Review article
Received: 5 May 2025
Accepted: 28 February 2026
JEL codes: M31, L22, C10
DOI: https://doi.org/10.22430/24223182.3479

Propensity Score Matching and Marketing: A Scientometric Study, Tree of Science Analysis, and Research Perspectives

Propensity Score Matching y marketing: estudio cienciométrico, árbol de la ciencia y perspectivas de investigación

Gabriel Antonio Moyano-Londoño [1], **Jhon Edwar Hernández** [2]
Mario Andrés Pava Idárraga [3]

[1] Universidad Católica Luis Amigó, Manizales - Colombia, gabriel.moyanolo@amigo.edu.co, [2] Universidad Católica Luis Amigó Manizales - Colombia, jhon.hernandezoc@amigo.edu.co, [3] Universidad de Manizales, Manizales - Colombia, mpava@umanizales.edu.co

How to cite
Moyano-Londoño, G. A., Hernández, J. E., & Pava Idárraga, M. A. (2026). Propensity Score Matching and Marketing: A Scientometric Study, Tree of Science Analysis, and Research Perspectives. *Revista CEA*, *12*(29), e3479. https://doi.org/10.22430/24223182.3479

ABSTRACT

Objective: This study aimed to analyze the evolution of scientific production; collaboration networks; and seminal, structural, and recent studies, as well as future research perspectives on the use of Propensity Score Matching (PSM) in marketing.
Design/Methodology: A total of 417 documents were retrieved from the Scopus and Web of Science databases and then analyzed using Bibliometrix, Tree of Science, and Gephi. To ensure reproducibility and transparency, elements of the PRISMA 2020 statement were applied throughout the study.
Findings: Scientometric mapping indicated a steady increase in academic output since 2012, with the United States, China, and Germany leading in the number of publications. Furthermore, the analysis revealed three main clusters: (i) the measurement of impact on marketing contracts and crop productivity, (ii) consumer behavior and business planning, and (iii) effect evaluation. In addition, key driving topics were identified, including risk marketing and consumer behavior.
Conclusions: The findings highlight PSM as an essential tool for evaluating marketing strategies. Moreover, its application across the identified clusters significantly reduces selection bias and enables more robust causal inferences in studies related to consumer behavior, organizational management, and rural development.
Originality: This study represents the first scientometric analysis combining Bibliometrix, Tree of Science, and Gephi to examine PSM in marketing research. Consequently, the approach provides a comprehensive characterization of the field's development, revealing both impact measurement strategies and emerging research directions in marketing.

Keywords: consumer behavior, impact evaluation, marketing, propensity score matching.

Highlights

- Scientific production on PSM in marketing has grown steadily since 2012.
- Recent studies apply PSM to marketing campaigns, customer loyalty, and digital marketing initiatives.
- PSM enhances the causal evaluation of marketing strategies and campaigns.
- PSM strengthens causal inference in marketing studies.

RESUMEN

Objetivo: el objetivo de este estudio fue analizar la evolución de la producción científica, las redes de colaboración, los estudios seminales, estructurales y recientes, así como las perspectivas de investigación sobre el uso del Propensity Score Matching en el campo del marketing.
Diseño/metodología: el estudio se adelantó a partir de la recopilación de 417 documentos de las bases de datos de Scopus y Web of Science, los cuales fueron procesados con herramientas como Bibliometrix, Tree of Science y Gephi, y, para garantizar reproducibilidad y transparencia investigativa, se adoptaron elementos de la declaración prisma 2020.
Resultados: el mapeo científico permitió identificar un crecimiento sostenido de la producción académica desde 2012, liderado por Estados Unidos, China y Alemania. Por su parte, el análisis de la información reveló tres clústeres principales centrados en la medición de impacto sobre los contratos de comercialización y la productividad de los cultivos, el comportamiento del consumidor y la planificación empresarial, así como en la evaluación de efectos. Asimismo, se identificaron temas motores como el marketing de riesgo y la conducta del consumidor.
Conclusiones: esta investigación revela que el Propensity Score Matching es una herramienta esencial para la evaluación de estrategias de marketing. De igual forma, que su uso transversal en los clústeres analizados aporta significativamente a la reducción de sesgos de selección y permite generar inferencias causales más sólidas y confiables en estudios relacionados con el comportamiento del consumidor, la gestión organizacional y el desarrollo rural.
Originalidad: esta investigación es el primer estudio cienciométrico en el que se implementaron herramientas como Bibliometrix, Tree of Science y Gephi para analizar el uso del Propensity Score Matching en el campo del marketing, posibilitando la caracterización integral del desarrollo investigativo y revelando tanto estrategias de medición de impacto como perspectivas de investigación en el mundo del mercadeo.

Palabras clave: comportamiento del consumidor, evaluación de impacto, Marketing, Propensity Score Matching.

Highlights

- La producción científica en Propensity Score Matching y marketing crece sostenidamente desde 2012.
- La literatura reciente aplica Propensity Score Matching a campañas, fidelización y marketing digital.
- El Propensity Score Matching mejora la evaluación causal de estrategias y campañas de marketing.
- Propensity Score Matching fortalece las inferencias causales en estudios de marketing.

1. INTRODUCTION

Marketing and its influence on the decisions of economic agents have long been central topics in business practice and academic research (Sinha et al., 2024; Żyminkowska, 2019). This interest stems from organizations' need to assess the impact of marketing strategies (e.g., advertising campaigns, discount programs, and loyalty schemes) on economic outcomes such as sales prices (Liu et al., 2021), number of subscribers (Chae et al., 2022), and profit (Hughes & Poletti-Hughes, 2016). However, establishing causal relationships in this context presents methodological challenges, as interventions are rarely assigned at random and tend to depend on pre-existing customer characteristics. As a result, comparability issues arise, since individuals exposed to a given strategy may differ from those who are not.

In this regard, Propensity Score Matching (PSM) helps address these limitations by estimating the probability of receiving treatment based on observable characteristics and then matching individuals with similar propensity scores, thereby enabling more balanced comparisons. From a statistical perspective, PSM mitigates selection bias in observable variables by comparing outcomes between groups with similar profiles, even when the treatment has not been randomly assigned (Wang, 2021). Consequently, marketing metrics and matching methods have become an established approach for causal inference, supporting a growing body of research across fields such as agricultural economics, behavioral sciences, business, and medicine (Clavijo, 2022; Hernández-Medina et al., 2024).

Against this backdrop, this paper aims to present the results of a scientometric study on PSM and marketing. To ensure transparency and reproducibility, elements of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement were applied (Haddaway et al., 2022). Data were collected and systematized from the Web of Science (WOS) and Scopus databases and subsequently analyzed using a combination of software and scientometric tools, including Bibliometrix, Tree of Science, and Gephi.

The article contributes to the marketing field in two main ways. First, it offers a novel perspective, as no prior studies or reviews have examined the use of PSM in marketing from a scientometric standpoint using the tools applied here. Second, it helps identify the main research perspectives, as well as the strategies employed to assess impact within the field.

The rest of the paper is organized as follows. Section 2 outlines the methodology, detailing the procedures and tools used for data processing. Section 3 presents the results, including the scientific mapping, the Tree of Science for this research area, and the three main research perspectives identified. Finally, Sections 4 and 5 present the discussion and the main conclusions, respectively.

2. METHODOLOGY

The methodological approach was structured in two stages. The first stage, focused on scientific mapping, began—following the guidelines proposed by Moyano-Londoño and Marín-Cardona (2024)—with the design and implementation of a search strategy in Scopus and WOS. These databases were chosen due to their broad thematic coverage, quality, scientific rigor, and strong bibliometric traceability. Subsequently, the search process led to the identification and retrieval of

417 documents, which were selected based on a set of inclusion and exclusion criteria. Table 1 summarizes the main search parameters used in this study.

Table 1. Search strategy

Tabla 1. Parámetros de búsqueda

Parameters	Scopus	Web of Science
Search strategy	("marketing" OR "digital marketing" OR "consumer behavior") AND ("propensity score" OR "propensity score matching" OR "propensity score analysis")	
Search date	February 11, 2025	
Period analyzed	1999–2025	
Document type	Articles, review papers	
Journal type	All types	
Search fields	Title, abstract, keywords	
Initial results	325	291
Final results	417	

Source: Authors' own work.

More specifically, the search strategy—run on February 11, 2025—initially identified 325 documents in Scopus and 291 in WOS. The period analyzed, spanning from 1999 to 2025, was defined by considering, on the one hand, the emergence of the earliest publications in the field and, on the other, the year in which this study was conducted. This approach ensures a comprehensive and up-to-date overview of the literature. For both databases, the search was limited to the title, abstract, and keywords fields. In addition, inclusion and exclusion criteria included the removal of duplicate records and the selection of documents based on type (articles and review papers), relevance to the field of study, and availability (open access). As a result, a final sample of 417 records was obtained.

Furthermore, to guarantee the reproducibility and transparency of the research process, elements of the PRISMA 2020 statement (Haddaway et al., 2022) were adopted as a guiding framework for academic rigor. In particular, this supported the documentation of the search strategies, the use of specific fields and terms, and the application of inclusion and exclusion criteria. Figure 1 illustrates the PRISMA flowchart for this study.

Once the 417 records had been selected, two files containing the full bibliographic information—a .txt file and a .bib file—were exported from Scopus and WOS. These files were then uploaded and processed in Bibliometrix, a scientometric tool developed by Aria and Cuccurullo (2017). This software enables, among other functions, the analysis of scientific growth in a field, the identification of the most productive authors and countries, the mapping of global collaboration networks, the exploration of thematic structures, and the detection of the most relevant publications (Alzate et al., 2024; Moyano Londoño, 2022). These dimensions were examined in the present study to characterize research on PSM and marketing.

The second stage of the methodology centered on constructing the Tree of Science and identifying the main research perspectives, or clusters. The Tree of Science is a methodological approach that organizes bibliographic information using a tree-like structure. In this framework, seminal works are placed in the roots, structural studies in the trunk, and research subfields in the leaves (Robledo et al., 2024; Ruiz et al., 2023). In addition to streamlining the selection of documents based on citation

levels (Duque & Díaz, 2024), this approach supported a narrative analysis that helped trace the epistemological development of the field of PSM and marketing.

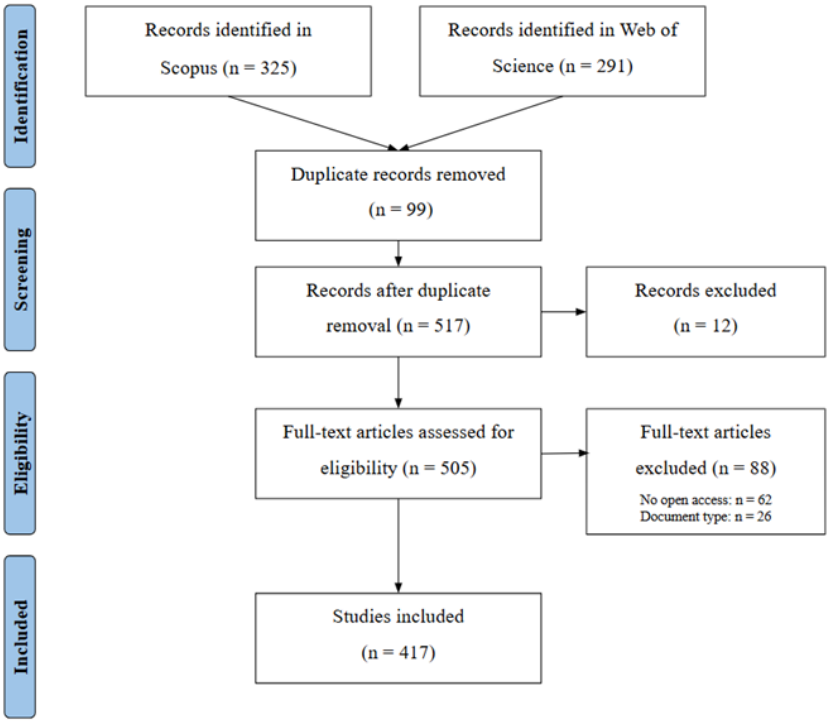

Figure 1. PRISMA flowchart
Figura 1. Diagrama de flujo de la declaración PRISMA
Source: Authors' own work based on Haddaway et al. (2022).

Finally, research perspectives were identified through the construction of a bibliographic network, which was subsequently analyzed using Gephi, a software tool designed for the visualization of co-citation networks (Bastian et al., 2009). This process allowed for the organization of the collected data and, by examining the nodes and the connections among the articles, made it possible to detect research communities or clusters. This step, in turn, provided a clearer understanding of how knowledge in this field has evolved over time.

3. RESULTS

Scientific Mapping

The evolution of scientific output in the topics examined in this scientometric study is presented in Figure 2. As shown, the field has experienced steady growth over time, with a particularly marked increase beginning in 2012. Notably, 2024 stands out as the year with the highest number of publications, totaling 56. Moreover, the analysis of publication trends made it possible to identify several key patterns. Among these, it revealed an annual growth rate of 10.03%. In addition, a substantial share of the literature—75.3% of all studies—was published between 2017 and 2025 (up to February 11, the cutoff date for this study).

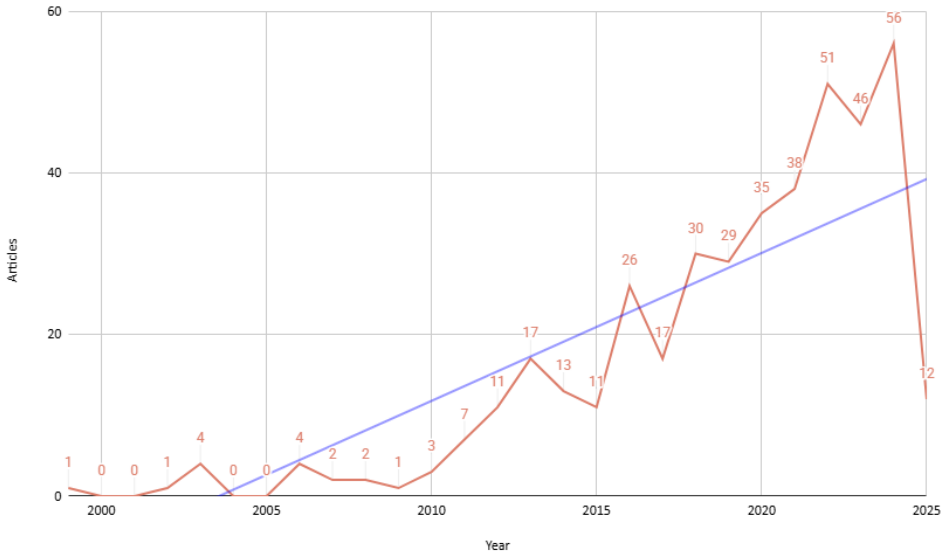

Figure 2. Evolution of publication volume in the field
Figura 2. Evolución del número de publicaciones en el área
Source: Authors' own work.

At the country level, the United States leads by a wide margin, with a total of 130 publications. It is followed by China and Germany, with 63 and 28 studies, respectively. Together, these three countries account for 53% of global scientific output in this field. The top five is completed by Japan (20 publications) and Italy (15). In Latin America, Brazil is the leading contributor, with three publications identified. Figure 3 depicts a global heat map illustrating the countries with the highest number of publications in this field.

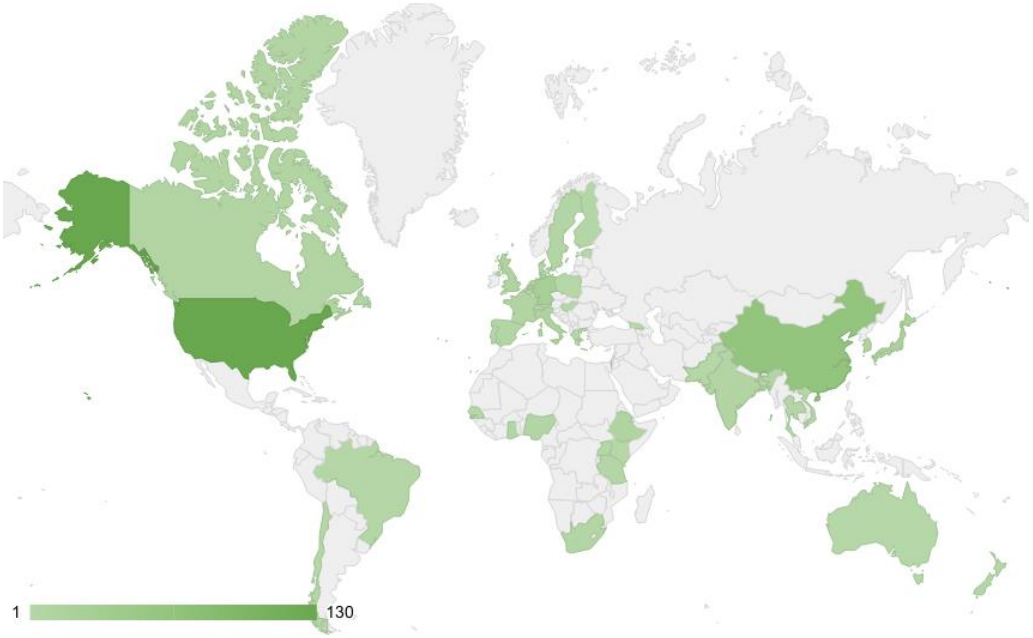

Figure 3. Countries with the highest number of publications
Figura 3. Países con mayor número de publicaciones
Source: Authors' own work.

Identifying the most productive authors in the field was also an important component of this study. As shown in Table 2, Schneeweiss S emerges as the leading contributor, with a total of 10 publications and 456 citations. He is followed by Gagne J and Rassen J, who have 7 and 5 publications, and 247 and 22 citations, respectively. In addition, Table 2 presents several bibliometric indicators that help assess the impact of scientific output. These include the H-index, G-index, and M-index, which measure, respectively, overall publication impact, highly cited works, and the relationship between citation count and the length of an author's research career. The table also reports the year in which each author began publishing.

Table 2. Authors with the highest number of publications

Tabla 2. Autores con mayor número de publicaciones

No.	Author	NP	TC	H-index	G-index	M-index	PYS
1	Schneeweiss S	10	456	9	10	0.4736842105	2007
2	Gagne J	7	247	7	7	0.4666666667	2011
2	Rassen J	5	222	5	5	0.3125	2010
4	Wang S	5	142	5	5	0.625	2018
5	Galgani S	4	165	4	4	0.2857142857	2012
6	Gasperini C	4	165	4	4	0.2857142857	2012
7	Prosperini L	4	165	4	4	0.2857142857	2012
8	Wang R	4	644	4	4	0.3636363636	2015
9	Wang X	6	57	4	6	0.3333333333	2014
10	Xu Y	6	72	4	6	0.4	2016

NP: Number of publications; TC: Total of citations; PYS: Publication year start.

Source: Authors' own work.

Table 3, for its part, lists the institutional affiliations associated with the highest number of publications in this field. With the exception of Capital Medical University (China) and Karolinska Institutet (Sweden), all institutions in the ranking are based in the United States, which evidences the dominant role of this country in the production of research on this topic.

Table 3. Institutional affiliations with the highest number of publications

Tabla 3. Afiliaciones institucionales con mayor número de publicaciones

No.	Affiliation	Publications	Country
1	Harvard University	77	United States
2	Capital Medical University	15	China
2	Brigham and Women's Hospital	13	United States
4	University of California	13	United States
5	University of Washington	13	United States
6	Us Food and Drug Administration	13	United States
7	University of North Carolina at Chapel Hill	12	United States
8	Karolinska Institutet	10	Sweden
9	Northwestern University	10	United States
10	University of California	10	United States

Source: Authors' own work.

United States' strong presence in the field is also reflected in the journals that most frequently publish research in this area. Table 4 shows the scientific journals with the highest number of publications, with eight of the top ten journals based in the United States. The exceptions are *Pharmacoepidemiology and Drug Safety* and *Sustainability*, published in the United Kingdom and

Switzerland, respectively, each with six articles. The ranking, however, is led by *PLOS One*, a Q1 journal with an H-index of 435, which accounts for 12 publications. It is followed by the *Journal of Marketing* and *Marketing Science*, with 10 publications each and H-indices of 284 and 153, respectively. In addition, Table 4 reveals that, with the exception of the *Journal of Biopharmaceutical Statistics* (Q2), all journals in the ranking are classified within the top quartile (Q1).

Table 4. Journals with the highest number of publications

Tabla 4. Revistas científicas con mayor número de publicaciones

No.	Journal	Publications	Quartile	H-index	Country
1	*PLOS One*	12	Q1	435	United States
2	*Journal of Marketing*	10	Q1	284	United States
2	*Marketing Science*	10	Q1	153	United States
4	*Journal of Business Research*	7	Q1	265	United States
5	*Pharmacoepidemiology and Drug Safety*	6	Q1	109	United Kingdom
6	*Sustainability*	6	Q1	169	Switzerland
7	*Information Systems Research*	5	Q1	185	United States
8	*Journal of Biopharmaceutical Statistics*	5	Q2	56	United States
9	*Journal of the Academy of Marketing Science*	5	Q1	207	United States
10	*Management Science*	5	Q1	290	United States

Source: Authors' own work.

The bibliometric analysis also made it possible to identify the most highly cited documents in the field of marketing and PSM. The most cited article is "Estimation and Inference of Heterogeneous Treatment Effects Using Random Forests" by Wager and Athey (2018), published in the *Journal of the American Statistical Association*, with a total of 732 citations. The second most cited study is "From Social to Sale: The Effects of Firm-Generated Content in Social Media on Customer Behavior" by Kumar et al. (2016), published in the *Journal of Marketing*, with 575 citations. Third place is held by "Linking Smallholders to Markets: Determinants and Impacts of Farmer Collective Action in Kenya" by Fischer and Qaim (2012), published in *World Development,* with 452 citations.

Overall, the most-cited papers—as observed in Figure 4—tend to focus on topics such as consumer behavior in marketing contexts, online shopping, the evaluation of advertising campaign effectiveness, the use of personalized recommendations, and the analysis of data derived from social media, transactions, and surveys.

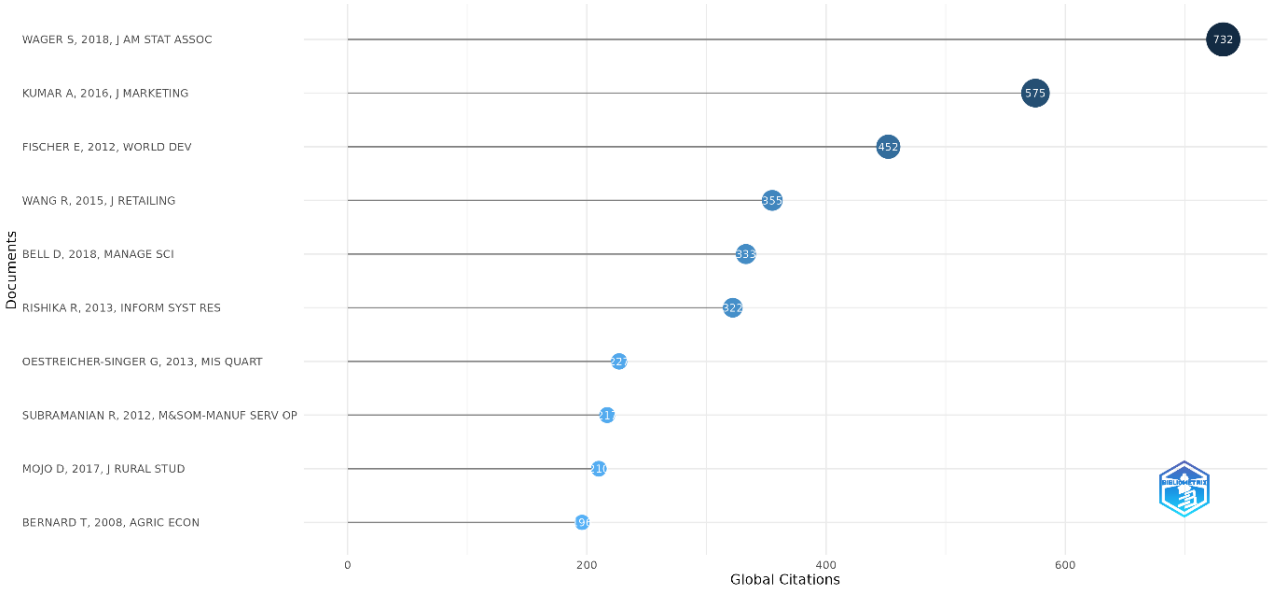

Figure 4. Most cited documents globally
Figura 4. Documentos más citados globalmente
Source: Authors' own work based on Aria and Cuccurullo (2017).

Figure 5, for its part, depicts the main global collaboration networks. The United States ranks first, with research partnerships involving 26 countries, followed by the United Kingdom and Germany, with 17 and 15 international collaborations, respectively. Notably, the United States maintains strong collaborative ties with countries such as China (11 collaborations), the United Kingdom (10), Germany (9), and Canada (8). Germany also shows significant cooperation with the Netherlands (7), the United Kingdom (5), and Canada (5). In total, the analysis identified 143 collaboration networks.

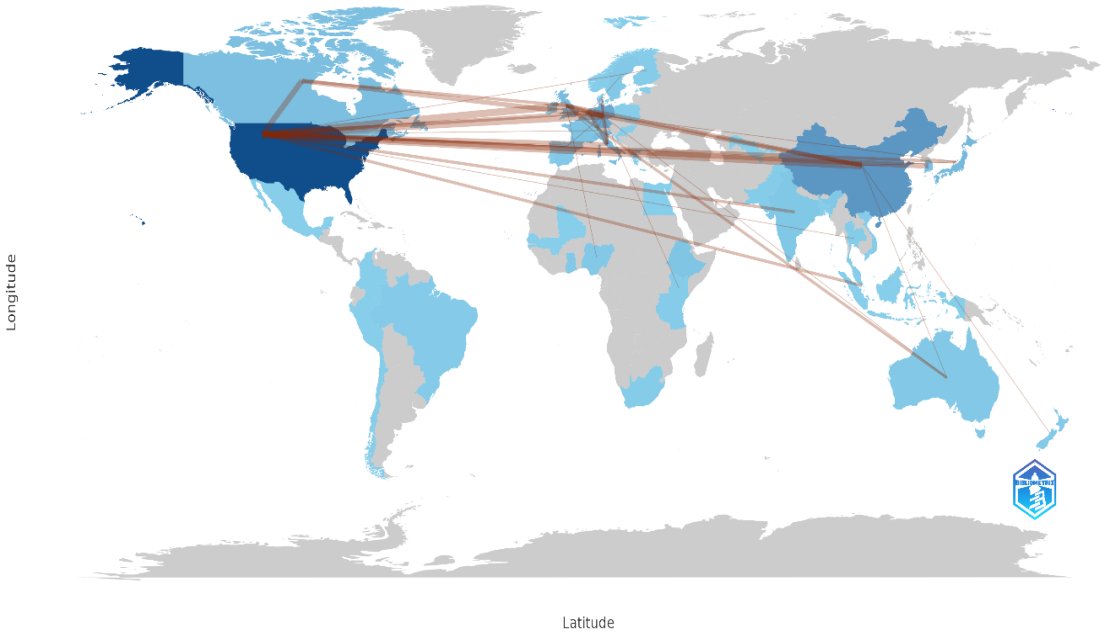

Figure 5. Global collaboration map
Figura 5. Mapa mundial de colaboraciones
Source: Authors' own work based on Aria and Cuccurullo (2017).

Figure 6 presents the thematic map of this field of study. The map is organized into four quadrants, which classify research topics according to their level of development and relevance. Specifically, topics are categorized as emerging or declining themes (low development and low relevance), niche themes (high development but low relevance), basic themes (high relevance but low development), and motor themes (both highly developed and highly relevant).

The analysis shows that the most prominent motor themes are those related to risk marketing and consumer behavior. For their part, key niche themes include information systems and the combination of marketing strategies. Regarding basic themes, e-commerce and consumption models stand out as central. Finally, emerging themes are primarily associated with outcomes in healthcare marketing.

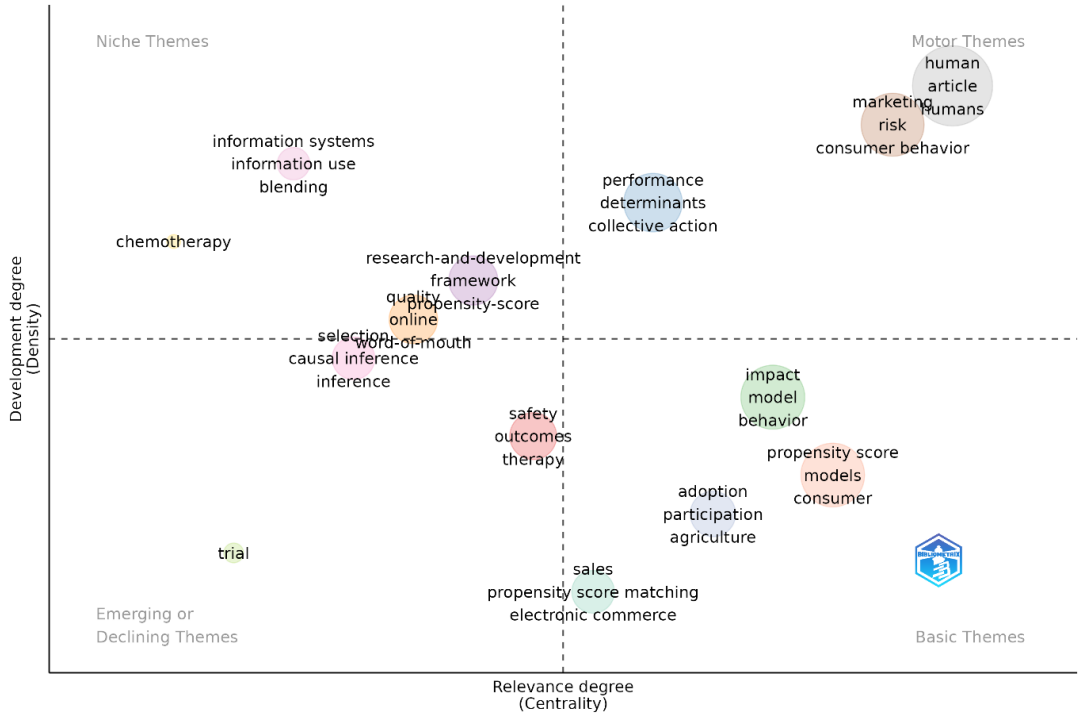

Figure 6. Thematic map

Figura 6. Mapa temático

Source: Authors' own work based on Aria and Cuccurullo (2017).

Propensity Score Matching (PSM)

PSM is an econometric technique used to estimate the impact of interventions in settings where an experimental control group is not available. When assessing the effect of a given measure—such as a social program, medical treatment, or advertising campaign—on a specific outcome (e.g., an economic indicator, a health condition, or company sales), it is not enough to simply compare those who received the intervention with those who did not. The two groups may differ substantially from the outset.

Under ideal conditions, causal relationships are identified through randomized experiments. However, implementing such designs in real situations is often difficult due to ethical, logistical, or financial constraints. To address this challenge, Rosenbaum and Rubin (1985) proposed an approach

that approximates the logic of a randomized experiment. They used the PSM, which estimates the probability that individuals with similar characteristics receive a given treatment and then compares outcomes between those who did and those who did not.

Given its versatility, PSM was initially widely adopted in the field of medicine, where it has been applied to evaluate the long-term effects of specific medications (Fu et al., 2006; Oberlander et al., 2006) and to examine the impact of interventions on hospital costs (Penrod et al., 2006). The method has also become well established in the social sciences, with numerous studies assessing the effects of social programs (Adimassu & Kessler, 2015; Admassie et al., 2009; Byun et al., 2015) and analyzing the consequences of behavioral patterns (Harknett, 2006; He and Meng, 2023; Jones & Richmond, 2006).

In the field of marketing, PSM is frequently used to evaluate the effectiveness of commercial strategies, loyalty programs, advertising campaigns, and segmentation decisions. This is particularly relevant when working with data from Customer Relationship Management (CRM) systems, digital platforms, or transactional databases. In such cases, results are obtained by comparing the performance of a group exposed to a marketing intervention with that of a matched control group, constructed to ensure similarity in observable characteristics.

Nevertheless, it is important to note that PSM presents several methodological challenges that may affect the results. These include the presence of unobserved factors, imperfect matching, potential loss of information during the matching process, and the need for large sample sizes (Pan & Bai, 2018). In this regard, Rubin (2009) argues that reasonably reliable causal estimates can still be achieved, provided that observable variables are carefully controlled for and that alternative matching techniques are employed as part of robustness checks.

Marketing Analysis

Marketing, as it is understood today, has evolved into a strategic discipline focused on meeting consumer needs and creating value within an increasingly digital environment. In this context, González-Ferriz (2024) introduced the concept of Marketing 5.0, which integrates technological advances—such as data analytics and artificial intelligence—into the field. These tools make it possible to better understand and anticipate consumer preferences and trends, thereby enabling more personalized and human-centered interactions. This perspective is further supported by Gómez-Bayona and Arrubla-Zapata (2020), who emphasized the importance of building stronger relationships with consumers through the consistent delivery of superior value. Such an approach requires continuous adaptation to the technological and social changes that directly impact consumer behavior.

From an institutional standpoint, marketing emerges as a set of activities aimed at facilitating value exchange between organizations and their target audiences. Jaramillo Luzuriaga and Hurtado Cuenca (2021) highlight that marketing is directly linked to product development, pricing decisions, distribution through channels aligned with consumer needs, and the selection of promotional—or more broadly, communication—strategies to ensure clarity. All of these efforts are ultimately directed toward satisfying consumer needs in an efficient and profitable manner. Moreover, Geiger and Kjellberg (2021) argue that strategic marketing demands a deep understanding of the competitive environment, as well as the ability to adapt organizational strategies in order to sustain relevance and maintain a competitive advantage in highly dynamic markets.

In this sense, marketing is a discipline that makes a direct contribution to scientific research, as it facilitates a better understanding of consumer behavior and promotes and projects effective strategies. As noted by Skålén et al. (2022), analyzing consumer behavior allows organizations to identify purchasing patterns, preferences, and underlying motivations, which are essential for developing offers that resonate with target audiences. Similarly, Grönroos (2023) emphasizes the growing importance of data analysis in decision-making within modern markets, enabling firms to make more informed choices, tailor customer experiences, strengthen loyalty, and ultimately foster sustained growth over time.

Within this framework, PSM has become a valuable methodological tool for enhancing rigor in studies of consumer behavior and for more accurately assessing the effectiveness of marketing strategies in non-experimental settings (Goldfarb et al., 2022). In practice, the allocation of strategies—such as promotions, digital campaigns, or loyalty programs—is rarely random. Instead, it is typically influenced by consumer characteristics, including purchase history, income level, or prior loyalty.

As a result, when an increase is observed in variables of interest such as sales or purchase frequency, it is difficult to attribute this change solely to the implemented campaign, since consumers' traits may also play a role in this behavior. In this context, PSM estimates the probability that each individual receives a given intervention based on observable variables and then matches consumers with similar propensity scores, allowing for more balanced comparisons. In doing so, this empirical approach helps reduce bias and provides more reliable assessments of the impact of such actions (Ongsakul et al., 2022).

Tree of Science

The Tree of Science was constructed following the methodology described by Duque and Díaz (2024). In this case, the tree representing the research field that links PSM with marketing comprises a total of 80 documents. Of these, 10 were classified as roots, 10 as trunk, and 60 as leaves. Table 5 summarizes the key contributions within each section of the tree.

Table 5. Tree of Science
Tabla 5. Árbol de la ciencia

Section of the tree	Title of document	Focus
Root	The central role of the propensity score in observational studies for causal effects (Rosenbaum & Rubin, 1983).	To introduce PSM as a method to control selection bias in studies.
	Some Practical Guidance for the Implementation of Propensity Score Matching (Caliendo & Kopeinig, 2008).	To examine key implementation challenges associated with PSM as an evaluation tool.
	Propensity Score-Matching Methods for Nonexperimental Causal Studies (Dehejia & Wahba, 2002).	To analyze PSM's application in non-experimental causal studies.
	Constructing a Control Group Using Multivariate Matched Sampling Methods That Incorporate the Propensity Score (Rosenbaum & Rubin, 1985).	To integrate PSM with multivariate matching techniques.
	Does matching overcome LaLonde's critique of nonexperimental estimators? (Smith & Todd, 2005).	To explore PSM as an econometric approach.

Section of the tree	Title of document	Focus
Trunk	Can Marketing Campaigns Induce Multichannel Buying and More Profitable Customers? A Field Experiment (Montaguti et al., 2015).	To incorporate PSM to evaluate the effectiveness of four marketing campaigns.
	Device Switching in Online Purchasing: Examining the Strategic Contingencies (de Haan et al., 2018).	To identify how product risk influences online purchasing behavior using PSM.
	Linking Smallholders to Markets: Determinants and Impacts of Farmer Collective Action in Kenya (Fischer & Qaim, 2012).	To assess the impacts and determinants of cooperative organizations through the application of PSM.
	Growing Existing Customers' Revenue Streams through Customer Referral Programs (Garnefeld et al., 2013).	To evaluate customer loyalty and retention, as well as recommendation programs.
	From Social to Sale: The Effects of Firm-Generated Content in Social Media on Customer Behavior (Kumar et al., 2016).	To examine the effects of firm-generated content on social media platforms.
Leaves	Methods for Causal Inference in Marketing (He & Rao, 2024).	To establish causal relationships between marketing variables and outcome measures such as sales.
	Influence of mobile phone and internet technology on income of rural farmers: Evidence from Khyber Pakhtunkhwa Province, Pakistan (Khan et al., 2022).	To assess the role of mobile and internet technologies in shaping sales productivity and the selection of distribution channels.
	Agrifood system participation and production efficiency among smallholder vegetable farmers in Northern Ghana (Abdul-Rahaman et al., 2023).	To investigate the impact of participation in an agri-food system.
	Poverty Reduction Effect of New-Type Agricultural Cooperatives: An Empirical Analysis Using Propensity Score Matching and Endogenous Switching Regression Models (Hu et al., 2021).	To analyze the involvement of low-income households in emerging forms of agricultural cooperatives.
	Design and Evaluation of Optimal Free Trials (Yoganarasimhan et al., 2022).	To explore the impact of free trial duration as a customer acquisition strategy in the software industry.

Source: Authors' own work.

Root

The studies classified at the root level focus on the methodological foundations used to estimate causal effects. For instance, Rubin (1974) demonstrated that impact estimation for treatment groups does not necessarily require random assignment; rather, with appropriate controls, it is possible to approximate the conditions of treatment groups. In this same vein, Rosenbaum and Rubin (1983) discussed the role of propensity scores in reducing selection bias in non-randomized settings. They later introduced the concept of *matching* as a strategy to identify a control group comparable to the treatment group based on the distribution of observed covariates (Rosenbaum & Rubin, 1985). From a more econometric perspective, however, Heckman et al. (1998) argued that PSM is not always the

most efficient estimator and proposed both parametric and nonparametric approaches as alternatives for estimating treatment effects.

Over time, as PSM became more widely adopted—particularly with its implementation in statistical software such as Stata—authors like Angrist and Pischke (2009) and Becker and Ichino (2002) emphasized that the effectiveness of bias reduction depends on the quality of the control variables included in the model. Likewise, Dehejia and Wahba (2002) expanded its scope by showing that PSM can also be successfully applied to non-experimental data, even when a limited number of comparison units is available. In addition, Smith and Todd (2005) and Stuart (2010), provided comprehensive reviews of the methodological evolution of PSM. They also outlined methodological advances, including diagnostic tools to assess model specification, criteria for selecting appropriate matching methods, and strategies for handling missing data in key covariates.

Trunk

Within the trunk of the tree, several studies can be identified that highlight the diverse directions marketing has taken. For instance, research by Montaguti et al. (2015) and Rishika et al. (2012) examined the impact of multichannel marketing and customer engagement on social media. These studies show how such strategies can enhance profitability while bringing forward the economic, accounting, and managerial dimensions that define marketing as a discipline. Similarly, de Haan et al. (2018) demonstrated how shifts in consumer behavior, from a digital standpoint, are opening new avenues for understanding the real conversion impact of marketing strategies. At the same time, this work shed light on the challenges associated with loyalty programs. In this context, the study by Mojo et al. (2017) further underscored the impact and importance of designing loyalty and recommendation strategies that align with consumer needs and with the organization's core mission and objectives.

Leaves

The literature located in the leaves of the tree primarily applies PSM to address causal issues across a range of contexts. For example, the study by He and Rao (2024) sought to establish causal relationships between marketing variables and organizational outcomes such as sales and profits. Likewise, Yoganarasimhan et al. (2022) explored, within the software industry, how the duration of free trials influences customer acquisition, retention, and profitability. In a related vein, Langen and Huber (2023) evaluated the impact of coupon campaigns on sales while also using machine learning techniques to identify more effective marketing strategies.

In addition, this section of the tree includes studies such as that of Kuang et al. (2019), which, although focused on the theory and practice of causal effect estimation, was not tied to a specific application context. This contrasts with the work of Gubela et al. (2024), who using a comparative approach to examine return on marketing investment, concentrated on causal models to estimate the effects of promotional and digital marketing campaigns.

Moreover, a number of studies show an interest in the agricultural sector. For instance, Tsai and Luh (2023) analyzed diverse agricultural organizations in terms of social capital and income growth. Similarly, Dagnew et al. (2024) investigated how contractual arrangements affect farmers' productive

and economic efficiency. Along the same lines, Dey and Singh (2025) used PSM to explore how market participation shapes the income and consumption patterns of small-scale rice producers in India.

Research Perspectives

The research perspectives were derived from the analysis of co-citation networks using Gephi, an open-source platform developed by Bastian et al. (2009). Through this approach, a network comprising 1,442 nodes (individual studies) and 3,781 edges (connections between documents) was examined. This process made it possible to identify three main research perspectives or clusters. Figure 7 presents the procedure followed to define these three perspectives.

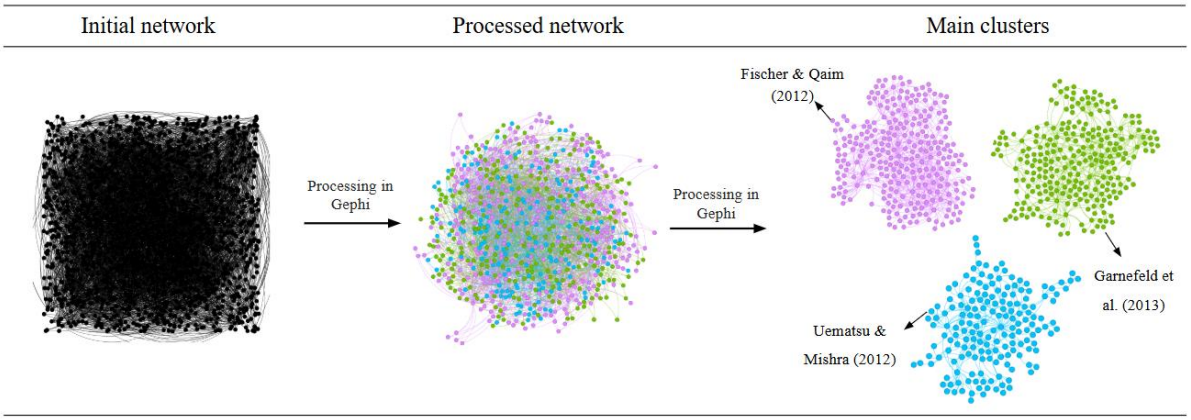

Figure 7. Network processing and clustering
Figura 7. Procesamiento de la red y los clústeres
Source: Authors' own work.

Perspective 1: Impact Measurement

Literature within this first perspective focuses on measuring the effects of, for instance, marketing contracts on key outcomes such as income, crop productivity, and food security among small-scale farmers. In this context, studies by Ganewo et al. (2022), Ma and Abdulai (2016), and Soullier and Moustier (2018) applied PSM as a causal inference strategy. This approach helps address selection bias arising from the non-random nature of contract participation, either due to firms' choice or farmers' own decisions.

Within the same cluster, other contributions were identified, including those by Adetoyinbo and Otter (2022), Dagnew et al. (2024), and Liang et al. (2023), which employed technical efficiency as the outcome variable. This variable makes it possible to assess whether marketing contracts enhance production efficiency, particularly through the diffusion of technologies.

Finally, the remaining studies in this group address issues such as the efficiency of marketing channels (Biggeri et al., 2022; Dey & Singh, 2025; Eresso & Tefera, 2025), the impact of collective action on smallholder economies (Tsai & Luh, 2023), and household poverty (Biggeri et al., 2022; Dey & Singh, 2025; Eresso & Tefera, 2025).

Perspective 2: Consumer Behavior and Business Planning

Research in the second cluster examines the relationship between consumer behavior in real-world settings and business planning. In this context, PSM serves not only to assess customer loyalty in relation to both consumers and competitors, but also to evaluate performance in line with organizational objectives and market dynamics. Together, these factors shape the outcomes of strategic initiatives in a global environment.

More specifically, this body of work highlights gaps in the use of loyalty programs, recommendation systems, and social media as mechanisms to strengthen customer retention (Dagnew et al., 2024). At the same time, it underscores the role of digitalization as a key driver of differentiation and competitiveness, particularly in improving profitability while reducing costs (Dagnew et al., 2024).

Another aspect emerging from this cluster is the central role of PSM in data-driven decision-making. By applying this method, organizations are better positioned to make more efficient choices (Dagnew et al., 2024). In this context, several studies point to the expansion of retail marketing channels, affecting the entire marketing chain, including suppliers and traditional competitors (Dehejia & Wahba, 2002).

Perspective 3: Effect Evaluation

Studies in the third cluster centered on the use of mathematical models, regression analysis, and PSM to evaluate how specific actions or decisions affect key outcomes, such as revenue, efficiency, compliance, and overall business performance. For instance, Arneja and Sharma (2024), drawing on panel data from Indian firms, showed that export-driven costs in marketing, research, and development have a positive effect on firm performance.

A comparable approach is taken by Ieva et al. (2022), who conducted an experiment with more than 9,000 loyalty program members and found that distributing and reading advertising brochures does not significantly influence purchasing behavior. For their part, Ge et al. (2017) reported that social deterrence (through social media) is associated with a lower loan default rate, while also increasing the likelihood that borrowers may default.

In general, this research perspective brings together studies that rely on quantitative methods to assess the effects of managerial decisions and related aspects. Beyond the examples above, it also includes work by Liu and Roehl (2025), who explored how combining virtual tours with in-person experiences shapes customer satisfaction, and by Chi et al. (2022), who analyzed the causal effects of tourist visa exemption policies on international tourists arrivals to member countries of the Organization for Economic Co-operation and Development (OCDE).

4. DISCUSSION

The results of the scientific mapping indicate that research on on PSM in marketing has grown notably in recent years. This is especially evident in countries such as the United States, China, and Germany, which have produced the largest number of publications. Even so, research activity remains highly concentrated in the United States. In fact, this country alone contributes nearly 32%

of the total output, leading both the ranking of the most productive institutions—eight of the top ten are U.S.-based—and the list of journals with the highest number of publications in this field—eight of the top ten are also U.S.-based. Furthermore, the use of Bibliometrix revealed that the United States has the highest level of international collaboration (81 collaborations), reinforcing its central role in this field.

In parallel, the Tree of Science analysis shows that seminal research primarily focused on the theoretical and methodological foundations of PSM. Studies such as those by Smith and Todd (2005) and Stuart (2010) illustrate how the technique developed in its initial stages. Meanwhile, structural research has tended to examine issues such as customer participation and behavior on digital platforms, as seen in Montaguti et al. (2015) and Rishika et al. (2012). More recent work, including studies by Dagnew et al. (2024), Dey and Singh (2025), and Tsai and Luh (2023), has centered on applications of PSM within marketing contexts.

Furthermore, the use of Gephi—a software tool for processing co-citation networks—made it possible to identify three main research perspectives, or clusters, within the field of PSM in marketing. The first, primarily oriented toward impact measurement, highlights how PSM functions as a key tool for evaluating, for example, the effectiveness of campaigns and communication channels. The second cluster centers on the analysis of consumer behavior, emphasizing the role of digitalization and digital transformation as important drivers of differentiation and competitiveness. Finally, the third perspective focuses on assessing managerial, commercial, and decision-making outcomes.

Overall, the findings presented in the results section suggest that, in recent years, the scientific community has increasingly turned its attention to exploring the applications and benefits of PSM in marketing. This trend carries practical implications, particularly in areas such as resource optimization, the control of selection bias, and the estimation of causal effects in marketing strategies and campaigns. In addition, future research could further examine how PSM can be integrated into marketing practice to support more evidence-based decision-making and enable more precise segmentation, including the comparison and evaluation of more effective strategies.

5. CONCLUSIONS

The scientometric analysis and the use of tools such as Bibliometrix, Tree of Science, and Gephi provided a comprehensive view of the current state, perspectives, and trends in research in PSM in marketing. This method has proven to be key for impact evaluation, particularly in contexts where random assignment is not feasible. According to the findings, its cross-cutting application in the identified clusters helps reduce selection bias and supports more robust causal inferences in studies of consumer behavior, organizational management, and rural development.

Additionally, the results show a steady increase in scientific output over time, with a marked rise beginning in 2012 and a peak in 2024. This growth reflects sustained academic and research interest, largely driven by leading contributors such as the United States, China, and Germany, which together account for 53% of global production. Such concentration points to strong institutional capacity for knowledge generation in this field, with prominent universities—such as Harvard—and various research centers contributing to the literature.

An analysis of collaboration networks—including those based on the most-cited publications—revealed a high level of interconnection within the field, with the United States emerging as the main global hub for collaboration. Also, the thematic map indicates that the motor themes are largely associated with risk-related marketing and consumer behavior, while niche themes tend to focus on the combination of marketing strategies with information systems.

With regard to the Tree of Science algorithm, its application made it possible to distinguish three key layers of the literature: the methodological foundations of PSM as a causal inference strategy (root), the analysis of multichannel marketing campaigns and behavior on digital platforms (trunk); and recent applications focused on evaluating marketing strategies (leaves). In parallel, the use of Gephi enabled the identification of three main research clusters: the first centers on measuring the economic and social impact of agricultural and commercial contracts; the second examines consumer behavior as a basis for strategic planning; and the third focuses on assessing managerial and commercial outcomes.

Finally, based on the analysis conducted in this study, it can be concluded that PSM—beyond its original applications in the medical and social sciences—is increasingly being adopted as a key tool for evaluating marketing strategies. This methodological expansion underscores its strength as a robust approach to causal inference across a range of research contexts. At the same time, it reflects the growing interest in marketing as a more rigorous, evidence-based discipline that contributes to business decision-making from a scientific perspective.

CONFLICTS OF INTEREST

The authors declare no financial, professional, or personal conflicts of interest that could have inappropriately influenced the results or interpretations presented in this study.

AUTHOR CONTRIBUTIONS

All authors made a substantial contribution to the development of this article, as outlined below:

Gabriel Antonio Moyano Londoño: data curation, formal analysis, methodology, writing.

Jhon Edwar Hernández Ocampo: conceptualization, investigation, writing, visualization.

Mario Andrés Pava Idárraga: conceptualization, investigation, writing, visualization.

REFERENCES

Abdul-Rahaman, A., Issahaku, G., y Ma, W. (2023). Agrifood system participation and production efficiency among smallholder vegetable farmers in Northern Ghana. *Agribusiness*, *39*(3), 812-835. https://doi.org/10.1002/agr.21793

Adetoyinbo, A., y Otter, V. (2022). Can producer groups improve technical efficiency among artisanal shrimpers in Nigeria? A study accounting for observed and unobserved selectivity. *Agricultural and Food Economics*, *10*(1), art. 10. https://doi.org/10.1186/s40100-022-00214-x

Adimassu, Z., y Kessler, A. (2015). Impact of the productive safety net program on farmers' investments in sustainable land management in the Central Rift Valley of Ethiopia. *Environmental Development*, *16*(1-2), 54-62. https://doi.org/10.1016/j.envdev.2015.06.015

Admassie, A., Abebaw, D., y Woldemichael, A. D. (2009). Impact evaluation of the Ethiopian health services extension programme. *Journal of Development Effectiveness*, *1*(4), 430-449. https://doi.org/10.1080/19439340903375724

Alzate, P., Moyano Londoño, G. A., Slater Carrasco, J. M., Isaza, G. A., Toro, E. M., y Jaramillo-Garzón, J. A. (2024). Scientific mapping and research perspectives of the vehicle routing problem: An approach from sustainability strategies. *Sustainable Futures*, *8*(3), art. 100390. https://doi.org/10.1016/j.sftr.2024.100390

Angrist, J. D., y Pischke, J.-S. (2009). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.

Aria, M., y Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, *11*(4), 959-975. https://doi.org/10.1016/j.joi.2017.08.007

Arneja, N., y Sharma, C. (2024). Dissecting performance gains from export-induced marketing and technological investments: Revisiting learning by exporting in Indian manufacturing. *The Quarterly Review of Economics and Finance*, *97*(6), art. 101886. https://doi.org/10.1016/j.qref.2024.101886

Bastian, M., Heymann, S., y Jacomy, M. (2009). Gephi: An Open Source Software for Exploring and Manipulating Networks. *Proceedings of the International AAAI Conference on Web and Social Media*, *3*(1), 361-362. https://doi.org/10.1609/icwsm.v3i1.13937

Becker, S. O., y Ichino, A. (2002). Estimation of Average Treatment Effects Based on Propensity Scores. *The Stata Journal*, *2*(4), 358-377. https://doi.org/10.1177/1536867X0200200403

Biggeri, M., Carraro, A., Ciani, F., y Romano, D. (2022). Disentangling the impact of a multiple-component project on SDG dimensions: The case of durum wheat value chain development in Oromia (Ethiopia). *World Development*, *153*(6236), art. 105810. https://doi.org/10.1016/j.worlddev.2021.105810

Byun, S. Y., Irvin, M. J., y Bell, B. A. (2015). Advanced math course taking: Effects on math achievement and college enrollment. *Journal of Experimental Education*, *83*(4), 439-468. https://doi.org/10.1080/00220973.2014.919570

Caliendo, M., y Kopeinig, S. (2008). Some practical guidance for the implementation of propensity score matching. *Journal of Economic Surveys*, *22*(1), 31-72. https://doi.org/10.1111/j.1467-6419.2007.00527.x

Chae, I., Ha, J., y Schweidel, D. A. (2022). Paywall Suspensions and Digital News Subscriptions. *Marketing Science*, *42*(4), 729-745. https://doi.org/10.1287/mksc.2022.1400

Chi, P. Y., Lee, K. C., y Chang, K. I. (2022). Causal effect of tourist visa exemption schemes on international tourist arrivals. *Economic Analysis and Policy*, *75*, 427-449. https://doi.org/10.1016/j.eap.2022.06.003

Clavijo, A. (2022). Productividad agraria en Bolivia: evaluación de impacto del crédito y asistencia técnica mediante Propensity Score Matching. *ARU Search*, *1*(1), 135-164. https://www.aru.org.bo/journalaru/index.php/arusearch/article/view/9

Dagnew, A., Goshu, D., Zemedu, L., y Sileshi, M. (2024). Impact of contract farming participation on the economic efficiency of malt barley farmers in northwestern Ethiopia. *Cogent Food & Agriculture*, *10*(1), art. 2292369. https://doi.org/10.1080/23311932.2023.2292369

de Haan, E., Kannan, P. K., Verhoef, P. C., y Wiesel, T. (2018). Device Switching in Online Purchasing: Examining the Strategic Contingencies. *Journal of Marketing*, *82*(5), 1-19. https://doi.org/10.1509/jm.17.0113

Dehejia, R. H., y Wahba, S. (2002). Propensity score-matching methods for nonexperimental causal studies. *The Review of Economics and Statistics*, *84*(1), 151-161. https://doi.org/10.1162/003465302317331982

Dey, S., y Singh, P. K. (2025). Market participation, market impact and marketing efficiency: an integrated market research on smallholder paddy farmers from Eastern India. *Journal of Agribusiness in Developing and Emerging Economies*, *15*(2), 311-332. https://doi.org/10.1108/jadee-01-2023-0003

Duque, P., y Díaz, S. (2024). Adopción tecnológica en el sector empresarial: origen, evolución y tendencias de investigación. *Revista Universidad y Empresa*, *26*(46), 1-35. https://doi.org/10.12804/revistas.urosario.edu.co/empresa/a.13129

Eresso, A. N., y Tefera, Y. D. (2025). Do collective actions reduce household poverty? Evidence from empirical evaluation of farmers cooperatives in East Shewa, Ethiopia. *International Journal of Social Economics*, *52*(5),715-729. https://doi.org/10.1108/ijse-03-2024-0231

Fischer, E., y Qaim, M. (2012). Linking Smallholders to Markets: Determinants and Impacts of Farmer Collective Action in Kenya. *World Development*, *40*(6), 1255-1268. https://doi.org/10.1016/j.worlddev.2011.11.018

Fu, A. Z., Christensen, D. B., Hansen, R. A., y Liu, G. G. (2006). Second-generation antidepressant discontinuation and depressive relapse in adult patients with bipolar depression: Results of a retrospective database analysis. *Clinical Therapeutics*, *28*(6), 979-989. https://doi.org/10.1016/j.clinthera.2006.06.011

Ganewo, Z., Balguda, T., Alemu, A., Mulugeta, M., Legesse, T., Kaske, D., y Ashebir, A. (2022). Are smallholder farmers benefiting from malt barley contract farming engagement in Ethiopia? *Agriculture & Food Security*, *11*(1), art. 58. https://doi.org/10.1186/s40066-022-00396-z

Garnefeld, I., Eggert, A., Helm, S. V., y Tax, S. S. (2013). Growing Existing Customers' Revenue Streams through Customer Referral Programs. *Journal of Marketing*, *77*(4), 17-32. https://doi.org/10.1509/jm.11.0423

Ge, R., Feng, J., Gu, B., y Zhang, P. (2017). Predicting and Deterring Default with Social Media Information in Peer-to-Peer Lending. *Journal of Management Information Systems*, *34*(2), 401-424. https://doi.org/10.1080/07421222.2017.1334472

Geiger, S., y Kjellberg, H. (2021). Market mash ups: The process of combinatorial market innovation. *Journal of Business Research*, *124*(3), 445-457. https://doi.org/10.1016/j.jbusres.2020.11.010

Goldfarb, A., Tucker, C., y Wang, Y. (2022). Conducting research in marketing with quasi-experiments. *Journal of Marketing*, *86*(3), 1-20. https://doi.org/10.1177/00222429221082977

González-Ferriz, F. (2024). La evolución de la disciplina del marketing hasta la versión 5.0. *RAN Revista Academia & Negocios*, *10*(2), 269-279. https://doi.org/10.29393/RAN10-17EDFF10017

Gómez-Bayona, L., y Arrubla-Zapata, J. P. (2020). Evolución del mercadeo en el sector universitario. *Revista Venezolana de Gerencia*, *25*(89), 159-173. https://doi.org/10.37960/revista.v25i89.31388

Grönroos, C. (2023). Towards a marketing renaissance: Challenging underlying assumptions. *Australasian Marketing Journal*, *31*(4), 270-278. https://doi.org/10.1177/14413582231172269

Gubela, R. M., Lessmann, S., y Stöcker, B. (2024). Multiple Treatment Modeling for Target Marketing Campaigns: A Large-Scale Benchmark Study. *Information Systems Frontiers*, *26*(3), 875-898. https://doi.org/10.1007/s10796-022-10283-4

Haddaway, N. R., Page, M. J., Pritchard, C. C., y McGuinness, L. A. (2022). PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis. *Campbell Systematic Reviews*, *18*(2), art. e1230. https://doi.org/10.1002/cl2.1230

Harknett, K. (2006). Does Receiving an Earnings Supplement Affect Union Formation? Estimating Effects for Program Participants Using Propensity Score Matching. *Evaluation Review*, *30*(6), 741-778. https://doi.org/10.1177/0193841X06293411

He, L., y Meng, T. (2023). How Facial Expressions of Recipients Influence Online Prosocial Behaviors? - Evidence from Big Data Analysis on Tencent Gongyi Platform. *Journal of Social Computing*, *4*(4), 337-356. https://doi.org/10.23919/JSC.2023.0026

He, Z., y Rao, V. R. (2024). Methods for Causal Inference in Marketing. *Foundations and Trends in Marketing*, *18*(3-4), 176-309. https://doi.org/10.1561/1700000080

Heckman, J. J., Ichimura, H., y Todd, P. (1998). Matching as an econometric evaluation estimator. *The Review of Economic Studies*, *65*(2), 261-294. https://doi.org/10.1111/1467-937X.00044

Hernández-Medina, P., Goncalves Hernández, D., y Morales La Paz, L. (2024). Employment and salaries of university graduates: impact evaluation of a financial aid programme by means of propensity score matching. *Suma de Negocios*, *15*(33), 99-110. https://doi.org/10.14349/sumneg/2024.v15.n33.a3

Hughes, D. A., y Poletti-Hughes, J. (2016). Profitability and Market Value of Orphan Drug Companies: A Retrospective, Propensity-Matched Case-Control Study. *PloS One*, *11*(10), art. e0164681. https://doi.org/10.1371/journal.pone.0164681

Hu, Z., Feng, Q., Ma, J., y Zheng, S. (2021). Poverty Reduction Effect of New-Type Agricultural Cooperatives: An Empirical Analysis Using Propensity Score Matching and Endogenous Switching Regression Models. *Mathematical Problems in Engineering*, (1), art. 9949802. https://doi.org/10.1155/2021/9949802

Ieva, M., Ziliani, C., Gázquez-Abad, J. C., y D'Attoma, I. (2022). I read, therefore I buy? Analyzing the impact of flyer distribution and readership on purchase behaviour. *Journal of Retailing and Consumer Services*, *64*(1), art. 102725. https://doi.org/10.1016/j.jretconser.2021.102725

Jaramillo Luzuriaga, S. A., y Hurtado Cuenca, C. D. (2021). Las estrategias de marketing y su importancia en las empresas en tiempos de COVID. *Espíritu Emprendedor TES*, *5*(1), 45-68. https://doi.org/10.33970/eetes.v5.n1.2021.234

Jones, A. S., y Richmond, D. W. (2006). Causal effects of alcoholism on earnings: Estimates from the NLSY. *Health Economics*, *15*(8), 849-871. https://doi.org/10.1002/HEC.1109

Khan, N., Ray, R. L., Zhang, S., Osabuohien, E., y Ihtisham, M. (2022). Influence of mobile phone and internet technology on income of rural farmers: Evidence from Khyber Pakhtunkhwa Province, Pakistan. *Technology in Society*, *68*, art. 101866. https://doi.org/10.1016/j.techsoc.2022.101866

Kuang, K., Cui, P., Li, B., Jiang, M., Wang, Y., Wu, F., y Yang, S. (2019). Treatment Effect Estimation via Differentiated Confounder Balancing and Regression. *ACM Transactions on Knowledge Discovery from Data*, *14*(1), art. 6. https://doi.org/10.1145/3365677

Kumar, A., Bezawada, R., Rishika, R., Janakiraman, R., y Kannan, P. K. (2016). From Social to Sale: The Effects of Firm-Generated Content in Social Media on Customer Behavior. *Journal of Marketing, 80*(1), 7-25. https://doi.org/10.1509/jm.14.0249

Langen, H., y Huber, M. (2023). How causal machine learning can leverage marketing strategies: Assessing and improving the performance of a coupon campaign. *PloS One*, *18*(1), art. e0278937. https://doi.org/10.1371/journal.pone.0278937

Liang, Y., Bi, W., y Zhang, Y. (2023). Can contract farming improve farmers' technical efficiency and income? Evidence from beef cattle farmers in China. *Frontiers in Sustainable Food Systems*, *7*, art. 1179423. https://doi.org/10.3389/fsufs.2023.1179423

Liu, H., y Roehl, W. S. (2025). Do virtual tours really enhance customer satisfaction with physical experiences? A quasi-experimental study on Airbnb. *Journal of Hospitality and Tourism Management*, *62*, 188-195. https://doi.org/10.1016/j.jhtm.2025.01.010

Liu, M., Min, S., Ma, W., y Liu, T. (2021). The adoption and impact of E-commerce in rural China: Application of an endogenous switching regression model. *Journal of Rural Studies*, *83*(1), 106-116. https://doi.org/10.1016/j.jrurstud.2021.02.021

Ma, W., y Abdulai, A. (2016). Linking apple farmers to markets: Determinants and impacts of marketing contracts in China. *China Agricultural Economic Review*, *8*(1), 2-21. https://doi.org/10.1108/CAER-04-2015-0035

Mojo, D., Fischer, C., y Degefa, T. (2017). The determinants and economic impacts of membership in coffee farmer cooperatives: recent evidence from rural Ethiopia. *Journal of Rural Studies*, *50*, 84-94. https://doi.org/10.1016/j.jrurstud.2016.12.010

Montaguti, E., Neslin, S. A., y Valentini, S. (2015). Can Marketing Campaigns Induce Multichannel Buying and More Profitable Customers? A Field Experiment. *Marketing Science*, *35*(2), 201-340. https://doi.org/10.1287/mksc.2015.0923

Moyano Londoño, G. A. (2022). Emprendimiento en zonas de post-conflicto: una revisión bibliográfica. *Económicas CUC*, *44*(1), 103-120. https://doi.org/10.17981/econcuc.44.1.2023.Org.4

Moyano-Londoño, G. A., y Marín-Cardona, P. F. (2024). La perdurabilidad empresarial de los emprendimientos sociales: revisión sistemática y perspectivas de investigación. *Tendencias*, *25*(1), 269-295. https://doi.org/10.22267/rtend.242501.249

Oberlander, T. F., Warburton, W., Misri, S., Aghajanian, J., y Hertzman, C. (2006). Neonatal outcomes after prenatal exposure to selective serotonin reuptake inhibitor antidepressants and maternal depression using population-based linked health data. *Archives of General Psychiatry*, *63*(8), 898-906. https://doi.org/10.1001/ARCHPSYC.63.8.898

Ongsakul, V., Chatjuthamard, P., y Jiraporn, P. (2022). Does the market for corporate control impede or promote corporate innovation efficiency? Evidence from research quotient. *Finance Research Letters*, *46*(3), art. 102212. https://doi.org/10.1016/j.frl.2021.102212

Pan, W., y Bai, H. (2018). Propensity score methods for causal inference: an overview. *Behaviormetrika, 45*(2), 317-334. https://doi.org/10.1007/s41237-018-0058-8

Penrod, J. D., Deb, P., Luhrs, C., Dellenbaugh, C., Zhu, C. W., Hochman, T., Maciejewski, M. L., Granieri, E., y Morrison, R. S. (2006). Cost and utilization outcomes of patients receiving hospital-based palliative care consultation. *Journal of Palliative Medicine*, *9*(4), 855-860. https://doi.org/10.1089/JPM.2006.9.855

Rishika, R., Kumar, A., Janakiraman, R., y Bezawada, R. (2012). The Effect of Customers' Social Media Participation on Customer Visit Frequency and Profitability: An Empirical Investigation. *Information Systems Research*, *24*(1), 108-127. https://doi.org/10.1287/isre.1120.0460

Robledo, S., Valencia, L., Zuluaga, M., Echeverri, O. A., y Valencia, J. W. A. (2024). TOSR: Create the Tree of Science from WoS and Scopus. *Journal of Scientometric Research*, *13*(2), 459-465. https://doi.org/10.5530/jscires.13.2.36

Rosenbaum, P. R., y Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, *70*(1), 41-55. https://doi.org/10.1093/biomet/70.1.41

Rosenbaum, P. R., y Rubin, D. B. (1985). Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. *The American Statistician*, *39*(1), 33-38. https://doi.org/10.2307/2683903

Rubin, D. B. (1974). Estimating causal effects of treatments in randomized and nonrandomized studies. *Journal of Educational Psychology*, *66*(5), 688-701. https://doi.org/10.1037/h0037350

Rubin, D. B. (2009). Should observational studies be designed to allow lack of balance in covariate distributions across treatment groups? *Statistics in Medicine*, *28*(9), 1420-1423. https://doi.org/10.1002/sim.3565

Ruiz, G. A., Robledo Giraldo, S., y Morales, H. H. (2023). Static Code Analysis: A Tree of Science Review. *Entre Ciencia e Ingenieria*, *17*(34), 9-14. https://doi.org/10.31908/19098367.2846

Sinha, M., Bhandari, A., Priya, S. S., y Kabiraj, S. (2024). *Future of Customer Engagement Through Marketing Intelligence*. IGI Global.

Skålén, P., Cova, B., Gummerus, J., y Sihvonen, A. (2022). Marketing como práctica: Un marco y una agenda de investigación para la creación de valor en el marketing. *Marketing Theory*, *23*(2), 185-206. https://doi.org/10.1177/14705931221123949

Smith, J. A., y Todd, P. E. (2005). Does matching overcome LaLonde's critique of nonexperimental estimators? *Journal of Econometrics*, *125*(1-2), 305-353. https://doi.org/10.1016/j.jeconom.2004.04.011

Soullier, G., y Moustier, P. (2018). Impacts of contract farming in domestic grain chains on farmer income and food insecurity. Contrasted evidence from Senegal. *Food Policy*, *79*, 179-198. https://doi.org/10.1016/j.foodpol.2018.07.004

Stuart, E. A. (2010). Matching methods for causal inference: A review and a look forward. *Statistical Science*, *25*(1), 1-21. https://doi.org/10.1214/09-STS313

Tsai, M.-H., y Luh, Y.-H. (2023). Group heterogeneity and the economic effect of farmer organisation participation: Empirical evidence from Taiwan. *Journal of Agricultural Economics*, *74*(2), 473-491. https://doi.org/10.1111/1477-9552.12515

Wager, S., y Athey, S. (2018). Estimation and Inference of Heterogeneous Treatment Effects using Random Forests. *Journal of the American Statistical Association*, *113*(523), 1228-1242. https://doi.org/10.1080/01621459.2017.1319839

Wang, J. (2021). To use or not to use propensity score matching? *Pharmaceutical Statistics*, *20*(1), 15-24. https://doi.org/10.1002/pst.2051

Yoganarasimhan, H., Barzegary, E., y Pani, A. (2022). Design and Evaluation of Optimal Free Trials. *Management Science*, *69*(6), 3220-3240. https://doi.org/10.1287/mnsc.2022.4507

Żyminkowska, K. (2019). *Customer Engagement in Theory and Practice: A Marketing Management Perspective*. Springer International Publishing.