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Bibliometric analysis of scientific research on PhD holders and the labour market as presented in the Web of Science database.

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Abstract

The purpose of this paper is to use bibliometric analysis tools to evaluate valid papers on the relationship between PhD holders and the labour market. A review study was carried out of research papers on PhD holders and the labour market published between 1995 and 2024. The bibliometric analysis was carried out according to the following criteria: (1) Annual scientific production, (2) Most Relevant Sources, (3) Most Local Cited Sources (from Reference Lists), (4) Source Local Impact (h-Index), (5) Authors' Local Impact, (6) Most Relevant Affiliations, (7) Corresponding Authors' Countries, (8) Country Scientific Production, (9) Most Cited Countries, (10) Most Global Cited Documents, (11) Keyword Plus TreeMap, (12) Thematic Map: Strategic Diagram, (13) Social Structure: Collaboration Network (Countries), and (14) Countries' Collaboration World Map. Data analysis was carried out using R program and bibliometrix codes to produce a descriptive bibliometric study and a matrix table. The results show that the number of studies in the field of PhD

holders and the labour market has continued to increase since 2001. There is interest in this area from many researchers, journals, countries and institutions, and both theoretical and experimental studies have been carried out. The studies generally focus on the labour market and job satisfaction of PhD holders through different research models.

Keywords: Bibliometric analysis; PhD holders Labour market; Satisfaction

1. Introduction

In the field of bibliometrics, bibliometric mapping is considered a significant area of research (Srisusilawati et al., 2021). The creation of bibliometric maps and their graphical representation are two distinct features within this domain. The development of such maps has drawn considerable attention in bibliometric literature. For instance, Marlina et al. (2021) investigated the impact of varying similarity measures as evaluated by different mapping methods. Despite the importance of graphical representation, it has received limited attention, although some scholars do recognize its significance (Campra et al., 2021). Most publications in bibliometrics rely on computer programs to generate basic graphical representations.

The Web of Science database is widely regarded as one of the most comprehensive abstract indexing databases, ensuring that significant works are neither overlooked nor excluded from studies (Abbas et al., 2020a, 2020b, 2021; Alsharif et al., 2020, 2021; Hazaea et al., 2021; Khatib et al., 2020, 2021; Zamil et al., 2021; Sahi et al., 2021; Ali et al., 2021a, 2021b). This database covers a broad range of topics and offers advanced search options that allow researchers to refine their searches for precise results, especially in expansive fields. The methodology for this study involves five key steps: (1) Study design, (2) Data collection, (3) Data analysis, (4) Data visualization, and (5) Data interpretation (Aria & Cuccurullo, 2017; Cobo et al., 2011). The findings from these analyses are valuable for identifying dominant research trends within each scientific field, as evidenced by published works in the respective areas.

One such field is education, which can be characterized as a cornerstone for societal development and the achievement of individuals' professional goals. In Greece, as in many other countries, the labor market is constantly undergoing changes and challenges, and PhD holders face a series of challenges and opportunities in their career paths.

Within the framework of the Bologna Process, during the Berlin meeting in 2003, ministers responsible for higher education across member states agreed to align doctoral studies with the European Union’s research objectives. This decision aimed to bridge the European Higher Education Area (EHEA) with the European Research Area (ERA), thereby contributing to the EU’s broader economic goals. Consequently, significant changes have occurred in the structure, content, and focus of doctoral studies across Europe, affecting both universities and students (Berlin Communiqué, 2003).

Economic theory suggests that in most developed countries, there is an inverse relationship between education and unemployment. Filer et al. (1996) found that job stability tends to increase with higher levels of education, which can be attributed to the higher fixed costs associated with skilled labor, resulting in a lower unemployment rate among more educated workers. This pattern is well-documented, with studies indicating that individuals with higher education levels tend to experience lower unemployment rates (OECD, 2000; ILO, 1996). Additionally, several empirical studies (Nickel, 1979; Mincer, 1991; Wolbers, 2000) support the notion that the likelihood of unemployment decreases as education levels increase.

However, despite the general trend linking higher education to better labor market outcomes,

there are instances where the supply of graduates exceeds demand, leading to adverse labor market conditions. For example, in the United Kingdom, graduate unemployment has risen in recent years (Moreau & Leathwood, 2006). Similarly, in Taiwan, graduates from tertiary education institutions have faced longer periods of unemployment compared to those with lower levels of education (Ghuang, 1999).

In Greece, high unemployment rates among graduates stand out as a prominent feature of the labor market, contrary to trends observed in most OECD countries (OECD, 2000). This issue has been highlighted in various studies. For instance, the European Commission (2003) reports a 2% annual increase in graduate unemployment. Additionally, the OECD Employment Strategy (2006) notes that the probability of unemployment among workers aged 25-44, relative to their educational attainment, is one of the lowest among OECD countries. Research by Livanos (2007, 2008a) further indicates that the level of higher education (e.g., PhD, master's, bachelor's) does not significantly impact the frequency of unemployment or long-term unemployment. Livanos (2009b) also examined wage flexibility among different groups of workers and found that graduates are particularly sensitive to potential increases in unemployment. Meanwhile, Patrinos (1997) explored the phenomenon of overeducation in Greece, arguing that the oversupply of graduates has led many to accept jobs unrelated to their field of study. Although numerous studies link overeducation with labor market challenges for graduates, some scholars, such as Magoula and Psacharopoulos (1999), argue that concerns over the expansion of higher education in Greece may be overstated, as the demand for higher education appears to rise alongside supply. Nevertheless, their analysis (Magoula & Psacharopoulos, 1997) focuses on the aggregate level of education and does not account for variations across different fields of study.

The professional integration of graduates is a widely studied topic in the literature, with numerous studies examining the employment outcomes of graduates in various disciplines (Smith et al., 2000; Boero et al., 2001).

A review of the literature also highlights that certain population groups, often distinguished by characteristics that make them more susceptible to unemployment, receive considerable attention. A notable example is young individuals who are unemployed or not engaged in education, employment, or training (referred to as "NEETs") (EENEE, 2012; Hutchinson & Kettlewell, 2015).

The examination of the literature also reveals that different groups of the population, often distinguished by characteristics that make them more vulnerable to unemployment compared to other groups, are brought to the forefront. A characteristic example is young unemployed individuals [and often young people not in education, employment, or training (known as "NEETs")] (EENEE, 2012; Hutchinson & Kettlewell, 2015).

In light of the above, an attempt is made to conduct a bibliometric analysis in the field of doctoral studies in relation to employment, prospects, and expectations of PhD holders as presented in the scientific database Web of Science. This study aims to record the dominant research trends in this field and its evolution over time.

2. Methodology

The data was sourced from the Web of Science scientific database. This database offers numerous capabilities and allows for a comprehensive recording of scientific texts identified using the keywords: PhD holders, labor market, doctorate holders, and perspectives and expectations.

In the first stage, a search for relevant articles was conducted using the keywords: PhD holders and labor market. Subsequently, two searches were conducted using the keywords: doctorate holders and perspectives and expectations. The term AND is used as a logical operation (searching for articles that include all terms simultaneously). Finally, a bibliometric analysis was conducted according to the following criteria: (1) Annual scientific production, (2) Most Relevant Sources, (3) Most Local Cited Sources (from Reference Lists), (4) Source Local Impact (h-Index), (5) Authors' Local Impact, (6) Most Relevant Affiliations, (7) Corresponding Authors' Countries, (8) Country Scientific Production, (9) Most Cited Countries, (10) Most Global Cited Documents, (11) Keyword Plus TreeMap, (12) Thematic Map: Strategic Diagram, (13) Social Structure: Collaboration Network (Countries), and (14) Countries' Collaboration World Map. The results of this analysis are presented.

3. Data analysis

Data analysis was conducted using the R program and bibliometrix codes to produce a descriptive bibliometric study and matrix table. This process was essential for classifying and organizing all the documents reviewed. Additionally, a network and conceptual map of co-citations were constructed using "biblioshiny," a web-based interface of bibliometrix.

4. Results

4.1 Investigation of Similar Works

The search using the keywords PhD holders and labor market, doctorate holders, and perspectives and expectations yields the results shown in Table 1. The keywords are those used in the Web of Science search engine. The number of articles listed in Table 1 corresponds to the number of search results.

Table 1. Results of Initial Literature Searches

	Keywords	**Numbers of articles**
1.	phd holders and labour market	46
2.	phd holders and labour market and doctorate holders	118
3.	phd holders and labour market and doctorate holders and perspectives and expectations	252

Note: Own research

Upon reviewing the articles according to the above table, it was observed that there was no article in the literature that dealt with a bibliometric analysis of our topic of interest. Thus, the

further analysis continues.

4.2 Descriptive Bibliometric Analysis

Table 2 presents the key findings from a bibliometric analysis of 252 articles published between 1995 and 2024, as indexed in the Web of Science database. Out of these, 118 articles were selected for their direct relevance to the research field. The table summarizes the primary results, including document type, document content, and author collaboration. This analysis encompasses the period from 1995 to 2024, with a total of 118 articles, an average of 10.19 citations per document, and a total of 4,439 references.

The study found that articles published in scientific journals (63) are the most common type of document. Across all articles, 350 unique keywords were used. Additionally, there were 219 Keywords Plus, which is 1.85 times the number of articles, indicating a broad range of terms appearing in article titles. Notably, there is a high proportion of single-author articles, with 41 out of 118 articles being authored by a single individual. On average, each article has 2.29 authors, and the Collaboration Index (CI) is 2.65, calculated as the total number of authors from multi-authored articles divided by the total number of multi-authored articles (Elango & Rajendran, 2012).

Table 2. Main information about data

Description	Results
Timespan	1995:2024
Sources (Journals, Books, etc)	81
Documents	118
Annual Growth Rate %	2,42
Document Average Age	6,37
Average Ccitations per Document	10,19
References	4439
Document Contents	
Keywords Plus (ID)	295
Author's Keywords (DE)	350
Authors	
Authors	242
Authors of Single-Authored Documents	38
Authors of Multi-Authored Documents	204
Authors Collaboration	
Single-Authored Documents	41
Documents per Author	0,49
Authors per Document	2,1
Co-Authors per Document	2,29
International Co-Authorships %	17,8
Collaboration Index	2,65
Document Types	
Article	63
Article; Book Chapter	9
Article; Early Access	35
Article; Proceedings Paper	2
Book	1
Editorial Material; Book Chapter	2
Proceedings Paper	6

Note: Own research

4.3 Annual scientific production

Diagram 1 presents the annual volume of research (1995-2024) on doctoral degree holders and the labor market. Observing in descending order, there are 20 published articles in 2016, 15 articles in both 2019 and 2020, and 14 articles in 2023.

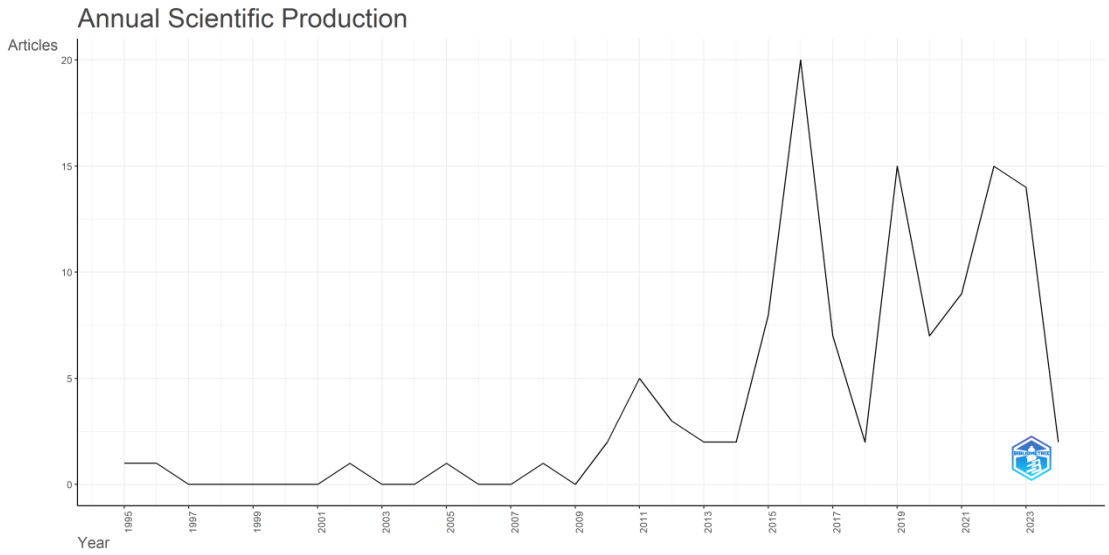

Diagram 1. Annual scientific production– «PhD holders» and «labour market» and «doctorate holders»

Note: Own research

4.4 Most Relevant Sources

Table 3 presents the most relevant academic-scientific sources regarding doctoral degree holders and the labor market. Within the Top 5, the journals *Higher Education* and *Science and Technology Labor Force: The Value of Doctorate Holders and Development of Professional Careers rank first* with 11 published articles. Following in the third position is the journal *Studies in Higher Education* with 7 published articles, and tied in the fourth position are the journals *European Journal of Education* and *Higher Education Quarterly*, each with 4 published articles.

Table 3. Sources containing the terms «phd holders» and «labour market» and «doctorate holders»

Sources	**Articles**
Higher Education	11
Science and Technology Labor Force: The Value of Doctorate Holders and Development of Professional Careers	11
Studies in Higher Education	5
European Journal of Education	4
Higher Education Quarterly	4
Research Evaluation	3
International Journal of Manpower	2
Portal-Libraries and The Academy	2
Research Policy	2
Science and Public Policy	2

Note: Own research

Figure 2, illustrating the rise in publications, showcases the academic journals that extensively cover the specific research field and related topics. Between 2016 and 2023, there has been a notable increase in the number of published articles focusing on this subject.

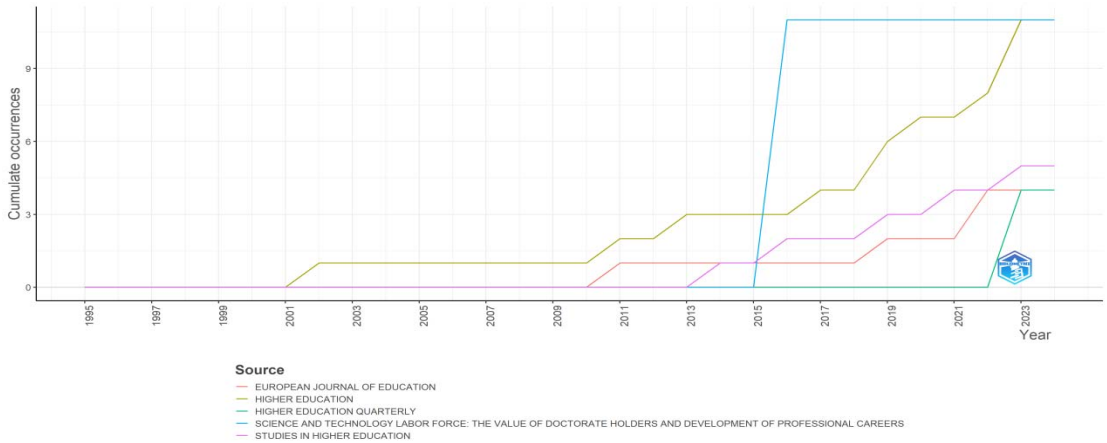

Figure 2. Sources' Production over Time

Note: Own research

4.5 Most Local Cited Sources (from Reference Lists)

Table 4 shows how many times an article or source is cited by other authors. Within the Top 5, *Higher Education* ranks first, appearing in 219 articles, followed by *Research Policy* in second place with 216 articles, *Studies in Higher Education* in third place with 131 articles, *Research Evaluation* in fourth place with 66 articles, and finally, *Scientometrics* in fifth place with 64 articles.

Table 4. Top 10 most locally cited sources (from reference lists) 1995–2024.

Sources	**Articles**
High Educ	219
Res Policy	216
Stud High Educ	131
Res Evaluat	66
Scientometrics	64
Nature	40
OECD SCI Technology	40
Plos One	40
Manage SCI	38
Am Econ Rev	33

Note: Own research

4.6 Source Local Impact (h-Index)

Table 5 highlights the scientific journals with the highest impact, using the h-index as a measure for comparison (Hirsch, 2005). The journals listed as having the highest impact align with those in Table 3, which detailed the journals with the most publications on the topic. The top five journals, ranked in descending order based on the number of publications, include Higher Education in the first position, with an h-index of 7. This indicates that at least 7 articles have received 7 or more citations, resulting in a total of 212 citations across 11 publications (beginning in 2002). Following this, the European Journal of Education holds the second position, with an h-index of 4, 62 citations, and 7 publications starting in 2011. Studies in Higher Education occupies the third position, also with an h-index of 4, but with 120 citations and 5 publications from 2014 onwards. Research Evaluation ranks fourth, with an h-index of 3, 103 citations, and 3 publications starting from 2005. Finally, Science and Technology Labor Force: The Value of Doctorate Holders and Development of Professional Careers is in fifth place, with an h-index of 2, 32 citations, and 5 publications beginning in 2016.

Table 5. Top 10 sources' local impact (h-Index) during 1995–2024. TC (Total Citations), NP (Number of Publications), and PY (Publication Year Start)

Element	h_index	g_index	m_index	TC	NP	PY_start
Higher Education	7	11	0,304	212	11	2002
European Journal of Education	4	4	0,286	62	4	2011
Studies in Higher Education	4	5	0,364	120	5	2014
Research Evaluation	3	3	0,15	103	3	2005
Science and Technology Labor Force: The Value of Doctorate Holders and Development of Professional Careers	3	4	0,333	32	11	2016
International Journal of Manpower	2	2	0,222	24	2	2016
Portal-Libraries and The Academy	2	2	0,118	16	2	2008
Science and Public Policy	2	2	0,2	28	2	2015
Technological Forecasting and Social Change	2	2	0,222	53	2	2016
21st International Conference on Science and Technology Indicators (sti 2016)	1	1	0,111	1	1	2016
African Journal of Library Archives and Information Science	1	1	0,2	3	1	2020

Note: Own research

4.7 Authors' Local Impact

Table 6 shows the author's impact. Among the Top 3, we find that the author Germain-Alamartine E has published 3 scientific papers related to PhD holders and the labor market, and these three articles have received at least 3 citations, resulting in an h-index of 3 and a total citation count of 56. Following Germain-Alamartine E is the author Wiese BS with an h-index of 3 and a total citation count of 19, and Auriol L with an h-index of 2 and a total citation count of 5.

Table 6. Top 10 authors' local impact την περίοδο 1995–2024. TC (Total Citations), NP (Number of Publications), and PY (Publication Year Start).

Element	h_index	g_index	m_index	TC	NP	PY_start
Germain-Alamartine E	3	3	0,5	56	3	2019
Wiese BS	3	3	0,429	19	3	2018
Auriol L	2	2	0,222	5	2	2016
Bin A	2	2	0,2	5	2	2015
Cattaneo M	2	2	0,333	39	2	2019
Colugnati Fab	2	2	0,2	5	2	2015
Cruz-Castro L	2	2	0,1	52	2	2005
Gilman T	2	2	0,118	16	2	2008
Herrera L	2	2	0,2	35	2	2015
Horta H	2	2	0,222	53	2	2016

Note: Own research

4.8 Most Relevant Affiliations

The "Most Relevant Affiliations" index refers to the most significant connections or collaborations that authors have in a scientific work. These connections can be universities, research institutions, companies, research centers, or any other collaborative environments contributing to the production of the work. Table 7 presents these connections or collaborations.

Table 7. Top 10 most relevant authors' affiliations during 1995–2024

Affiliation	Articles
University of Washington Seattle	4
RWTH AACHEN University	4
Instituto Politecnico De Santarem	3
Linkoping University	3
Universidade Estadual De Campinas	3
Universidade Nova De Lisboa	3
University of Bergamo	3
University of Washington	3
Consejo Superior De Investigaciones Cientificas (CSIC)	3
Organisation for Economic Co-Operation and Development (OECD)	3

Note: Own research

4.9 Corresponding Authors' Countries

Figure 3 and Table 8 show the countries of the Corresponding Authors. The Corresponding Author is the author who submits the article to the journal's publisher and with whom the

journal communicates via correspondence. Additionally, their email address typically appears on the first page of the article, serving as the point of contact for other interested researchers (Mattsson, Sundberg, Laget, 2011). Among the Top 5, we find the USA in the 1st position, with a total of 14 articles where the Corresponding Author was based in the USA. This is followed by Germany in the 2nd position with 11 published papers with Corresponding Authors based in Germany, Italy in the 3rd position with 11 publications and Corresponding Authors based in Italy, Spain in the 4th position with 11 publications and Corresponding Authors based in Spain, and France in the 5th position with 8 publications and Corresponding Authors based in France. The countries with the highest rates of international collaboration are China, Portugal, Italy, and the USA.

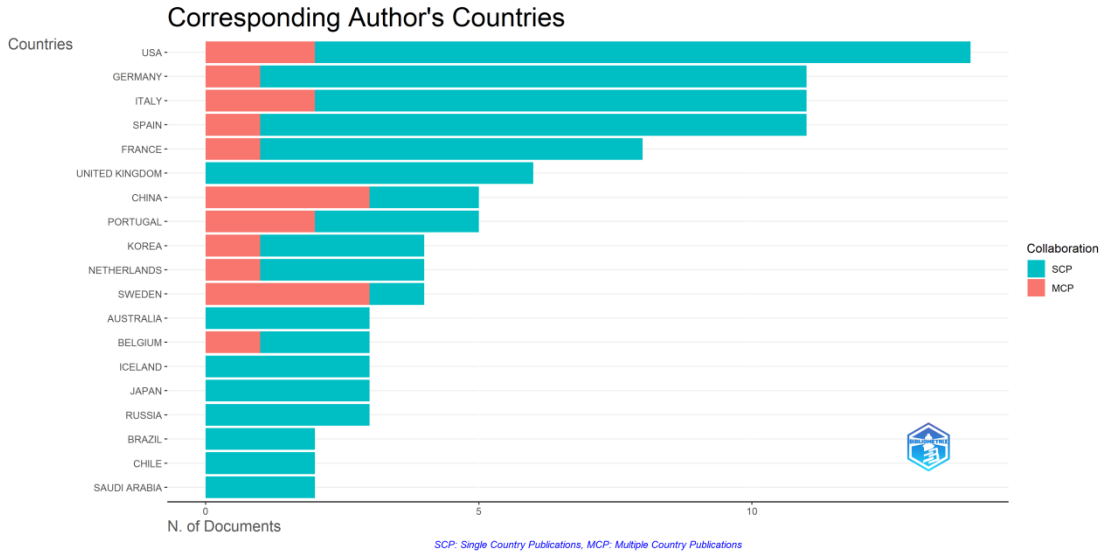

Figure 3. Corresponding author's country. Intra-country (SCP) and inter-country (MCP) collaboration during 1995–2024.

Note: Own research

Table 8. The intra-country (SCP) and inter-country (MCP) collaboration indices during 1995–2024.

Country	Articles	SCP	MCP	Freq	MCP_Ratio
USA	14	12	2	0,119	0,143
GERMANY	11	10	1	0,093	0,091
ITALY	11	9	2	0,093	0,182
SPAIN	11	10	1	0,093	0,091
FRANCE	8	7	1	0,068	0,125
UNITED KINGDOM	6	6	0	0,051	0
CHINA	5	2	3	0,042	0,6
PORTUGAL	5	3	2	0,042	0,4
KOREA	4	3	1	0,034	0,25
NETHERLANDS	4	3	1	0,034	0,25

Note: Own research

4.10 Country Scientific Production

Figure 4 and Table 9 illustrate the global distribution of scientific productivity by the country of affiliation. The USA leads the Top 5 with the highest frequency (29 occurrences), followed by Italy in the second position (23 occurrences). Portugal ranks third with 17 occurrences, while Spain is fourth with 16 occurrences, and the United Kingdom rounds out the Top 5 with 15 occurrences.

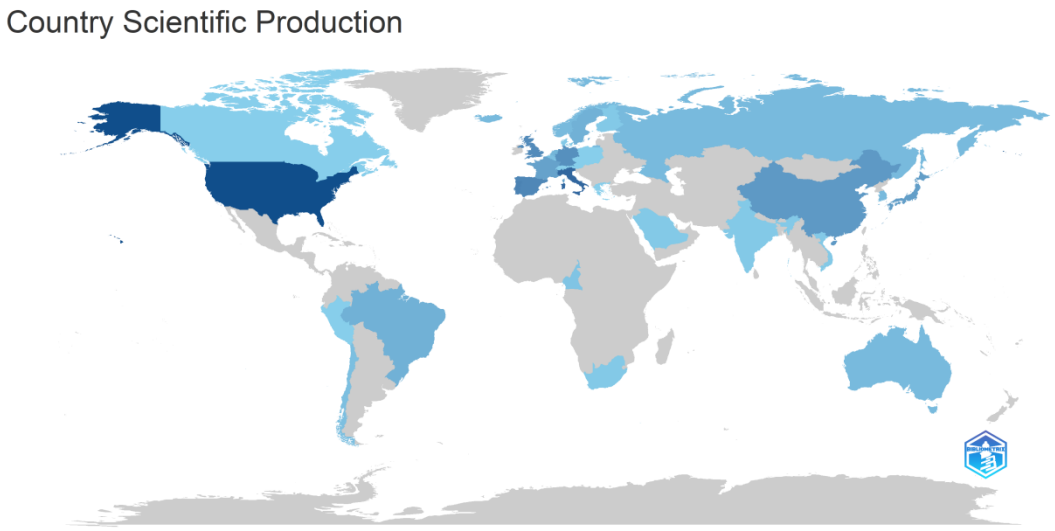

Figure 4. Countries' scientific production (1995–2024).

Note: Own research

Table 9. Top 10 countries' scientific production during 1995–2024 (Freq.).

region	Freq
USA	29
ITALY	23
PORTUGAL	17
SPAIN	16
UK	15
GERMANY	14
CHINA	12
JAPAN	11
FRANCE	10
BRAZIL	7

Note: Own research

4.11 Most Cited Countries

Table 10 displays the total number of citations received by various countries within the selected study sample. The rankings, listed in descending order, highlight the top three countries: The USA holds the top position with a total of 193 citations from the 118 articles, averaging 13.80 citations per article. In second place, Spain received a total of 169 citations, with an average of 15.40 citations per article. Finally, Italy ranks third with a total of 143 citations, averaging 13.00 citations per article.

Table 10. Top 10 most cited countries (2015–2019). Total Citations (TC) and Average Article Citations (AAC).

Country	TC	Average Article Citations
USA	193	13,80
SPAIN	169	15,40
ITALY	143	13,00
GERMANY	87	7,90
NETHERLANDS	81	20,20
FRANCE	69	8,60
PORTUGAL	65	13,00
NORWAY	64	64,00
SWEDEN	56	14,00
CHINA	45	9,00

Note: Own research

4.12 Most Global Cited Documents

Table 11 presents the selection of the most cited articles regarding PhD holders and the labor market. Among the Top 3, in descending order of total citations, we find the work of Enders J in the 1st position with Total Citations of 77, the work of Devaro J in the 2nd position with Total Citations of 74, and the work of Thune T in the 3rd position with Total Citations of 64.

Table 11. Top 10 most global cited documents. Total Citations (TC) and Total Citation per Year (TCpY).

Paper	Total Citations	TC per Year	Normalized TC
Enders J, 2002,	77	3,35	1,00
Devaro J, 2012,	74	5,69	2,47
Thune T, 2010,	64	4,27	1,75
Rizzo U, 2015,	59	5,90	3,63
Durette B, 2016,	53	5,89	5,35
Cruz-Castro L, 2005,	50	2,50	1,00
Santos JM, 2016,	38	4,22	3,84
Bloch C, 2015,	38	3,80	2,34
Germain-Alamartine E, 2021,	33	8,25	5,21
Schwabe M, 2011,	33	2,36	2,14

Note: Own research

4.13 Keyword Plus TreeMap

The terminology related to the terms PhD holders and labor market is presented in the following figure (Figure 5). We find that some of the most frequent terms are education (frequency 16), labor-market (frequency 16), science (frequency 15), students (frequency 14). The terms used less frequently were satisfaction (frequency 3), scientific mobility (frequency 3), time (frequency 3), and academic career (frequency 2).

Figure 5. Keyword Plus TreeMap. The number of words

Note: Own research

4.14 Thematic Map: Strategic Diagram

Figure 6 depicts the strategic diagram of the analysis performed. The x-axis represents density, which measures the proportion of relationships in the network relative to the maximum possible number of relationships. The density of each group's network ranges from 0 to 1, where 0 indicates no relationships among the group members, and 1 indicates that all group members are interconnected, representing the highest level of relationship. On the y-axis, centrality is depicted, identifying the nodes with the most connections within the network. More central factors have an advantage over others, as they have more alternatives to meet their needs, greater access to resources, and are considered less dependent. The strategic diagram provides a visual representation of the relationships within the analyzed network, demonstrating the density of connections and the centrality of nodes, which are critical aspects for understanding the network's dynamics and structure.

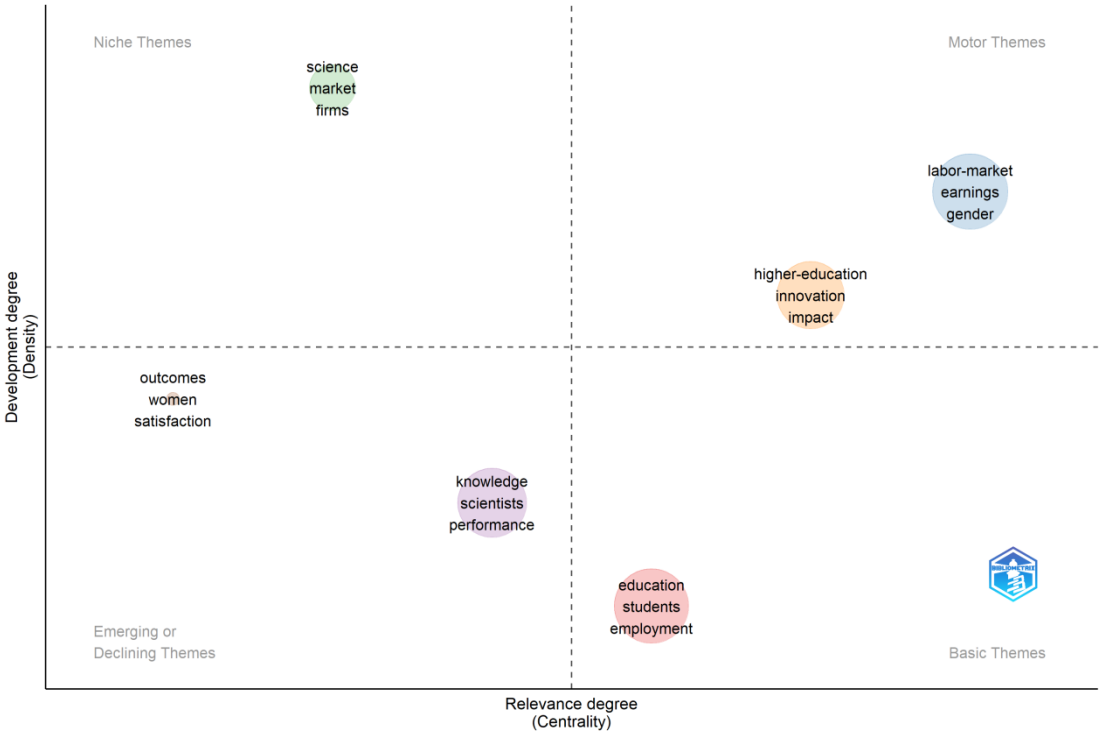

Figure 6. Strategic Diagram. TM Parameters: Field (Keyword Plus), Number of words (50–100), Min Cluster Frequency (1–5), Number of Labels (for each cluster 1–3), Label Size (0–0.2), Clustering algorithm: Louvain.

Note: Own research

Figure 6 illustrates a strategic diagram divided into four quadrants, each representing different categories of themes within the analyzed scientific field:

Central Themes: Located in the upper right quadrant, these themes are well-developed and significant within the field. The study identified two clusters:

Cluster 1: Labor-market, earnings, gender.

Cluster 2: Higher-education, innovation, impact.

These themes are characterized by high centrality and density, indicating their pivotal role in shaping the scientific discourse.

Peripheral and Marginal Themes: Positioned in the upper left quadrant, these themes are considered peripheral and marginal. The study identified a cluster with the following sub-themes:

Cluster: Science, market, firms.

While these themes are internally developed, they are isolated from other themes and hold marginal significance in the scientific field.

Emerging or Disappearing Themes: Represented in the lower left quadrant, these themes are either emerging or disappearing. The analysis identified two emerging clusters:

Cluster 1: Outcomes, women, satisfaction.

Cluster 2: Knowledge, scientists, performance.

These themes are in transition, indicating new trends or declining relevance in the field.

General and Cross-Cultural Themes: Found in the lower right quadrant, these themes are fundamental and cross-cultural. The analysis revealed a cluster with the following sub-themes:

Cluster: Education, students, employment.

Although these themes are not as well-developed, they are essential for understanding the broader context of the scientific field.

The strategic diagram visually represents the relationships and significance of various themes, helping to elucidate their roles and interconnections within the scientific network.

4.15 Social Structure: Collaboration Network (Countries)

Figure 7 depicts the social structure of collaboration among countries conducting research on PhD holders and the labor market. Although research on this topic is widespread, the analysis identifies four distinct collaborative clusters:

Cluster 1: Spain, Italy, Peru, Canada, and Switzerland.
Cluster 2: USA, Germany, China, Japan, Korea, Netherlands, South Africa, and Vietnam.
Cluster 3: United Kingdom, Portugal, Sweden, Denmark, and United Arab Emirates.
Cluster 4: France, Czech Republic, Poland, Luxembourg, and Belgium.

The figure highlights the significant number of countries involved in research on the subject and illustrates the representative structure of their collaborative patterns. This network visualization provides insight into how countries are interconnected through collaborative research efforts in the field.

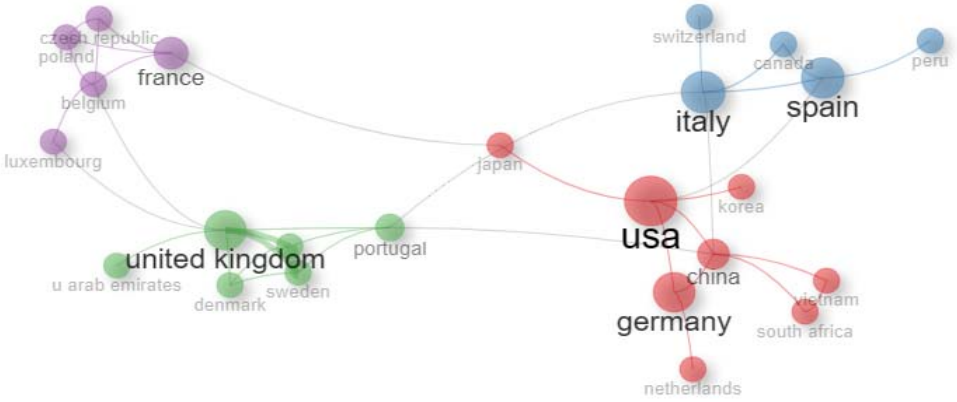

Figure 7. Social structure: collaboration network (countries). Clustering algorithm: Louvain, min edges (1), number of labels (5–50) and number of nodes (5–50).

Note: Own research

4.16 Countries' Collaboration World Map

Figure 8 illustrates the trajectory of global collaboration, with international research networks highlighted in blue on the map. The figure reveals that countries with the highest number of publications related to PhD holders and the labor market are also those exhibiting the most extensive international collaboration. This suggests that these countries have actively shared

information and supported one another to achieve significant scientific outcomes. Notably, the USA, Italy, Spain, Germany, the United Kingdom, and China are identified as having the highest rates of networking with other countries.

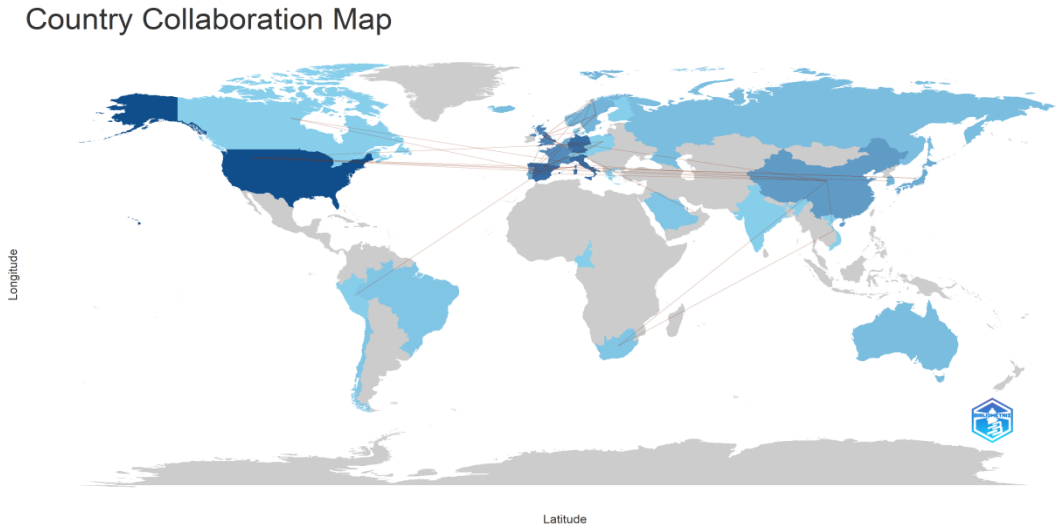

Figure 8. Countries' Collaboration World Map.

Note: Own research

5. Conclusions - Discussion

An attempt was made to study the issue of PhD holders and the labor market through a bibliometric analysis. The search was conducted in the Web of Science database, resulting in the identification of 252 articles published between 1995 and 2024. Out of these, 118 articles were selected as they were deemed relevant to the topic. The study encompassed the period from 1995 to 2024, yielding a total of 118 articles, with an average of 10.19 citations per document and a total of 4,439 references. The study showed that articles in scientific journals (63) are the preferred type. A total of 350 keywords were used in all articles comprising the study sample. Additionally, the total number of Keywords Plus (frequently appearing keywords in article titles) is 219, which is 1.85 times the number of articles. It is noteworthy that there is a high proportion of single authors. Of the 118 articles, 41 were written by a single author. Lastly, each article is written on average by 2.29 authors, and the collaboration index (CI) is 2.65.

Analyzing the results in terms of the annual research volume, we observe in descending order that there were 20 published articles in 2016, 15 articles in 2019 and 2020, and 14 articles in 2023. The most relevant academic-scientific sources related to PhD holders and the labor market are the journals *Higher Education*, *Science and Technology Labor Force: The Value of Doctorate Holders and Development of Professional Careers*, *Studies in Higher Education*, *European Journal of Education*, and *Higher Education Quarterly*. The study showed that between 2016 and 2023, there is an increase in the number of articles published on this topic. According to the number of times an article or source is cited by other authors, we find that within the top 5, *Higher Education* ranks first (appearing in 219 articles), followed by *Research Policy* (216 articles), *Studies in Higher Education* (131 articles), *Research*

Evaluation (66 articles), and *Scientometrics* (64 articles).

The journals with the highest impact align with those listed in Table 3, which highlighted the journals with the most studies published on the topic. The top five journals with the highest impact are: *Higher Education* with an h-index of 7, *European Journal of Education* with an h-index of 4, *Studies in Higher Education* with an h-index of 4, *Research Evaluation* with an h-index of 3, *Science and Technology Labor Force: The Value of Doctorate Holders and Development of Professional Careers* with an h-index of 2. The most influential authors are Germain-Alamartine E with an h-index of 3 and a total of 56 citations, followed by Wiese BS with an h-index of 3 and Auriol L with an h-index of 2. Regarding significant connections or collaborations among authors, we observe University of Washington Seattle, Rwth Aachen University, Instituto Politecnico De Santarem, Linkoping University, and Universidade Estadual De Campinas.

Among the top 5 countries, the USA ranks first with a total of 14 published articles where the corresponding authors were researchers based in the USA, followed by Germany with 11 published papers, Italy with 11 publications, Spain with 11 publications, and France with 8 publications. The countries with the highest rates of international collaboration are China, Portugal, Italy, and the USA. The USA ranks first (29 freq), Italy second (23 freq), followed by Portugal (17 freq), Spain (16 freq), and the UK (15 freq) in terms of the distribution of scientific productivity frequencies worldwide by the country of affiliation.

The countries with the highest total citations of the selected study sample are the USA, which is the first choice of authors regarding citations from the 118 articles (total of 193 citations, average of 13.80), and Spain, the second choice of authors in terms of citations (total of 169 citations, average of 15.40). Finally, Italy ranks third (total of 143 citations, average of 13.00).

The study showed that the works of Enders J (77 total citations), Devaro J (74 total citations), and Thune T (64 total citations) have the highest citations concerning PhD holders and the labor market. We find that some of the most frequent terms are education (frequency 16), labor-market (frequency 16), science (frequency 15), students (frequency 14). The terms used less frequently were satisfaction (frequency 3), scientific mobility (frequency 3), time (frequency 3), and academic career (frequency 2). The strategic diagram analysis showed the following:

Central Themes: The study identified two clusters of central themes: Cluster 1: Labor market, earnings, gender and Cluster 2: Higher education, innovation, impact. These themes are crucial for the development of the scientific field due to their strong centrality and high density.

Peripheral and Marginal Themes: The study identified a cluster with the following sub-themes: science, market, firms. These themes are well-developed internally but are isolated from other themes, indicating their marginal significance within the scientific field.

Emerging or Disappearing Themes: The analysis revealed two emerging clusters: Cluster 1: Outcomes, women, satisfaction and Cluster 2: Knowledge, scientists,

performance. These themes are either gaining importance or losing relevance in the field.

General and Cross-Cultural Themes: The analysis showed a cluster with the following sub-themes: education, students, employment. Although these themes are not as well-developed, they are fundamental and relevant to the scientific field.

The analysis of the social structure representing a network of collaboration among countries producing research on PhD holders and the labor market showed that despite many countries publishing on the subject, we identify four small collaborative clusters. The 1st cluster includes the following countries: Spain, Italy, Peru, Canada, and Switzerland. The 2nd cluster includes the following countries: USA, Germany, China, Japan, Korea, Netherlands, South Africa, and Vietnam. The 3rd cluster includes the following countries: United Kingdom, Portugal, Sweden, Denmark, and United Arab Emirates. Finally, the 4th cluster includes the following countries: France, Czech Republic, Poland, Luxembourg, and Belgium. The study highlights a significant number of countries involved in this research area and provides a representative overview of collaborative patterns among them. Notably, the countries with the highest number of publications on PhD holders and the labour market are also those exhibiting the highest rates of international collaboration. This suggests that these countries have actively shared information and supported each other to achieve valuable scientific outcomes. Specifically, the USA, Italy, Spain, Germany, the United Kingdom, and China are identified as having the highest networking rates with other countries.

As a consequence, we could argue that studies in the field of PhD holders and the labor market have continued to increase since 2001. There is interest in this field from many researchers, journals, countries, and institutions, and both theoretical and experimental studies have been conducted. The studies generally focus on the labor market and job satisfaction of PhD holders through different research models.

One of the limitations of the present study concerns the data source, which is restricted to the Web of Science database. Additionally, this research is limited by not utilizing theses and dissertations. Lastly, this study includes only research conducted in English. Therefore, it is recommended that these limitations be considered in future studies concerning this field.

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