

Integrating Intellectual Capital and Productivity: A Bibliometric Analysis of VAIC and Production Function Research

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Abstract

The growing importance of knowledge-based resources has increased academic interest in intellectual capital and its role in organizational performance and productivity. Although extensively studied in management and accounting research, its integration with productivity and production function models remains limited. This study examines the development and intellectual structure of research linking intellectual capital and productivity through a bibliometric analysis. Using Scopus data (1996–2026), the dataset comprises 398 publications from 261 sources, analysed with the Bibliometrix package in R. The methodological approach combines descriptive bibliometric analysis, keyword co-occurrence analysis and thematic mapping. The results indicate a steady increase in scientific production, particularly after 2010, reflecting the growing importance of intellectual capital in contemporary research. Keyword network analysis reveals strong connections between intellectual capital, firm performance, innovation, knowledge management, and organizational efficiency. The findings further indicate that intellectual capital, knowledge management, and production functions are only partially interconnected in the literature, revealing a structural gap and a clear opportunity for future integration.

Keywords: Intellectual capital, VAIC, Cobb-Douglas, production functions, bibliometric analysis, knowledge-based economy

INTRODUCTION

The transition from industrial economies to knowledge-based economies has significantly transformed the sources of value creation and organizational competitiveness. While traditional economic models emphasize physical capital and labour, modern organizations increasingly rely on intangible resources such as knowledge, innovation, and human expertise (Corrado, Haskel, Jona-Lasinio & Iommi, 2022; Iskandar, Joeliaty, Kaltum & Hilmiana 2021, p. 310).

Intellectual capital has therefore become a key determinant of firm performance and long-term competitive advantage. Albertini & Berger-Remy (2019) study confirm its strong impact on organizational outcomes, including innovation capacity and value creation. Despite the growing relevance of intellectual capital, these two research streams have evolved largely independently. While intellectual capital research emphasizes its pivotal role in firm performance, innovation, and value creation in knowledge-based economies (Corrado et al., 2022; Iskandar et al., 2021, p. 310), productivity studies grounded in production functions like the Cobb–Douglas model have focused predominantly on traditional tangible inputs such as labour and physical capital (Hall, Lotti & Mairesse, 2008; Neumann et al., 2024, p. 2; Vadi, Reino & Alida, 2019).

In this context, the present study addresses the following research question: To what extent does the existing literature integrate intellectual capital into productivity modelling, and what structural gaps remain between intellectual capital research and production function approaches?

To answer this question, the study conducts a bibliometric analysis of the scientific literature, focusing on the relationship between intellectual capital, particularly the Value-Added Intellectual Coefficient (VAIC) and production function modelling. Rather than merely describing publication trends, the study aims to identify structural patterns, thematic gaps, and underexplored connections between these research domains. The study applies a bibliometric approach to analyse the structure and evolution of the literature. The aim is to delineate the intellectual evolution, thematic clusters, and interconnections between VAIC and Cobb-Douglas production function modelling, thereby addressing a critical research gap (Quintero-Quintero, Blanco-Ariza & Castrilion, 2021; Zeer, 2023). This integration is crucial given that intangible assets are increasingly recognized as primary drivers of value creation in the Industry 5.0 era (Crouzet, Eberly, Eisefeldt & Papanikolaou, 2022), necessitating a more holistic understanding of economic output.

The study contributes to the literature in three main ways. First, it provides a systematic mapping of the intellectual structure of research linking intellectual capital and productivity. Second, it identifies a persistent fragmentation between management-oriented and economics-oriented approaches. Third, it highlights specific opportunities for integrating intellectual capital indicators into production function frameworks, thereby offering directions for future empirical and theoretical research.

CONCEPTUALIZATION

Intellectual capital represents a fundamental resource in knowledge-based economies and is typically divided into human, structural, and relational capital (Bellucci, Marzi, Orlando & Ciampi, 2020). While this classification is well established, its operationalization in empirical research remains fragmented, particularly when linking intangible resources to measurable economic outcomes (Shakina, Molodchik & Parshakov, 2020). Although a substantial body of literature demonstrates that intellectual capital positively influences firm performance, innovation, and value creation, these relationships are predominantly examined within management and accounting frameworks. As a result, intellectual capital is often evaluated through financial performance indicators rather than integrated into broader productivity models (Ahmed, Hussin & Pirzada, 2022; Albertini & Berger-Remy, 2019).

Intellectual Capital and Firm Performance

Contemporary research increasingly positions intellectual capital as a central driver of organizational growth in post-industrial economies. This shift reflects a transition from production systems based on physical inputs toward value creation mechanisms grounded in knowledge and intangible assets (Albertini & Berger-Remy, 2019). However, this perspective also exposes an important limitation. Marzo (2021) systematic literature analysis reviews emphasize that this strategic shift necessitates a move away from isolated performance metrics toward integrated measurement frameworks capable of capturing the value-creation dynamics inherent in volatile business environments. Specifically, this evolution challenges the traditional reliance on Cobb-Douglas specifications, suggesting that the non-linear interaction between intangible inputs and total factor productivity requires more sophisticated empirical validation. VAIC model is designed to measure the efficiency of both tangible and intangible assets in value creation, it has been criticized for failing to account for critical strategic assets such as research and development expenditure or relational capital, which are essential for sustaining competitive advantage (Bellucci et al., 2020; William, Gaetano & Nicolò, 2019).

VAIC Methodology

The Value-Added Intellectual Coefficient (VAIC) model is one of the most widely used approaches for measuring intellectual capital efficiency. It evaluates how efficiently firms use human capital, structural capital, and capital employed to generate value added. Despite its popularity, VAIC has several limitations, particularly its reliance on accounting data, which may not fully capture the complexity of intellectual capital (Bassetti, Maso, Liberatore, & Mazzi, 2019; Marzo, 2021). For instance, while the VAIC model is designed to measure the efficiency of both tangible and intangible assets in value creation, it has been criticized for failing to account for critical strategic assets such as research and development expenditure or relational capital, which are essential for sustaining competitive advantage (Bellucci et al., 2020; William et al., 2019).

Production Function and Productivity

Production functions describe the relationship between inputs and output, with the Cobb–Douglas function being one of the most widely applied models in productivity analysis (Bontepi & Mariesse, 2014). However, most empirical studies focus on traditional inputs, while the role of intangible assets remains underexplored. Integrating intellectual capital into production models could provide a more comprehensive understanding of productivity dynamics (Quintero-Quintero et al., 2021; Zeer, 2023). While management and accounting studies focus on financial performance (e.g., ROA, Tobin's Q), economic productivity research often remains restricted to traditional production factors like labour and physical capital (Ahmed et al., 2022). Integrating intellectual capital indicators into production function frameworks therefore represents an important research opportunity. Such integration could provide a more comprehensive understanding of productivity dynamics by capturing the role of intangible assets in generating economic output, particularly in knowledge-based economies.

METHODOLOGY

The dataset was obtained from the Scopus database using a structured search query including terms such as “intellectual capital,” “VAIC,” and “productivity.” The search query used in Scopus was: (“intellectual capital” OR “VAIC”) AND (“productivity” OR “production function”). The data were

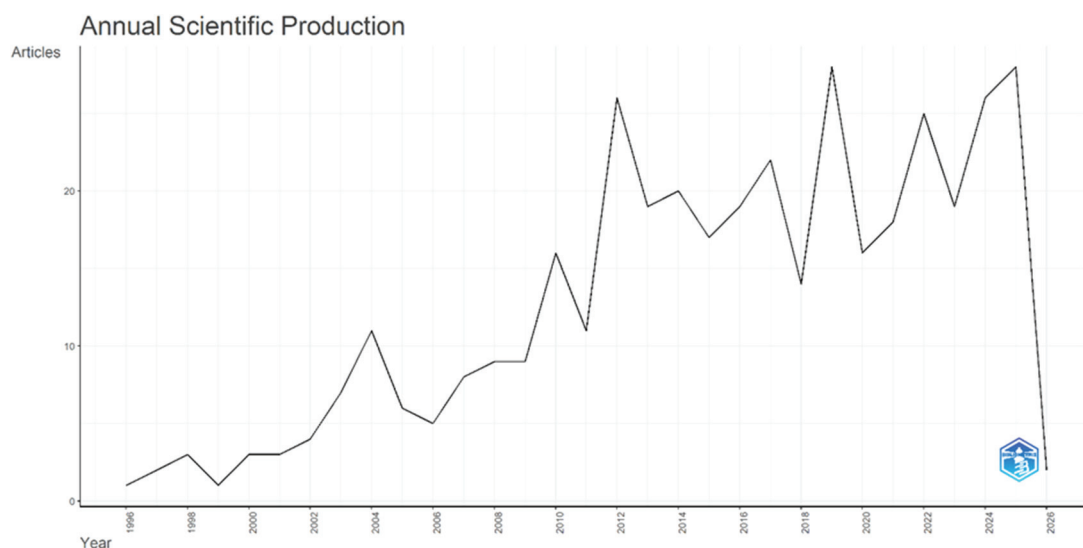
extracted in January 2026. The final dataset consists of 398 documents published between 1996 and 2026. Prior to analysis, the dataset was systematically cleaned to improve data quality and consistency. This process involved the removal of duplicate records, standardization of author names and keywords, and the exclusion of incomplete or irrelevant entries. Such pre-processing is essential to ensure the validity and robustness of bibliometric results.

Prior to analysis, the dataset was systematically cleaned to ensure consistency and reliability. This process included the removal of duplicate records, standardization of author names and keywords, and the exclusion of incomplete or irrelevant entries. The analysis was conducted using the Bibliometrix package in R and the Biblioshiny interface, which enable comprehensive science mapping and visualization of bibliometric networks. The study combines descriptive bibliometric analysis, keyword co-occurrence analysis, thematic mapping, and citation analysis to identify research trends, thematic clusters, and the intellectual structure of the field.

Publication Trends and Growth

The analysis of annual scientific production reveals the evolution of research activity related to intellectual capital and productivity over time (Shakina et al., 2020; Zeer, 2023). During the early phase of the research field (approximately 1996–2003), the number of publications remained relatively low, reflecting the formative stage of intellectual capital research, when foundational theoretical frameworks were being established. From the mid-2000s onwards, the number of publications began to increase gradually. This growth can be associated with the broader shift toward knowledge-based economies, where intangible assets such as human capital, innovation, and organizational knowledge gained increasing importance in both academic research and managerial practice.

Picture 1: Annual scientific production of publications (1996–2026)



A more pronounced acceleration in scientific output is observed after 2010, with the period between 2012 and 2024 representing the most active phase of research development. This surge likely reflects the growing recognition of intellectual capital as a key driver of firm performance and competitiveness, as well as the increasing availability of empirical data and measurement approaches such as VAIC.

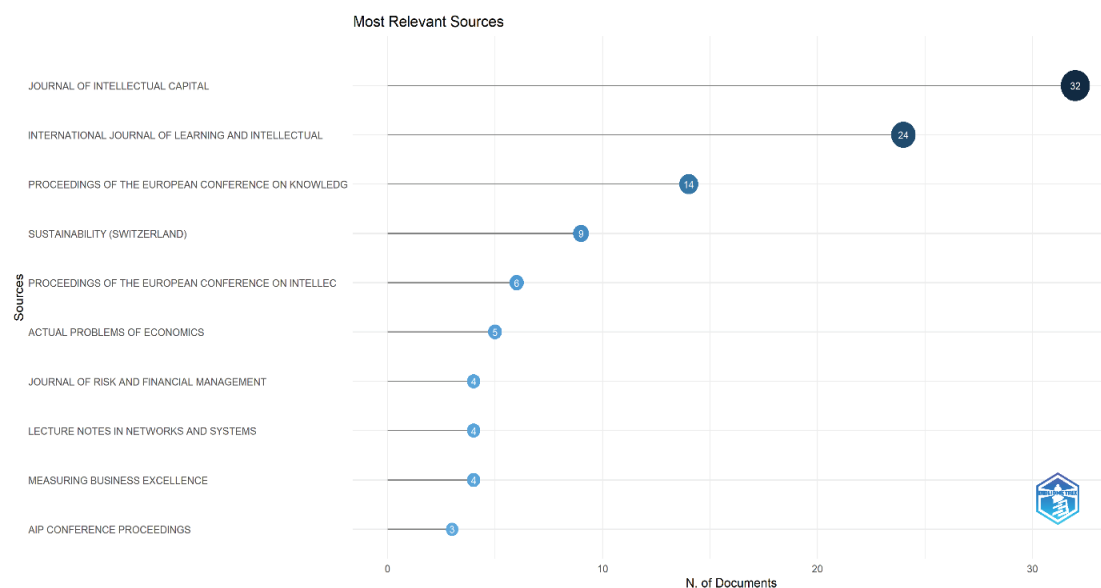
However, despite the observed growth in publications, the increasing volume of research does not necessarily imply theoretical integration within the field. Instead, the expansion appears to be accompanied by a fragmentation of research streams, particularly between management-oriented studies on intellectual capital and economics-based approaches to productivity modelling. This suggests that, while the topic has gained significant attention, the integration of intellectual capital into production function frameworks remains limited.

The dataset used for this analysis consists of 398 publications from 886 authors, with an average of 2.55 authors per document and an annual growth rate of 2.34%, indicating steady but not exponential development. This relatively moderate growth rate further supports the interpretation that the field is evolving incrementally rather than undergoing a fully consolidated theoretical expansion.

Most Relevant Sources

The analysis of the most relevant sources provides insight into the journals that contribute most significantly to the development of research on intellectual capital and productivity (Zeer, 2023). The results indicate that publications are highly concentrated in journals focusing on intellectual capital, knowledge management, and business research.

Picture 2: Most relevant sources publishing research



This concentration suggests the presence of a relatively well-defined and specialized academic community that has played a central role in shaping the development of the field. Journals dedicated to intellectual capital and knowledge management appear to act as primary platforms for knowledge exchange, reinforcing the theoretical and empirical foundations of this research domain.

However, this pattern also reveals an important limitation. The dominance of a relatively narrow group of journals indicates that research on intellectual capital is largely embedded within management and accounting disciplines, with limited presence in economics-oriented or productivity-focused journals.

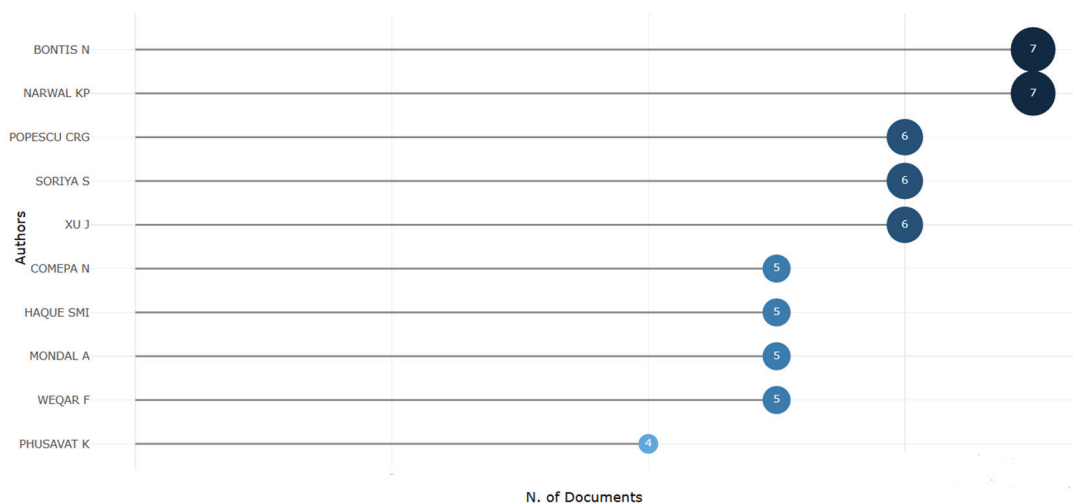
This disciplinary concentration may contribute to the fragmentation identified in the literature, as it restricts the integration of intellectual capital concepts into broader productivity modelling frameworks. In other words, while the field is well-developed within its own domain, its diffusion into adjacent research areas, particularly economic productivity analysis remains limited.

Consequently, the observed publication patterns not only reflect the maturity of the intellectual capital research community but also highlight structural boundaries that may hinder interdisciplinary integration.

Most Productive Authors

The analysis of the most productive authors provides insight into the key contributors shaping the development of intellectual capital research. The results indicate that research output is distributed across a group of authors rather than dominated by a single leading figure, suggesting a relatively decentralized structure of knowledge production.

Picture 3: Most productive authors



This distribution reflects the presence of multiple research clusters, where different groups of scholars contribute to the field from diverse theoretical and methodological perspectives. Such a pattern indicates that intellectual capital research has evolved through parallel streams rather than a unified or consolidated research agenda.

Importantly, the absence of a clearly dominant group of authors may be interpreted in two ways. On the one hand, it reflects the diversity and interdisciplinarity of the field. On the other hand, it may signal a lack of theoretical convergence, which aligns with the broader fragmentation observed between intellectual capital research and productivity modelling.

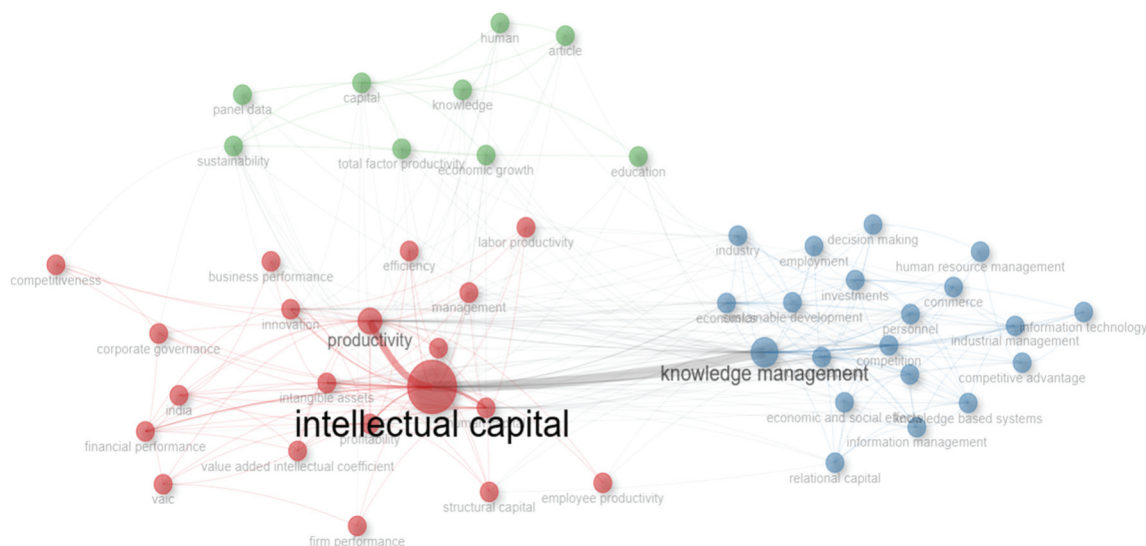
The authorship structure not only highlights key contributors but also reveals underlying structural characteristics of the field, particularly its dispersed and partially fragmented nature.

Keyword Co-occurrence Network

The keyword co-occurrence network provides deeper insight into the conceptual structure of research on intellectual capital and productivity. The visualization reveals several distinct yet partially connected

thematic clusters, reflecting the underlying organization of the field (Bamel, Pereira, Bamel & Kumar, 2020).

Picture 4: Keyword co-occurrence network



At the centre of the network, the keyword intellectual capital occupies a dominant position, with strong connections to terms such as firm performance, innovation, efficiency, and VAIC. This centrality indicates that the majority of studies focus on the role of intellectual capital in explaining organizational performance outcomes, particularly within management and accounting research.

A second prominent cluster is centred around knowledge management and human resource management, highlighting the importance of organizational learning, capabilities, and knowledge processes in value creation. This cluster appears to function as an intermediary domain, linking intellectual capital with broader organizational and strategic perspectives.

In contrast, keywords related to productivity, economic growth, and total factor productivity form a more peripheral and less densely connected cluster. Although these terms are present within the network, their weaker connections to the central intellectual capital cluster suggest that the integration between intellectual capital and productivity research remains limited.

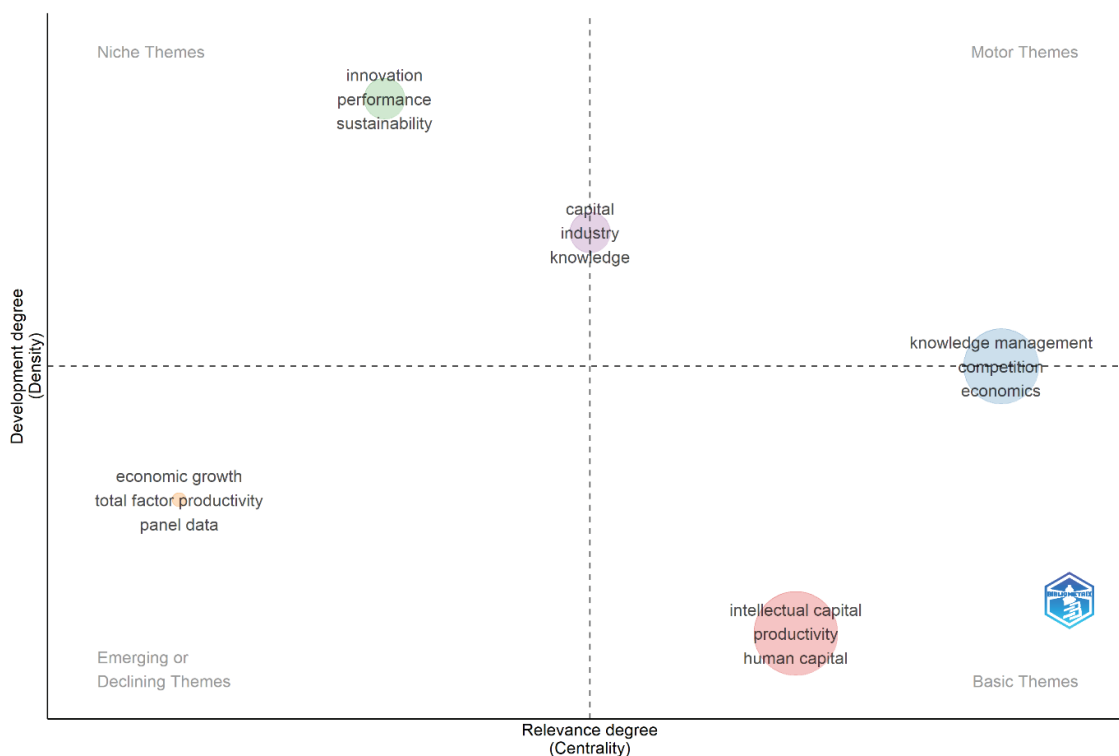
This structural separation provides important evidence supporting the existence of fragmentation within the literature. While intellectual capital is strongly embedded within performance-oriented research streams, its connection to productivity modelling and economic analysis is comparatively underdeveloped.

Therefore, the network does not merely illustrate thematic diversity but reveals a structural gap between management-oriented and economics-oriented research domains. This finding directly supports the central argument of the study, namely that intellectual capital and productivity research have evolved in parallel rather than as an integrated body of knowledge.

Thematic Map Analysis

The thematic map provides a structured overview of the development and relevance of research themes within the field, classifying them into motor, basic, niche, and emerging or declining themes (Zeer, 2023).

Picture 5: Thematic map



The results indicate that knowledge management and competition are positioned as motor themes, suggesting that these topics are both highly developed and central to the intellectual capital literature. This highlights the maturity of research streams that focus on organizational processes, capabilities, and strategic management perspectives.

In contrast, intellectual capital, productivity, and human capital appear within the basic themes quadrant. While these concepts are central to the field, their relatively lower level of development indicates that they have not yet been fully integrated into a coherent theoretical framework. This is particularly notable given that intellectual capital represents the core construct of the research domain.

Furthermore, themes related to economic growth, total factor productivity, and panel data analysis are located in the emerging or declining quadrant. This positioning suggests that the integration of intellectual capital into productivity modelling and macroeconomic analysis remains underdeveloped, despite its increasing relevance.

Taken together, these findings reveal a structural imbalance within the field. While knowledge management has evolved into a mature and central research area, intellectual capital and productivity, despite being core concepts, remain insufficiently developed in terms of theoretical integration.

This pattern provides further evidence of the fragmentation identified throughout the study. Specifically, it indicates that research on intellectual capital has advanced more rapidly within management-oriented domains, while its incorporation into productivity modelling and economic frameworks is still at an early stage.

DISCUSSION

The findings of this study provide a comprehensive view of the evolution and structural characteristics of research on intellectual capital and productivity. While the results confirm a steady increase in scientific output over the past decades, they also reveal a more important pattern: growth has not been accompanied by theoretical integration. Similar trends have been identified in prior bibliometric studies, which report a significant expansion of intellectual capital research in recent years (Bamel et al., 2020; Zeer, 2023). Bibliometric analysis has therefore become an important methodological approach for mapping scientific knowledge structures and identifying emerging research directions within complex interdisciplinary domains (Donthu, Kumar, Mukherjee, Pandey & Lim, 2021).

A central insight emerging from the analysis is the persistent fragmentation of the research field. The keyword co-occurrence network and thematic map both demonstrate that intellectual capital is strongly embedded within performance-oriented research streams, while its connection to productivity modelling and economic analysis remains comparatively weak. In particular, productivity-related concepts appear as peripheral or emerging themes, confirming that their integration into the intellectual capital literature is still limited.

This fragmentation is further reinforced by publication patterns and authorship structures. The concentration of research within a relatively narrow set of journals, together with the presence of multiple loosely connected author clusters, indicates that knowledge production occurs within parallel research communities. As a result, intellectual capital and productivity research have evolved largely independently, with limited conceptual and methodological convergence.

The expansion of the literature reflects the increasing recognition of intangible assets as key drivers of value creation in knowledge-based economies (Albertini & Berger-Remy, 2019; Corrado et al., 2022). However, this development has taken place primarily within management and accounting domains, with limited diffusion into economics-oriented research. This disciplinary imbalance further contributes to the lack of integration between intellectual capital and productivity modelling.

These findings have important theoretical implications. They highlight the need to move beyond isolated research approaches and to develop integrated frameworks that explicitly incorporate intellectual capital into productivity analysis. Existing production function models appear incomplete, as they do not fully account for the role of intangible assets in value creation. Extending traditional frameworks, such as the Cobb–Douglas production function, to include intellectual capital variables may provide a more comprehensive understanding of output generation in knowledge-based economies.

At the same time, the analysis underscores limitations in current measurement approaches. Although the VAIC model is widely used as a proxy for intellectual capital efficiency, its reliance on accounting-based data and simplified assumptions limits its ability to capture the full complexity of intangible assets. This raises concerns regarding the validity of existing empirical models and highlights the need for more robust and theoretically grounded measurement frameworks.

Overall, the findings indicate that the field is characterized by conceptual diversity but lacks theoretical consolidation. While this diversity reflects its interdisciplinary nature, it also constrains the development of integrated models of productivity. Future research should therefore focus on bridging the gap between management and economics perspectives by developing frameworks that explicitly incorporate intellectual capital into productivity analysis. Ultimately, progress in the field will depend less on increasing research volume and more on achieving conceptual and methodological integration.

CONCLUSION

This study provides a bibliometric analysis of research on intellectual capital and productivity, mapping its evolution, intellectual structure, and thematic development. Although the literature has expanded significantly over the past decades, this growth has not been matched by theoretical integration. Instead, the field remains fragmented across two largely separate research streams: management-oriented studies focusing on firm performance and knowledge management, and economics-based approaches centred on productivity and production functions.

The findings demonstrate that intellectual capital remains strongly embedded within performance-oriented research, while its integration into productivity modelling is still limited. While concepts such as knowledge management partially bridge these domains, the connection between intellectual capital and production function frameworks, particularly the Cobb–Douglas model, remains underdeveloped.

This study contributes to the literature in three key ways. First, it provides a comprehensive bibliometric mapping of research linking intellectual capital and productivity. Second, it identifies a persistent structural gap between intellectual capital research and production function modelling. Third, it outlines a research agenda for integrating intellectual capital indicators, particularly VAIC, into productivity analysis.

These findings highlight the need to move beyond descriptive and performance-oriented approaches toward the development of integrated empirical models that explicitly incorporate intangible assets into productivity frameworks. This requires re-evaluating the role of intellectual capital within production functions and addressing the limitations of existing measurement approaches such as VAIC.

Future research should focus on developing more robust and theoretically grounded models that capture the contribution of intellectual capital to productivity, while also addressing conceptual limitations related to measurement and model specification. Such efforts are essential for advancing the understanding of value creation processes in knowledge-based economies. Ultimately, the findings suggest that the limitation of the field does not lie in the lack of research volume, but in the lack of theoretical integration across disciplinary boundaries.

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