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ASSESSING THE VALUE OF INTELLECTUAL CAPITAL FOR COMPETITIVE ADVANTAGE IN WIG INDEX COMPANIES: A COMPARATIVE ANALYSIS OF BANKING AND IT SECTORS USING GROUP METHODS BASED ON ROA AND MARKET CAPITALIZATION

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Abstract

Intellectual capital has gained prominence in the knowledge-based economy, where intangible assets are key to organizational value and competitiveness. Though always integral to business, its strategic importance has grown, particularly in innovation-driven sectors and in industries undergoing technological transformation. This article examines intellectual capital's theoretical foundations, focusing on management and measurement. Effective management requires understanding its size, value, and impact. The primary objective is to identify how intellectual capital drives competitive advantage and value creation in Poland's banking and IT sectors during 2019–2023. In doing so, the paper addresses a clear gap in the literature on cross-sector comparisons in emerging markets. The guiding research question is: How does the role and valuation of intellectual capital differ between knowledge-intensive IT firms and banking institutions characterized by relational, structural, and increasingly technological capital? The study explores two measurement methods: the Market Value to Book Value (MV/BV) ratio and the Calculated Intangible Value (CIV) model, using financial data from 2019–2023 for companies listed on WIG-Banks and WIG-IT indices. These sectors highlight differing dependencies on intellectual capital: IT prioritizes innovation, specialized knowledge, and R&D, while banking relies more on relational and structural capital, including client relationships, reputation, regulatory compliance, and risk-management systems. The analysis reveals sectoral and corporate variations in intellectual capital, shaped by external factors like the COVID-19 pandemic. Results stress the importance of customized measurement approaches, integrating financial metrics with strategic management insights. The novelty of this study lies in examining intellectual capital during the COVID-19 crisis and the subsequent post-pandemic recovery, providing sector-specific insights into resilience and adaptability. It offers practical guidance for businesses to harness intellectual capital for competitive advantage and market adaptability.

JEL classification: D24, E22, M49, O34

Keywords: Intellectual Capital, IC, Knowledge-Based Economy, Measurement Of IC, MV/BV, CIV, IT, Banking, WIG - Index

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Introduction

Recent years have brought significant socio-economic changes, necessitating modifications in business strategies (Alvino et al., 2020). The instability of the financial system, exacerbated by global crises such as the COVID-19 pandemic, has forced companies to adopt more flexible organizational structures to adapt to uncertain market conditions (Al-Omoush et al., 2022; Granziera & Sihvonen, 2022; Huynh et al., 2024). The transition from the industrial era, characterized by capital-intensive enterprises, to the information era, driven by the growth of knowledge-based businesses, has compelled companies to focus on both tangible and intangible assets, such as intellectual capital (Arı et al., 2024; Huynh et al., 2024). This shift has been closely tied to the evolution of organizational management approaches, particularly the development of the intellectual industry, in which intellectual capital is a core component (Suaedi & Trisliatanto, 2020). Intellectual capital, an intangible resource, encompasses the knowledge and competencies embedded in organizational structures and external relationships (Palimąka & Mierzejewski, 2017). Currently, intellectual capital is a focal point of extensive research across various scientific disciplines (Anielak-Sobczak, 2023; Ozkan & Zeytinoglu, 2024). The origins of IC research date back to the late 1950s/1960s (Penrose, 1959; Sveiby, 1997), and in Poland to studies such as Klimontowicz (2013). Although intellectual capital is intangible and difficult to measure, its identification and effective use can significantly enhance organizational competitiveness (Malik, 2019). The technology sector, in particular, views intellectual capital as an essential knowledge base that enables value creation and fosters market advantage (Battisti et al., 2022; Ju, 2023; Nwachukwu, 2023). In contrast, the banking sector relies primarily on relational and structural capital, including client relationships, reputation, risk-management systems, and regulatory compliance (Mention & Bontis, 2013; Klimontowicz, 2013; Anielak-Sobczak, 2023). Approaches to evaluating intellectual capital vary depending on the context. Accounting-based methods differ substantially from those focused on managing intellectual capital (Jarugowa & Fijałkowska, 2002). Selecting the appropriate method for measuring intellectual capital presents methodological challenges, such as the availability of required data, while also considering the unique characteristics of the organization, industry, and the goals to be achieved through such measurement (Beyer, 2014; Nita, 2013). Although IC has long been studied (Penrose, 1959; Sveiby, 1997), relatively little is known about cross-sector comparisons in Poland. Most existing studies concentrate on banking, while comparative analyses with knowledge-intensive industries such as IT are scarce (Klimontowicz, 2013; Anielak-Sobczak, 2023). This constitutes a clear research gap, especially in the context of the disruptive effects of the COVID-19 pandemic. The aim of this study is therefore to determine whether intellectual capital contributes differently to competitive advantage and value creation in the banking versus IT sectors among WIG index companies. The guiding research question is: How does the role and valuation of intellectual capital differ between knowledge-intensive IT firms and banking institutions characterized by relational and structural capital? These sectors were deliberately chosen because they represent contrasting intellectual capital profiles in the Polish economy: IT relies primarily on innovation, specialized expertise, and R&D, while banks combine relational and structural capital with increasing technological intensity. Recent research has shown that Polish banks increasingly operate as BankTechs (Klimontowicz, 2013; Anielak-Sobczak, 2023), which makes their comparison with IT firms particularly relevant for understanding sectoral IC dynamics in times of crisis and recovery. This study contributes to the literature by examining intellectual capital in the disruptive context of the COVID-19 pandemic and the subsequent post-pandemic recovery. While earlier Polish studies, such as Klimontowicz (2013), pre-date these events, our analysis captures how IC operated under crisis conditions and how its role evolved afterwards. This time-sensitive perspective offers novel insights into sectoral resilience and adaptability.

The paper is structured as follows, the literature review examines theoretical foundations, the methodology presents the research approach, the results report empirical findings, and the conclusion discusses implications and limitations.

Literature review

The understanding and interpretation of the concept of "intellectual capital" have evolved alongside shifts in economic and social relationships that have accompanied economic development (Toffler & Toffler, 1996). Academic studies outline successive stages of industrial advancement that have shaped the economy and competitive dynamics, from mechanization and electrification to digital transformation, system integration, and the convergence of artificial intelligence with human skills, all within the framework of sustainable development (Rosińska-Bukowska, 2022). By the 1960s, it was increasingly recognized that traditional financial statements did not fully capture the essence of a company's value, as they excluded human capital (Szczepańska, 2012; Szczygielska, 2009). The roots of intellectual asset concepts date back to 1959, when Penrose distinguished between a company's tangible and human resources (Mroziewski, 2008). Despite decades of intellectual capital research, cross-sector comparisons in Poland remain underdeveloped. Most stud-

ies focus exclusively on banking (Klimontowicz, 2013; Anielak-Sobczak, 2023), overlooking knowledge-intensive industries such as IT. Prior work by Klimontowicz and Anielak-Sobczak emphasized innovativeness in banks, challenging the assumption that banking is primarily trust-driven. In fact, Polish banks exhibit strong technology intensity, earning them the designation 'BankTechs'. This gap is especially salient given the disruptive impact of the COVID-19 pandemic on both sectors.

The success of organizations in modern markets depends on investing in intellectual capital (Ujwary-Gil, 2018). Unique knowledge and competencies within companies can transform into market value (Salvi et al., 2020), enabling competitive advantage, increased productivity, and market value (Guthrie & Petty, 2000). Intellectual capital comprises three main components: human, structural, and relational capital (Neeliah & Seetanah, 2016). Human capital fosters innovation and problem-solving, structural capital facilitates knowledge application, and relational capital promotes external collaboration and resource access (Nonaka, 2009; Leal-Millán et al., 2016).

These components collectively generate value, supporting investments in research and technology (Huang et al., 2012). Intellectual capital plays a critical role in achieving strategic goals and maintaining competitiveness (Guthrie & Petty, 2000). Its significance varies across sectors - customer relationships and data management are vital in banking, innovation drives IT, and intangible assets are central in media (Firlej et al., 2016).

Recent studies emphasize that Polish banks are not only trust- and regulation-intensive but also increasingly technology-driven, leading some scholars to describe them as 'BankTechs' (Anielak-Sobczak, 2023). This perspective highlights that innovativeness and digital infrastructure are also central components of intellectual capital in banking.

The IT sector, by contrast, is deeply rooted in knowledge and innovation, making intellectual capital fundamental to its success (Skordoulis et al., 2020). In this industry, intellectual capital is utilized to develop advanced technologies, create new products and services, and establish robust relationships with clients and partners (Nwachukwu, 2023). Moreover, understanding how intellectual capital can be strategically leveraged to drive technological innovation and promote sustainable practices offers valuable insights for firms aiming to enhance their competitive position in the market (Battisti et al., 2022). Efficient management of intellectual capital directly translates to increased market value and operational efficiency in IT companies (Nwachukwu, 2023). Previous empirical research confirms sectoral differences: Klimontowicz (2013) highlighted the importance of innovativeness in Polish banks, while Anielak-Sobczak (2023) demonstrated that IC significantly contributes to operational efficiency. In IT firms, studies consistently underline the role of R&D and human capital in sustaining competitiveness (Battisti et al., 2022; Ju, 2023). These findings provide the foundation for our comparative analysis.

The literature also employs diverse approaches to measure IC. Market-based measures, such as the Market-to-Book Value (MV/BV) ratio, capture the difference between market capitalization and book value, signaling the presence of intangibles (Urbanek, 2007; Beyer, 2014). Performance-based approaches, including the Calculated Intangible Value (CIV), attribute excess returns (firm ROA minus sector average) to IC and capitalize those earnings using an appropriate cost of capital (Fijałkowska, 2012; Nita, 2007). Another widely cited framework is the Value-Added Intellectual Coefficient (VAIC), which evaluates the efficiency of capital employed, human capital, and structural capital in generating value (Pulić, 1998; Pulić, 2000). While VAIC is often recommended, this study deliberately adopts MV/BV and CIV to ensure comparability with earlier Polish research (Kasiewicz et al., 2006; Palimąka & Mierzejewski, 2017) and because these measures are particularly suited to listed companies with market data available for 2019 - 2023.

Methodology

The aim of this study is to determine whether intellectual capital contributes differently to competitive advantage and value creation in the banking versus IT sectors, based on companies listed on the WIG indices. This evaluation will be conducted using the Return on Assets (ROA) indicator and market capitalization, enabling a comparison of various intellectual capital valuation models. The study focuses on an empirical analysis of the intangible assets of firms in these sectors, considering the impact of the pandemic on changes in the value of intellectual capital.

To analyze intellectual capital, the following measurement models were employed: MV/BV (Market Value/Book Value) and CIV (Calculated Intangible Value). The study employs MV/BV and CIV models because these approaches are widely applied in Polish and international studies (Zubek, 2023; Adamska, 2019) and are particularly suited for listed companies with available market data. Unlike VAIC, which focuses on efficiency of IC components, MV/BV and CIV capture market-based and performance-based perspectives, making them appropriate for comparative analysis of sectors during the pandemic and post-pandemic period. These methods represent two complementary approaches: market-based (MV/BV) and performance-based (CIV), which together provide a comprehensive assessment of intellectual capital in different industries. The sample

comprises five WIG-Banks and five WIG-IT constituents selected to balance representativeness and data completeness: (i) firms with sufficient market capitalization to reflect sector leaders and (ii) full annual financial and market data availability for 2019 - 2023 in Orbis. Applying these criteria yielded ten companies (five banks and five IT firms), ensuring the dataset's completeness and representativeness. The MV/BV model belongs to the category of ratio-based methods and is based on comparing a company's market value to its book value.

$$\frac{MV}{BV} = \frac{Stock\ price * Number\ of\ shares}{(Assets - Liabilities)} \quad (1)$$

This ratio helps determine what portion of a company's actual value is reflected by its book value (Jarugowa & Fijałkowska, 2002). The method is founded on the assumption that a company's market value should align with its book value, as this correlation reflects how effectively the company utilizes its assets, as shown on the balance sheet, to generate profits (Firlej & Mierzejewski, 2020; Kasiewicz et al., 2006; Nita, 2013). The MV/BV ratio provides insight into the relationship between a company's market and book values (Jarugowa & Fijałkowska, 2002). When the ratio equals 1, it indicates that the company's market value is precisely equal to its book value, suggesting that the firm operates in line with market expectations and its tangible assets fully represent its market value. A ratio greater than 1 signifies that the company holds intangible assets, such as intellectual capital, innovation, know-how, or brand reputation, which enhance its market value. These intangible resources contribute to the creation of additional value that is not captured in the balance sheet. Conversely, a ratio below 1 suggests that the company's market value is lower than its book value, which may point to operational inefficiencies, limited market potential, or insufficient intellectual resources. Such a scenario could also indicate challenges in maximizing the potential of its tangible assets (Nita, 2013). It's important to recognize that the MV/BV ratio does not measure the magnitude of intellectual capital directly; rather, it signals the presence of such assets (Beyer, 2014). While market value reflects the current perception of the company's worth, book value is derived from historical data. Comparing these two values provides insights into whether the market has overvalued or undervalued the company (Jarugowa & Fijałkowska, 2002). Despite its simplicity and clarity, the MV/BV method has limitations. It is most applicable to publicly traded companies and can be influenced by short-term market fluctuations, potentially distorting the results (Urbanek, 2007).

The second method discussed in this article is the CIV model, which evaluates the difference between a company's return on assets (ROA) and the average return for its industry. This approach helps determine the impact of intellectual capital on a company's financial performance, making it especially relevant for knowledge-driven industries (Fijałkowska, 2012). The method involves a structured seven-step process that ultimately calculates the so-called "intellectual premium," representing the company's ability to generate additional profits through its intangible assets (Nita, 2007). The CIV calculation begins by analyzing the company's financial performance relative to industry standards and capital costs (Kasiewicz et al., 2006). ROA is computed as EBIT/Total Assets. This value is compared with the industry benchmark ROA to identify the profit surplus, determined by subtracting the sector benchmark. After application of a 19% tax rate, the remaining surplus constitutes the intellectual premium, reflecting the additional net profit attributable to intellectual capital.

The intellectual premium is then converted into a present value by dividing it by the weighted average cost of capital (WACC). This produces the capitalized value of intellectual capital, effectively quantifying the added value generated by intangible assets. The intellectual premium serves as a metric for assessing the company's ability to outperform its industry peers through the effective use of intellectual capital (Nita, 2007). It also highlights the additional gains a company could achieve, relative to competitors, due to its intangible resources (Kasiewicz et al., 2006). An increase in the CIV value indicates improved management and utilization of intellectual capital, contributing to long-term growth. In contrast, a decline suggests inefficiencies in handling intangible assets, which may lead to over-reliance on tangible resources (Urbanek, 2007). However, this method has its limitations. It requires precise financial data, which can be challenging to obtain as intellectual capital is not explicitly documented in financial reports, making its valuation more complex (Palimąka & Mierzejewski, 2017). Moreover, the method's aggregated nature may mask distinctions between the individual components of intellectual capital, potentially leading to an incomplete representation of its actual potential (Kasiewicz et al., 2006).

Results

This study applied two methods to estimate intellectual capital in companies: MV/BV and CIV. The analysis examined financial data from 10 firms listed on the Warsaw Stock Exchange, representing the WIG-Banks and WIG-IT indices. The companies included PKO BP, Pekao, ING BŚ, BNP Paribas, mBank (banking sector) and Asseco, Text, Comp, DataWalk, and Betacom (IT sector). Grouping the firms by industry ensured a meaningful interpretation of differences in intellectual capital across sectors. Financial data for the years 2019 to 2023 were retrieved from the Orbis database (Bureau van Dijk), which provides standardized compa-

ny-level financials and market data with market capitalization calculated using stock prices from the last trading day of each calendar year. The results of the calculations, displayed in tables, outline the intellectual capital indicators for each company during the study period. This analysis aimed to evaluate the methods suggested in the literature and estimate intellectual capital levels using the selected models. Additionally, the results were contextualized with significant events from the past five years, such as the COVID-19 pandemic, which likely influenced the operations of the studied companies. It should be noted that these findings are approximations and may differ from actual values due to limitations in the models used and the availability of data.

Table 1 presents MV/BV calculations for companies in the WIG-Banks index between 2019 and 2023. Among the analyzed firms, ING BŚ demonstrated the highest MV/BV values, reaching a peak of 2.6284 in 2021. PKO BP and Pekao mostly recorded MV/BV ratios above 1, although their values dropped in 2020, the peak of the COVID-19 pandemic, to 0.8995 and 0.9969, respectively. BNP Paribas often reported ratios below 1, with the lowest value of 0.7779 also occurring in 2020. The most pronounced variations were observed in mBank, where the MV/BV ratio fell to 0.4610 in 2020 but climbed to 1.6628 by 2023, driven by fluctuations in its stock price. The global uncertainty caused by the COVID-19 pandemic during 2020–2021 led to declines in MV/BV ratios for most companies, reflecting the challenges posed by economic instability on their market valuations.

Table 1: IC value of companies from WIG- Banks index in the period 2019-2023 exemplified by the MV/BV method

Company	2019	2020	2021	2022	2023
PKO BP	1.0360	0.8995	1.4900	1.0604	1.3908
PEKAO	1.3153	0.9969	1.3419	0.6290	1.1268
ING BŚ	1.7430	1.2110	2.6284	2.3137	2.0041
BNP PARIBAS	0.8963	0.7779	1.1809	0.7370	0.9866
MBANK	1.0233	0.4610	1.3721	1.0050	1.6628

Source: Own elaboration based on financial statements of each company.

In the IT sector (Table 2), Text recorded the highest MV/BV ratio during the analyzed period, achieving a peak of 25.5268 in 2020. Although this value declined in subsequent years, it remained at an impressive 23.7529 in 2023, the highest in the sector. The consistently elevated share price of Text throughout the study significantly contributed to its strong MV/BV results. DataWalk started the period with relatively high MV/BV values, reaching 11.8559 in 2019. However, this figure dropped sharply in the following years, settling at 5.9701 in 2023. This decline was largely due to a significant reduction in the company's equity. Asseco displayed stable MV/BV ratios above 1 throughout the period, with its highest value of 1.5552 recorded in 2023. In contrast, Comp reported MV/BV ratios consistently below 1 for the entire study period, with its lowest value of 0.4680 in 2022. Betacom's MV/BV results fluctuated over the analyzed years, reaching a maximum of 2.1518 in 2020 and a minimum of 0.9523 in 2023.

Table 2: IC value of companies from WIG- IT index in the period 2019-2023 exemplified by the MV/BV method

Company	2019	2020	2021	2022	2023
ASSECO	1.0798	1.1530	1.4450	1.1986	1.5552
TEXT	14.3916	25.5268	24.4442	23.4973	23.7529
COMP	0.8482	0.6660	0.6118	0.4680	0.7147
DATAWALK	11.8559	11.5335	15.6763	6.2120	5.9701
BETACOM	1.8184	2.1518	1.3674	1.3999	0.9523

Source: Own elaboration based on financial statements of each company.

Tables 3–4 summarize the analysis of discounted intellectual premium (CIV) values for selected companies in the WIG-Banks and WIG-IT indices over the 2019 - 2023 period. CIV calculation proceeded in three stages. First, for each firm - year observation ROA was calculated as EBIT/Total Assets (robustness checks with alternative ROA definitions produced consistent results) and the sectoral benchmark ROA (simple average for WIG-Banks or WIG-IT) was subtracted to derive the excess return rate (N). Excess returns were converted into a monetary excess profit (E) by multiplying N by Total Assets (results were similar when Tangible Assets were used). Second, a 19% corporate income tax rate was applied to obtain the after-tax intellectual premium (PI = E × 0.81). Third, PI was capitalized by the firm's weighted average cost of capital (WACC) to yield the

present value of the intellectual premium, interpreted as CIV. Under a perpetuity assumption, CIV = PI / WACC; for a finite horizon, CIV equals the sum of PI_t discounted at WACC. WACC estimates combined a CAPM-based cost of equity (risk-free rate: 10-year sovereign yield; market risk premium derived from WIG index returns; five-year beta) with an after-tax cost of debt, using each firm's target capital structure.

Table 3 focuses on companies in the WIG-Banks index, revealing significant fluctuations in CIV values across the years. PKO BP recorded an intellectual premium of 73,049,607.57 PLN in 2019, which dropped sharply to -42,240,007.64 PLN in 2021, before partially recovering to 1,325,286.52 PLN by 2023. Similarly, Pekao's CIV fell from 74,573,528.98 PLN in 2019 to -40,012,032.80 PLN in 2021 and further to -10,099,947.43 PLN in 2023. ING BŚ and BNP Paribas displayed similar trends, with steep declines during 2020 - 2021 followed by modest recoveries in 2022. The year 2021 was particularly challenging for the WIG-Banks index, marked by a significant downturn that led to negative CIV values for many of the analyzed firms. In contrast, mBank showed relatively smaller fluctuations. Its intellectual premium started at 27,217,679.10 PLN in 2019 and climbed to 113,425,787.88 PLN by 2023, reflecting a more stable trajectory compared to its peers.

Table 3: IC value of companies from the WIG-Banks index in the period 2019-2023 exemplified by the CIV method [PLN]

Company	2019	2020	2021	2022	2023
PKO BP	73,049,607.57	53,366,300.53	-42,240,007.64	27,968,532.01	1,325,286.52
PEKAO	74,573,528.98	38,110,205.29	-40,012,032.00	32,154,504.10	-10,099,947.43
ING BŚ	44,987,189.18	34,497,252.13	-65,138,777.38	49,146,755.58	-69,236,345.09
BNP PARIBAS	-21,000,345.46	5,294,735.55	-15,423,357.03	4,038,076.96	-91,521,360.16
MBANK	27,217,679.10	24,172,562.06	-22,141,286.16	1,326,099.17	113,425,787.88

Source: Own elaboration based on financial statements of each company.

Table 4 highlights the intellectual premium trends for companies in the WIG-IT index during the analyzed period, revealing varied performances across the sector. Asseco experienced a significant drop in CIV, declining from 320,012.57 PLN in 2019 to -1,154,133.28 PLN in 2021. However, it showed a strong recovery by 2023, achieving a positive value of 1,854,615.93 PLN. Text exhibited a steady decline in CIV values until 2022 but rebounded to 404,981.24 PLN in 2023. In contrast, COMP maintained negative CIV values throughout the period, starting at -213,055.70 PLN in 2019 and improving slightly to -54,053.27 PLN by 2023. DataWalk followed a similar pattern, with a drop to -92,423.38 PLN in 2021, a partial recovery in 2022, but closing the analysis period at -263,109.51 PLN in 2023. Betacom also consistently reported negative CIV values, ending at -27,955.38 PLN in 2023.

Table 4: IC value of companies from the WIG-IT index in the period 2019-2023 exemplified by the CIV method [PLN]

Company	2019	2020	2021	2022	2023
ASSECO	320,012.57	-5,199.50	-1,154,133.28	-795,515.10	1,854615.93
TEXT	25,341.01	-33,783.54	-291,322.55	-161,225.41	404,981.24
COMP	-213,055.70	-336,820.94	-724,280.23	-1,123,031.09	-54,053.27
DATAWALK	-43,581.37	-50,681.17	-92,423.38	138,677.52	-263,109.51
BETACOM	-8,625.10	-7,260.38	-48,659.33	-39,404.00	-27,955.38

Source: Own elaboration based on financial statements of each company.

Conclusion

The detailed empirical results demonstrate that market-based perceptions and realized financial impact of intellectual capital can diverge substantially across sectors and under crisis conditions. The analysis covers the largest Polish banking and IT companies for which a complete set of annual data was available. In banking, MV/BV ratios ranged from 0.46 (mBank, 2020) to 2.63 (ING BŚ, 2021), with most institutions dipping at or below one during 2020 - 2021 and rebounding by 2023 (e.g., mBank at 1.66). Yet CIV values fell into negative territory for key players - PKO BP from 73,049,608.0 PLN in 2019 to -42,240,008.0 PLN in 2021 - before partial recovery, illustrating persistent challenges in converting relational and structural capital into excess returns during shocks. In contrast, IT firms exhibited extreme MV/BV dispersion - from 0.47 (Comp, 2022) to over 25.5 (Text, 2020) - while CIV remained negative for several companies, with only a minority converting innovation investments into positive intellectual premiums.

These findings confirm that combining MV/BV and CIV offers a nuanced lens on intellectual capital dynamics: market valuations capture investor sentiment under stress, whereas performance-based measures reveal actual value capture. The study extends existing frameworks by applying dual models to an emerging market during crisis and post-crisis periods, documenting episodes of market-performance decoupling that persisted in IT for multiple years.

Practically, banks should develop process-driven monetization of digital and risk-management capabilities - prioritizing back-office automation, data-driven cross-sell strategies, and formalized knowledge repositories - to boost excess ROA and CIV. Technology firms must link high market valuations to sustainable earnings by productizing R&D, driving customer success metrics that reduce churn and expand recurring revenue, and enforcing disciplined patent and pricing management.

The analysis is limited to the largest companies with full data availability in the WIG-Banks and WIG-IT indices; results may not generalize to SMEs or unlisted firms. MV/BV remains sensitive to market volatility and CIV to modeling assumptions. Future research should broaden the sample to include mid- and small-cap firms, incorporate qualitative assessments (surveys, interviews, text mining), explore intra-year data frequencies, and apply quasi-experimental designs around regulatory changes to strengthen causal inference on intellectual capital's financial impact.

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The use of AI statement

The authors used AI-based tools solely as support in the preparation of the paper. These tools were used to support the translation of the paper into English, as well as for language editing, stylistic refinement, and verification of grammar and clarity.