximum	Mean	Std. Deviation
NPLTL		0.004	0.456	0.073	0.276
ROA		-12.432	6.052	1.293	1.234
ICE		0.751	0.987	0.892	0.046
ID		0.005	2.24	0.584	0.225
RWATA		0.009	1.272	0.673	0.218
SIZE	530	8.371	14.854	11.339	1.108
LIQ		0.061	1.546	0.820	0.126
CAP		-0.135	0.151	0.075	0.033
LEV		0.007	1.130	0.921	0.102
GGDP		3.831	7.601	6.051	0.909
IFR		3.26	8.169	6.070	1.379
FCY		0.000	1.000	0.249	0.327

Source: Author's calculation by using SPSS-20

values except capital where the minimum value is negative, indicating that the sample banks failed to maintain the minimum capital requirement during the study period.

3.5. Determination of ICE Using stochastic frontier analysis (SFA)

By following (Altunbas et al., 2007; Girardone et al., 2004; Kwan & Eisenbeis, 1997; Niţoi & Spulbar, 2015; Zheng et al., 2017), we used SFA to measure efficiency and this paper employs the production function of SFA for deterring intellectual capital efficiency. Methodologically, this paper introduces a new dimension of intellectual capital efficiency calculated by SFA of the banking industry.

To determine each bank's efficiency, we used a stochastic frontier production method created by (Aigner et al., 1977). In the case of the nth Bank,

$$LnICn = f(lnQi, Pj) + \epsilon n$$
⁽¹⁾

Where, IC_n denotes Intellectual capital of bank_n, Qi specifies three outputs, i.e., Q_1 = Total operating income, Q_2 = Loan and advances, Q_3 = Non-interest income, P_j represents three inputs, i.e., P_1 = Fixed assets, P_2 = Personal expenses, and P_3 = Non-performing loan. ε_n indicates the deviation of the actual intellectual capital of a bank from the intellectual capital-efficient frontier having two disturbance terms that are shown below:

$$\epsilon n = Vn - Un$$
 (2)

Here, the error term defined by V_n . It is assumed that this is independent and identically distributed N ($o_r \sigma_v^2$). U_n signifies intellectual capital inefficiency and assumed to be independently distributed of $V_n \& a$ half normal distribution, i.e., N ($o_r \sigma_u^2$).

To specify Intellectual Capital functions, we formulated the following multiproduct translog production functions using an intermediation approach (Sealey & Lindley, 1977):

$$IniC_{n} = \alpha + \sum_{i} \alpha_{i} lnQ_{i} + \sum_{j} \beta_{j} lnP_{j+\frac{1}{2}} \sum_{i} \sum_{k} \gamma_{ik} ln Q_{i} lnQ_{k} + \frac{1}{2} \sum_{j} \sum_{h} \delta_{jh} lnP_{j} lnP_{h} + \sum_{i} \sum_{j} \lambda_{ij} lnQ_{i} lnP_{j+\epsilon}$$
(3)

Based on the (Jondrow et al., 1982) the expected value of U_n on conditional to

 ϵ_n shows the Intellectual capital inefficiency of bank n (termed as C_n).

	Indicators	-1	2	e	4	2	9	7	8	6	10	11	12
1	NPLTL												
2	ROA	.091**	7										
č	ICE	.291**	253**	1									
4	ID	.083**	194**	.209**	1								
5	RWATA	.021**	.218**	169**	151**	1							
6	SIZE	.077	306**	.370**	.166**	.241**	1						
7	LIQ	131**	.188**	239**	348**	**607.	023	1					
8	CAP	552**	.432**	257**	296**	.628**	.121**	.423**	1				
6	LEV	.138**	203**	.064	*460.	088*	147**	067	201**	1			
10	GGDP	210**	189**	.063	073	.224**	.513**	.169**	.206**	115**	1		
11	IFR	304**	.004	.091*	077	.502**	.443**	.140**	.378**	153**	.339**	1	
12	FCY	.032*	.482*	.052**	.321**	038*	.102**	023*	061*	.042**	.062*	.021	1
**.Correlatio	n is significant c i is significant at	at the 0.01 lev t the 0.05 leve	el (2-tailed). I (2-tailed).										
a Note : The tabl	e represents the Pean	rson's correlation r	natrix for the variat	bles used in this pa	per. The dependent	t variable in regress	sion model are Non	1-Performing Loan (I	NPLTL) and Return	on Assets (ROA). Th	ie primary explanat	tory variables are Ir	ntellectual Capita
Efficiency (ICE)	and Income Diversity	y (ID). Where Risk	Weighted Assets t	to Total Assets (RV	VATA), Size, Liquidit	ty (LIQ), CAP, Leve	erage (LEV), Growth	i of Gross Domesti	c Product (GGDP) a	ind Inflation (IFR)	and Financial Crisis	. Year 2007-2009 (FCY) are used as
independent va	riable. ***. Correlatior	n is significant at	the 0.01 level and	0.05 level (2-tailed	 respectively. 								

The table represents the Pearson's correlation matrix for the variables used in this paper. The dependent varia y (ICE) and Income Diversity (ID). Where Risk Weighted Assets to Total Assets (RWATA), Size, Liquidity (LIf dent variable. ***, Correlation is significant at the 0.01 level and 0.05 level (2-tailed) respectively.
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$$Cn = E Un/\varepsilon_n = [\lambda/(1+\lambda^2)][\varphi(\varepsilon_n\lambda/\sigma)/\varphi(\varepsilon_n\lambda/\sigma) + \varepsilon_n\lambda/\sigma]$$
(4)

Where the ratio of the standard deviation U_n is denoted as λ . The cumulative standard normal density function represent by φ . The standard normal density function represent by Φ . Using equation 3, C_n can be estimated.

In this work, a computer program entitled Frontier Version 4.1 developed by (Coelli, 1996) was used to assess the efficiency of the Frontier production function using the approach of maximum likelihood, which was estimated using the Frontier production function.

3.6. Econometric model

The GMM estimator, which was proposed by Arellano and Bover (1995), is utilized in this investigation because of the panel data structure that is utilized.

The goal of generalized method of moment's analysis (GMM) is to achieve control over two fundamental issues, namely unobserved heterogeneity and endogeneity issues (Arellano, 2002). The GMM estimator takes into account both the presence of unobserved heterogeneity and the persistence of the variable being estimated. As a result, the estimations that this estimator produces of the parameters are reliable. Since a comprehensive collection of instruments is used, the derived coefficients have a higher degree of accuracy (Le et al., 2020).

The system GMM estimator uses lagged values of the dependent variables (in levels and differences) and lagged values of additional regressors that possibly suffer from endogeneity as instruments in order to address endogeneity issues. Both of these types of regressors can be affected by endogeneity (Bond, 2002). In accordance with Bond (2002), we employ the lagged values of the variables that are considered to be endogenous in the form of instruments. These values are presented in the result table in italics. The strategy that we take makes use of instruments for all regressors, with the exception of those that are regarded as exogenous. Arellano-Bond autocorrelation (AR) tests and tests for over-identifying constraints are also used to determine the number of delays in addition to these tests (Hansen, 1982). If the null hypothesis of the Hansen test is found to be rejected, then the orthogonality constraints for the instruments being tested will not be satisfied. In addition, the moment criteria are only considered to be correct if there is no evidence of a correlation between the idiosyncratic errors and their serial order. If it is not possible to reject the null hypothesis when looking at the second-order autocorrelation (AR2), then the moment criteria are still true.

In banking business, the trend of previous period influences the banking activities hence banks are adjusted their risk, performance and IC efficiency based on the last year (Buallay et al., 2019b; Zheng, Gupta, Moudud-Ul-Huq et al., 2018).

In this study, we have developed the following two simultaneous equations specifying the empirical model of the study:

$$RISK_{I,t} = \alpha_0 + \beta_1 RISK_{i,t-1} + \beta_2 ICE_{i,t} + \beta_3 PERF_{i,t} + \beta_4 ID_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 LIQ_{i,t} + \beta_7 GGDP_{i,t} + \beta_8 INFR_{i,t} + \beta_9 FCY_{i,t} + \epsilon_{i,t}$$
(5)

$$PERF_{I,t} = \alpha_0 + \beta_1 PERM_{i,t-1} + \beta_2 ICE_{i,t} + \beta_3 RISK_{i,t} + \beta_4 RWATA_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 CAP_{i,t} + \beta_7 LIQ_{i,t} + \beta_8 LEV_{i,t} + \beta_9 GGDP_t + \beta_{10} IFR_t + \beta_{11} FCY_{i,t} + \epsilon_{i,t}$$
(6)

Here, the i subscript signifies the cross-sectional dimension across banks, and t represents the time dimension. Risk is used as a dependent variable in equation 5 where risk measurement by NPLTL. PERF uses as a dependent variable in equation 6 which indicates the bank performance of that measurement by ROA. The overall efficiency of IC is denoted as ICE, SIZE, LIQUIDITY, LEVERAGE,

Table 4. Shows the effect of ROA and Intellectual capital efficiency on NPLTL (GMM)				
	NPLTL	NPLTL		
Variables	Coefficient	Coefficient		
NPLTL (t-1)	0.094*** (0.025)	0.091*** (0.029)		
ROA	-0.018*** (-7.969)			
ICE		0.045*** (6.930)		
ID	0.083*** (5.316)	0.097*** (3.897)		
SIZE	0.006** (2.033)	0.056*** (6.093)		
LIQUIDITY	0.073** (2.180)	0.005** (4.903)		
GGDP	-0.019** (-5.144)	-0.032** (-6.093)		
IFR	-0.014** (-4.904)	-0.007*** (-11.849)		
FCY	0.019*** (5.794)	0.004*** (9.038)		
C	-0.163* (-2.672)	-0.124* (-3.093)		
Year Dummy	Yes	Yes		
R-squared	0.481	0.470		
Adjusted R-squared	0.473	0.461		
Hansen Test	0.291	0.319		
AR(1)	0.002	0.001		
AR(2)	0.287	0.264		
Instrument rank	12	12		

Note: The GMM approach was used to arrive at these results. The GMM estimator, which was proposed by Arellano and Bover (1995). The Hansen J test standard demonstrates that the instrument may be trusted for the purpose of this investigation.AR (1), AR (2) are first and second order autocorrelation. In this instance, ***, **, and * use one percent, five percent, and ten percent, respectively.

CAP, ID are to be used as control variables (independent variables) for individual banks. INF, GGDP, and FCY are used as macroeconomic variables for both equation 5 and 6 that affect the relationships among IC efficiency, performance, and risk. Equation (5) examines whether the level of risk is affected by the changes in IC efficiency, whereas equation (6) examines whether bank performance is affected by the changes in IC efficiency of IC along with other bank level and macro-economic variables during study period. α_0 and \in intercept and error terms, respectively.

In addition, HCE, RCE, and SCE are utilized in this research project in order to validate the primary findings. ICE has been replaced with HCE, RCE, and SCE in several applications.

Among the independent variables in the correlation matrix, the correlation values show below 0.70. Such models are free from the major multicollinearity problem (Syed Moudud-Ul-Huq et al., 2021).

4. Empirical results

The System Generalized Method of Moments (GMM) technique was used in this study to analyze the "Does intellectual capital efficiency matter for banks' performance and risk-taking behavior?" In this study, the regression equations are applied to the panel data, and consideration is given to

issues of endogeneity and heteroskedasticity. The system GMM, which was proposed by Blundell and Bond (2000) and Arellano and Bover (1995), is what we employ for our dynamic panel data in order to handle the model's endogeneity, unobserved heteroskedasticity, and autocorrelation problems (Arellano & Bover, 1995; Blundell & Bond, 2000). Table 3 presents the indicators' correlations and degrees of statistical significance.

This study uses the GMM model for basic results where 2SLS uses it for robustness check. Table 4 and Table 5 show the basic results, whereas Tables 6 and Table 7 shows the robustness results of this study, respectively. NPLTL is used as a dependent variable in Table 4, whereas ROA is used as a dependent variable in Table 5.

The lag variable of both Tables 4 and 5 shows that a significant and positive sign. It indicates that the dynamic character of the model is the specification.

In Table 4 shows, there is a significant and negative link between ROA and NPLTA. Since the p-value is 0.002, which is less than the 0.01 significance level, and the coefficients are negative (-0.018), this shows that there is a significant and negative link between ROA and NPLTA in Bangladeshi banks. It indicates that if the performance of banks in a developing country is increased, NPLTA will be decreased. When we use ROA as a dependent variable in Table 5, there shows the same impact between ROA and NPLTA. Where the p-value is 0.008, which is less than the 0.01 significance level, and the coefficients are negative (-0.036), the result suggests that the banking systems of developing countries are well decorated and a good monitoring system as well as excellent management mechanism. This helps to detect non-performing loans and can reduce the number of non-performing loans. Finally, it reduces credit risk. The findings cannot reject the third hypothesis.

In Table 4 shows, there is a significant and positive link between Intellectual Capital Efficiency and NPLTA. Since the p-value is 0.000, which is less than the 0.01 significance level, and the coefficients are positive (0.045), this shows that there is a significant and positive link between Intellectual capital efficiency and NPLTA in Bangladeshi banks. It represents that when the intellectual capital increases, then NPL will increase. This result is supported by previous studies showing a positive association of ICE with risk (Guimón, 2005; Sarmiento & Galán, 2014; Sun & Chang, 2011). The findings cannot reject the first hypothesis (H1). However, our findings are dissimilar to (Ullah et al., 2021). When we use dependent variables such as ROA in Table 5, there is a significant positive relationship between ROA and ICE. Where the p-value is 0.000, which is less than the 0.01 significance level, and the coefficients are positive (0.287), It shows that the coefficient of ICE is significant and positively associated with bank performance. It indicates that with the increases of ICE the performance of bank will also increase. The findings accepted the second hypothesis. This result is similar to (Alhassan & Asare, 2016; Buallay et al., 2019b; Guerrini et al., 2014; Gupta & Raman, 2021; Makki & Lodhi, 2008; Mohiuddin et al., 2006; Urbanek, 2016) who found positive association of bank performance with intellectual capital efficiency. Our results are similar to resource-based theory (Grant, 1996).

In Table 4 shows, there is a significant and positive link between income diversity and NPLTL. Since the p-value is 0.000, 0.000, respectively, which is less than the 0.01 significance level, and the coefficients are positive 0.006 and 0.097, this shows that there is a significant and positive link between income diversity and NPLTL in Bangladeshi banks. It indicates that when income diversification increases, NPL will increase.

There is a significant and positive sign between the bank size and NPLLT in Table 4. Since the p-value is 0.043, 0.008, respectively, which is less than the 0.05 significance level, and the coefficients are positive 0.006 and 0.056, this shows that there is a significant and positive link between bank size and NPLTL in Bangladeshi banks. The findings are similar to (Ullah et al., 2021). It indicates larger bank size increases the risk. Where the size of the bank is large, in addition to providing long-term loans, short-term loans also provide long-term loans that earn a higher income. Sometimes banks fail to recover the money invested as well as the interest, which leads

Table 5. Shows the effect of NPLTL and Intellectual capital efficiency on ROA (GMM)				
	ROA	ROA		
Variables	Coefficient			
ROA _(t-1)	0.021*** (3.932)	0.006*** (6.271)		
NPLTA	-0.036*** (6.021)			
ICE		0.287*** (4.831)		
RWATA	-0.075*** (3.921)	-0.029*** (5.902)		
SIZE	-0.299** (-5.763)	-0.267*** (6.032)		
САР	0.055*** (5.329)	0.012*** (3.032)		
LIQUIDITY	0.097** (6.984)	0.102** (2.005)		
LEVERAGE	-0.002 (1.302)	-0.056 (1.832)		
GGDP	-0.044*** (-4.860)	-0.004*** (-4.901)		
IFR	-0.136** (-3.769)	-0.073** (-2.038)		
FCY	-0.132*** (-4.796)	-0.037*** (-3.010)		
C	4.828** (5.830)	-0.034** (4.008)		
Year Dummy	Yes	Yes		
R-squared	0.139	0.157		
Adjusted R-squared	0.128	0.141		
Hansen Test	0.572	0.510		
AR(1)	0.000	0.001		
AR(2)	0.382	0.319		
Instrument rank	14	14		

Note: The GMM approach was used to arrive at these results. The GMM estimator, which was proposed by Arellano and Bover (1995). The Hansen J test standard demonstrates that the instrument may be trusted for the purpose of this investigation.AR (1), AR (2) are first and second order autocorrelation. In this instance, ***, **, and * use one percent, five percent, and ten percent, respectively.

to non-performing. On the other hand, Table 5 shows the inverse association between them. Where the p-value is 0.023, 0.037, respectively, which is less than the 0.05 significance level, and the coefficients are positive -0.299 and -0.267. There is a significant and positive sign between the bank CAP and NPLLT in Table 5. Since the p-value is 0.000, 0.000, respectively, which is less than the 0.01 significance level, and the coefficients are positive 0.055 and 0.012, this shows that there is a significant and positive link between bank CAP and NPLTL in Bangladeshi banks. This indicates that well-capital regulation improves the banks performance.

There has a positive sign between bank liquidity and NPLTL in Table 4. Since the p-value is 0.021, 0.037, respectively, which are less than the 0.05 significance level, and the coefficients are positive 0.073 and 0.005, this shows that there is a significant and positive link between bank liquidity and NPLTL in Bangladeshi banks. It represents that if the bank increases NPLTL, the bank liquidity will decrease. If we use ROA as a dependent variable (Table 5), then ROA and bank liquidity show a positive relationship between them. Since the p-value is 0.042, 0.029, respectively, which is less than the 0.05 significance level, and the coefficients are positive 0.097 and 0.102. On the other

hand, leverage shows the negative impact on NPLTA in developing countries like Bangladesh (Table 5). Where p-value is 0.162, 0.125, respectively, which is more than the 0.10 significance level, and the coefficients are negative -0.002 and -0.056.

Unfortunately, the co-efficient of GGDP has a significant negative sign between GGDP & NPLTA in Table 4. Since the p-value is 0.043, 0.029, respectively, which is less than the 0.05 significance level, and the coefficients are negative -0.019, -0.032, this shows that there is a significant and negative link between GGDP and NPLTL in Bangladeshi banks. When we use dependent variables such as ROA in Table 5, there is also a significant negative relationship between ROA and GGDP. Where the p-value is 0.000, 0.000, respectively, which is less than the 0.01 significance level, and the coefficients are negative -0.044 - 0.004. It denotes that with the higher progression of the economy, financial stability has declined in developing countries like Bangladesh.

The co-efficient of inflation has a significant negative sign between inflation & NPLTA in Table 4. Since the p-value is 0.032, 0.027, respectively, which is less than the 0.05 significance level, and the coefficients are negative -0.014 - 0.007, this shows that there is a significant and negative link between inflation and NPLTL in developing countries like Bangladesh. It indicates that the NPLTA will decline when inflation rises in developing countries like Bangladesh. It denotes that financial stability in the banking sector may increase during inflation in developing countries like Bangladesh. When we use a dependent variable as ROA in Table 5, there is also a significant negative relationship between ROA and inflation. Where the p-value is 0.041, 0.028, respectively, which is less than the 0.05 significance level, and the coefficients are negative -0.136 - 0.073.

In Table 4 shows, there is a significant and positive link between the financial crisis period and NPLTA. Since the p-value is 0.000, 0.000, respectively, which is less than the 0.01 significance level, and the coefficients are positive 0.019 0.004, this shows that there is a significant and positive link between financial crisis period and NPLTA in developing countries like Bangladesh. It represents that during the global financial crisis, NPL will be increased in developing countries. When we use dependent variables such as ROA in Table 5, there is a significant negative relationship between ROA and FCY. Where the p-value is 0.000, 0.000, respectively, which is less than the 0.01 significance level, and the coefficients are negative -0.132 - 0.037. It denotes that during the global financial crisis period risk will be increased that turn into declined financial stability in developing countries like Bangladesh.

4.1. Robustness check and analysis

This study uses additional alternative variables for measuring intellectual capital efficiencies, such as human capital efficiency (HCE), relational capital efficiency (RCE), and structural capital efficiency (SCE). Where intellectual capital efficiency has been used for measuring intellectual capital in this study.

To make sure that the results of this study are reliable, the following intellectual capital components were measured with as follows:

Human Capital efficiency (HCE): HCE represents how much VA is created by one monetary unit of investment in human capital (Clarke et al., 2011) and thereby, in this paper, the HCE can be formed as follows: HCE = VA/HC. The higher the HCE, the higher the VA relation to salaries and wages (HC).

Structural capital efficiency (SCE): Structural capital including organizational capital and relational capital in the VAIC model is the difference between VA and HC, i.e., SC = VA—HC (Hsu & Wang, 2012) and thus, the SCE can be computed using the following formula SCE is defined as SCE = SC/VA.

Rational Capital efficiency (RCE): RCE provides the infrastructure and necessary resources for HCE and SCE to make the best use of resources to increase overall firm performance (Widowati &

Table 6. Shows the effect of ROA and intellectual capital efficiency on NPLTL (2SLS)				
	NPLTL	NPLTL		
Variables	Coefficient	Coefficient		
NPLTL (t-1)	0.091*** (4.073)	0.096*** (3.072)		
ROA	-0.010*** (-5.069)			
HCE		0.003* (4.130)		
RCE		0.073** (2.093)		
SCE		0.009 (1.026)		
ID	0.035*** (3.316)	0.197*** (3.897)		
SIZE	0.006* (1.933)	0.056*** (6.093)		
LIQUIDITY	0.073** (2.180)	0.005** (4.903)		
GGDP	0.019 (5.144)	0.032* (6.093)		
IFR	-0.014 (-4.904)	-0.007*** (-11.849)		
FCY	0.020*** (4.320)	0.003*** (6.038)		
C	-0.163* (-2.672)	-0.124* (-3.093)		
Year Dummy	Yes	Yes		
R-squared	0.521	0.493		
Adjusted R-squared	0.517	0.481		
Hansen Test	0.372	0.325		
AR(1)	0.001	0.000		
AR(2)	0.372	0.273		
Instrument rank	14	14		

Note: The 2SLS approach was used to arrive at these results. The Hansen J test standard demonstrates that the instrument may be trusted for the purpose of this investigation.AR (1), AR (2) are first and second order autocorrelation. In this instance, ***, **, and * use one percent, five percent, and ten percent, respectively.

Pradono, 2017). Relational capital as "relationships with customers and suppliers" and thereby, in this paper, the RC can be formed as follows: RCE = RC/VA (Andriessen, 2004).

This study uses the robustness check by the 2Stage Least Square (2SLS) Approach, as shown in Tables 6 (NPLTL as dependent variable) and Table 7 (ROA as dependent variable).

In Table 6 shows, there is a significant and negative link between ROA and NPLTA. Since the p-value is 0.000, which is less than the 0.01 significance level, and the coefficients are negative (-0.010), this shows that there is a significant and negative link between ROA and NPLTA in Bangladeshi banks. When we use ROA as a dependent variable in Table 7, there shows the same impact between ROA and NPLTA. Where the p-value is 0.000, which is less than the 0.01 significance level, and the coefficients are negative (-0.027). These findings show that they are consistent with the baseline equations results.

Table 7. Shows the effect of NPLTL and intellectual capital efficiency on ROA (2SLS)				
	ROA	ROA		
Variable	Coefficient			
ROA _(t-1)	0.021*** (3.932)	0.006*** (6.271)		
NPLTA	-0.027*** (-6.021)			
HCE		-0.087*** (-6.831)		
RCE		0.047* (2.094)		
SCE		0.018** (3.091)		
RWATA	-0.085*** (3.621)	-0.069*** (5.002)		
SIZE	-0.004** (-6.063)	-0.067*** (6.032)		
САР	0.075*** (3.029)	0.912*** (3.032)		
LIQUIDITY	0.597* (7.984)	0.102* (2.305)		
LEVERAGE	-0.012 (1.302)	-0.036 (1.832)		
GGDP	-0.034*** (-4.860)	-0.004*** (-4.901)		
IFR	-0.136 (-3.769)	-0.073 (-1.038)		
FCY	-0.082*** (-3.053)	-0.104*** (-5.029)		
C	3.064** (4.734)	-0.182** (5.378)		
Year Dummy	Yes	Yes		
R-squared	0.174	0.216		
Adjusted R-squared	0.163	0.205		
Hansen Test	0.372	0.231		
AR(1)	0.000	0.000		
AR(2)	0.321	0.319		
Instrument rank	14	14		

Note: The 2SLS approach was used to arrive at these results. The Hansen J test standard demonstrates that the instrument may be trusted for the purpose of this investigation.AR (1), AR (2) are first and second order autocorrelation. In this instance, ***, **, and * use one percent, five percent, and ten percent, respectively.

In Table 6 shows, there is a significant and positive link between Human Capital Efficiency and NPLTA. Since the p-value is 0.062, which is less than the 0.10 significance level, and the coefficients are positive (0.003), this shows that there is a significant and positive link between Intellectual capital efficiency and NPLTA in Bangladeshi banks. When we use ROA as a dependent variable in Table 7, it shows a significant negative impact between HCE and ROA. The findings are similar to (Ur Rehman et al., 2022). Where the p-value is 0.000, which is less than the 0.01 significance level, and the coefficients are positive (0.087).

In Table 6 shows, there is a significant and positive link between RCE and NPLTA. Since the p-value is 0.042, which is less than the 0.05 significance level, and the coefficients are positive (0.073), this shows that there is a significant and positive link between RCE and NPLTA in

Bangladeshi banks. When we use ROA as a dependent variable in Table 7, it shows the same impact between RCE and ROA. The findings are similar to (Ur Rehman et al., 2022). Where the p-value is 0.020, which is less than the 0.05 significance level, and the coefficients are positive (0.047).

In Table 6 shows, there is a positive but insignificant link between SCE and NPLTA. Since the p-value is 0.125, which is more than the 0.10 significance level, and the coefficients are positive (0.009), this shows that there is a significant and positive link between SCE and NPLTA in Bangladeshi banks. When we use ROA as a dependent variable in Table 7, it shows a significant positive impact between SCE and ROA. The findings are similar to (Ur Rehman et al., 2022). Where the p-value is 0.010, which is less than the 0.05 significance level, and the coefficients are positive (0.018).

According to the findings, the IC components coefficient has a significant influence on bank performance and a positive correlation with that influence. It indicates that improvements in IC will result in improvements in performance on the part of financial organizations, such as banks.

The rest of the indicators uses the same indicators and the same formula for robustness check. This test supports the main results shown in Tables 6 and Table 7 and consistent with the baseline equations results. The coefficient of ICE is significant (insignificant) and positively associated with bank performance. It indicates that with the increases of ICE the performance of bank will also increase. The coefficients of ROA and RWATA are significantly and negatively related to risk in both the methods. It indicates that if the performance of banks and RWATA in a developing country is increased, NPLTL will be decreased. This result is also supported by Tables 4-5 of this study. This helps to detect non-performing loans and can reduce the number of non-performing loans. Again ID, SIZE, (CAP) LIQUIDITY and NPL (t-1) variables significantly show significant (insignificant) and negative effects on NPL. It denotes that with the higher progression of the economy. Financial stability has declined in developing countries like Bangladesh.

In Table 6 shows, there is a significant and positive link between the financial crisis period and NPLTA. Since the p-value is 0.037, 0.021, respectively, which are lower than the significance level of 0.05 and the coefficients are positive values of 0.020 and 0.003, this indicates that there is a significant and positive link between periods of financial crisis and NPLTA in developing countries such as Bangladesh. It is an indication that non-performing loans (NPL) would increase in emerging countries as a result of the global financial crisis. Table 7 reveals a statistically significant and inversely proportional association between ROA and FCY when the dependent variable is interpreted as ROA. Where the p-values are 0.000 and 0.000, respectively, which is lower than the significance level of 0.01, and the coefficients are -0.082 and 0.104. It suggests that the overall performance of banks in developing nations like Bangladesh may deteriorate as a result of the global financial crisis. In conclusion, throughout the period of the global financial crisis, risks will increase, which will ultimately result in a reduction in the developing countries' ability to maintain financial stability. One such country is Bangladesh.

5. Discussion and implications

The purpose of this research is to investigate the influence of IC efficiency on performance and risk-taking behavior in the banking sector of Bangladesh. In this research, IC efficiency and bank-specific characteristics are used to achieve its goal, and a comprehensive panel data set of 30 banks in Bangladesh is used to achieve this goal within a time span 2002–2019. The banking business in Bangladesh is an appropriate subject for investigation due to the industry being one of the most productive industries in terms of intellectual capital use. An instrumental approach called GMM and 2SLS is used in this research to determine the influence of ICE on a variety of performance and risk parameters.

This study found a positive association of intellectual capital efficiency with bank risk, which is not in line with the result of (Guimón, 2005; Sun & Chang, 2011; Zheng, Gupta, Moudud-Ul-Hug et al., 2018). Whereas prior research employed VAIC, GMM estimators to demonstrate the impact of IC on risk, this study applied SFA, GLM, and OLS estimators as innovative approaches to obtain the conclusion. The outcomes of our research counter findings found in (Alrashidi & Alarfaj, 2020) since there was a discrepancy between the levels of investment in intellectual capital acheived by ther countries and Bangladeshi banking institutions.. On the other hand, this study indicates that intellectual capital efficiency contributes in improving bank performance in Bangladesh, and comparable outcomes were obtained by other studies despite using various performance measures (Gupta & Raman, 2021; Makki & Lodhi, 2008; Muhammad & Ismail, 2009; Wang et al., 2013). The results of our study differ from (Ting et al., 2020) and they found that IC efficiency is negatively and significantly associated with bank performance. This might happen due to the difference in size and investment in IC capital by the banks. Because (Kaupelytė & Kairytė, 2016) found that IC has an impact on performance, but it differs between large and small banks. For example, due to poor investment in structural capital (network, data synchronization, IT infrastructure), a part of IC nationalized banks of Bangladesh having hundreds of branches did not progress satisfactorily. Human capital (employees) in nationalized banks is not more efficient due to shortage of training. Also, the customer relationship is not satisfactory as compared to other countries banks. So, it is high time to rethink the necessity of investment in IC. However, private banks in Bangladesh offer a goods service environment in global standards (Saleheen et al., 2014). So, the policymakers of Bangladesh banking sectors need to formulate strategies to invest more on intellectual capital to reduce the risk and enhance the bank performance. Since the GMM model supports all assumptions, this study offers a deep and novel insight into how each factor of IC efficiency connects to the performance and risk of a financial institution.

Theoretically, this study contributes to the current literature on IC efficiency by performing an empirical assessment into the usage of Stochastic Frontier Analysis (SFA) in the Banking Sector of Bangladesh. Overall, this research demonstrates that IC has a significant influence in determining banks' performance. Moreover, this research contributes to the IC literature by providing a new empirical analysis of the influence of IC efficiency on bank performance and risk-taking behavior, which takes into account macroeconomic variables. The findings of this research will serve as a foundation for the recommendations of some other studies that will be conducted in other emerging countries. Finally, by revealing that financial institutions may benefit from IC efficiency in order to improve their performance, this research could perhaps serve as a foundation for future studies in the IC knowledge disciplines.

In terms of practical implications, the findings of this research imply that it is critical for banks to employ information technology (IC) effectively in order to obtain better performances. In particular, while the GDP and inflation rates have a negative impact on both bank performance and risktaking behavior, regulatory authorities, managers and policymakers should step up their surveillance of banks and other financial institutions acquiring knowledge from these findings. In addition, after analyzing the conclusions of this research, the bank managers will be better able to articulate why they must strengthen IC efficiency resources since they are the most important drivers of bank performance. In general, our findings support the efforts of regulatory bodies in developing countries to promote intellectual-based economies via policy measures. Having a consistent focus on IC investment is essential for long-term development and improved bank performance. In light of the findings of this research, it is recommended that Bangladeshi financial institutions regulate the IC efficiency appropriately.

6. Conclusion, implication, limitation, and future research

Banking industry is facing competitive environment in recent times, and the banking sector is being forced to have sustainable performance due to cross-border competition. For doing researches on IC issues, the banking sector is an ideal sector for its knowledge-intensive nature, and the staff of whole-banking sector is intellectually more identical and consistent than any other service and business industry of an economy . However, very few studies are made in relation to IC efficiency with bank performance and risk in the world. As a result, this study uses unbalanced panel data to show the impact of intellectual capital efficiency with bank performance and risk of 30 commercial banks of Bangladesh during 2002–2019. The study results found that intellectual capital efficiency motivates the company to reduce risk and to increase the bank performance. The study also found a negative association between risk and performance of banks, indicating excessive risk-taking behavior hindrances the performance of banking operations. This study uses the GMM system to obtain these findings. Furthermore, the main result is justified with the robust result of an alternative regression measure called 2SLS with additional alternative variables. The highest ethical standards are maintained not only in the data collection process but also at every stage of this research.

The conclusions of the study have repercussions not only for the application of knowledge but also for the formation of public policy. This research makes a contribution to the existing body of the literature in the field of knowledge because it focuses on IC Efficiency and Risk, IC Efficiency and Performance, and Risk and Performance in the highly concentrated banking industry in Bangladesh. This helps fill in some gaps in the existing research.

The findings are indicative of the current state of play with regard to IC efficiency and its component parts. As a result, it will be much simpler to appreciate the potential of commercial banks to improve their performance and generate value through the efficient implementation of IC Efficiency. It is conceivable for commercial banks and Islamic banks to take advantage of their ICE (Human Capital Efficiency, Rational Capital Efficiency, and Structure Capital Efficiency) even when they are located in developing countries like Bangladesh. The fact that they are unable to maximize IC efficiency, on the other hand, compels them to devise strategies that are uniquely suited to the situation.

The findings suggest that the relevant authorities, such as lawmakers, central banks, and stock exchanges should place more emphasis on strategic reforms, which are important for the process of policymaking. This is significant because most developing countries have plans to diversify their economies and transition into knowledge-based economies, both of which will be environments in which IC Efficiency will play a significant role in playing a significant role in enhancing the performance of businesses. This is significant because most developing nations have plans to diversify their economies and transition into knowledge-based economies. In addition, the findings are beneficial for the governing bodies of developing nations such as Algeria, Angola, Bahrain, Benin, Brunei, and Cambodia. This is particularly the case given that these countries are working toward becoming financial hubs for Bangladeshi mixed-finance.

This study will suffer from a number of key limitations. For example, the study's generalizability might be limited due to the fact that the panel dataset used in this study is confined to the Bangladeshi banking industry and contains a limited number of samples. Again, owing to the lack of widespread adoption of the International Financial Reporting Standards (IFRS), the difficulties in obtaining comprehensive time series data may be a problem for researchers in developing nations. Moreover, the future research may broaden its sample by covering businesses that really depend largely on IC, such as non-financial industries, as well as businesses that do not currently use much IC. Last but not least, exploring the relationship between IC efficiency and bank's performance employing primary data would also be an extremely interesting research project. Future research might include more factors in this connection, including the idea of "Halal Banking," as well as some other dimensions of performance in the context of IC efficiency.

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