

A literature-based view on technology transfer and culture

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Abstract

Purpose – The purpose of this paper is to examine the evolution of the literature on technology transfer and culture, identifying the main contents of the current body of knowledge encompassing culture and technology transfer (TT), thus contributing to a better understanding of the relationship between TT and culture based on bibliometric and multivariate statistical analyses of the relevant body of literature.

Design/methodology/approach – Data for this study were collected from the Web of Science (WoS) Core Collection database. Based on a bibliometric analysis and in-depth empirical review of major TT subjects, supported by multivariate statistical analyses, over 200 articles were systematically reviewed. The use of these methods decreases biases since it adds rigor to the subjective evaluation of the relevant literature base.

Findings – The exploratory analysis of the articles shows that first, culture is an important topic for TT in the literature; second, the publication data demonstrate a great dynamism regarding the different contexts in which culture is covered in the TT literature and third, in the last couple of years the interest of stimulating a TT culture in the context of universities has continuously grown.

Research limitations/implications – This study focuses on culture in the context of TT and identifies the main contents of the body of knowledge in the area. Based on this first insight, obtained through more detailed bibliometric and multivariate analyses, it is now important to develop and validate a theory on TT culture, emphasizing the dimensions of organizational culture, entrepreneurial culture and a culture of openness that fosters economic and societal spillovers, and to link those dimensions to the performance of TT activities.

Practical implications – From the practical point of view, managers in companies and universities should be aware of the importance of identifying those dimensions of culture that contribute most to the success of their TT activities.

Originality/value – Despite several literature reviews on the TT topic, no studies focusing specifically on culture in the context of TT have been developed. Therefore, given the multifaceted nature of the research field, this study aims to expand and to deepen the analysis of the TT literature by focusing on culture as an important and commonly cited element influencing TT performance.

Keywords Technology transfer, Culture, Bibliometric analysis, Factor analysis, University, Firms

Paper type Literature review

1. Introduction

The ability to improve competencies is a key factor for all organizations in achieving competitive success in the knowledge economy (Bellini *et al.*, 2019). In this context, several authors state that the development and diffusion of new innovations, including the transfer of technology (TT) are important drivers for economic and sustainable growth (Bengoa *et al.*, 2021; Bellini *et al.*, 2019). The speed of technological change, high levels of competition, the complexity and uncertainty of the innovation process, for instance, foster collaboration and TT among different stakeholders (Bellini *et al.*, 2019). Intra- and inter-firm TT, among different companies and multinational companies and their subsidiaries, are important sources of competitive advantage (Almeida *et al.*, 2002; Malik, 2002). At the same time, collaboration with universities is crucial for companies to explore valuable human capital,



novel scientific insights and research infrastructure resources, as well as to gain access to scientific knowledge (Bellini *et al.*, 2019).

The nature and scope of university-industry relationships have changed considerably during the last few decades. On the one hand, firms must speed up their process of innovation necessary for business survival in today's environment by seeking new ways of outsourcing R&D activities, for instance. On the other hand, universities increase their entrepreneurial activities fostered by cognitive, financial and societal factors. Cognitive factors signal the valuable spillovers between scientific insight and methods in academia and the innovation and application problems detected in the business world. Those cognitive spillovers enrich the research agenda of academic scientists and help guiding the problem choices in their research agenda (Van Looy *et al.*, 2004, 2006; Ranga *et al.*, 2003). Financial factors are linked to the need for increasing universities' budgets given the ever-mounting costs of scientific activities. While societal expectations on science contributing to economic welfare creation and transition challenges push for the commercialization of research results (Ghuri and Rosendo Rios, 2016; Huyghe and Knockaert, 2015). As a consequence, TT from universities to the industry has emerged as an important mission of the modern university, thus contributing to national competitiveness and economic growth (Baglieri *et al.*, 2018).

Not surprisingly, TT has received significant attention from researchers and practitioners and the TT research field has grown rapidly resulting in a large body of knowledge (De Wit-de Vries *et al.*, 2019; Noh and Lee, 2019) and in dedicated scientific journals. Bengoa *et al.* (2021) have identified several studies focusing on identifying the factors that could influence a successful technology transfer. In these studies, differences in organizational culture are often cited as a barrier and a constraining factor to the transfer and diffusion of knowledge (Bjerregaard, 2010; De Wit-de Vries *et al.*, 2019). Nguyen and Aoyama (2015), for instance, highlight the importance of organizational culture in explaining the efficiency effects of TT on a firm's performance. Gopalakrishnan and Santoro (2004) treat knowledge and TT as distinct constructs and conclude that TT is best supported by a flexible, change-oriented culture while knowledge transfer by a stable and direction-oriented culture.

The influence of culture on the success of TT has been investigated in studies that consider the international TT processes (e.g. Walsham, 2002; Hansen and Lovas, 2004; Buckley *et al.*, 2006; Murovec and Prodan, 2009) as well as TT from the perspective of universities and their collaborations with firms (e.g. Gopalakrishnan and Santoro, 2004; Ghuri and Rosendo-Rios, 2016; Huyghe and Knockaert, 2015; Galan Muros and Plewa, 2016). For instance, Hansen and Lovas (2004) studying a large multinational high-technology company found that with increasing cultural distance and national differences between a focal team and a target subsidiary, the level of comfort and trust is likely to decrease, making collaboration more difficult and jeopardizing TT. Moreover, Buckley *et al.* (2006) state that the success in TT in multinational companies (MNCs) between their subsidiaries depends on the ability of managers in building trust between the partners. In addition, they conclude that it is difficult to establish trust with local partners due to differences in business orientations and organizational cultures.

Regarding the perspective of the university, Galan Muros and Plewa (2016), studying European academics from 33 countries, conclude that cultural barriers are negatively associated with the performance of University–Industry (U–I) collaboration. They found that trust, commitment and shared goals are the most important factors in facilitating U–I collaboration. In addition, they conclude that neither barriers nor drivers affect various TT activities in the same manner. Leading to similar insights, Huyghe and Knockaert (2015) show that the extent to which universities articulate entrepreneurship as a fundamental element of their culture fosters scientists' intentions to engage in spin-off creation and developing intellectual property rights, but not in industry–science interaction. Based on these findings, the authors conclude that formal (e.g. patenting, licensing and spin-offs)

versus informal (e.g. consulting, contract research) collaborations have different determinants.

De Wit-de Vries *et al.* (2019) argue that in spite of organizational culture being frequently mentioned in the literature, it is not a well-defined barrier to nor driver of U–I collaboration. The authors claim that more research is needed into how institutional differences influence knowledge transfer and collaboration success. In their literature review, they found that cultural differences are used as an aggregated term for different goals and organizational and managerial differences. The authors argue that this is problematic since it makes it hard to understand the cause-effect relations of the individual aspects of cultural differences on knowledge transfer, and conclude that the extent to which cultural differences affect U–I collaboration is unclear. In addition, Grzegorzczuk (2019) states that despite the recent increase of interest in the social aspects of TT processes, the role of culture in TT remains “*largely overlooked (p. 133)*”.

In their bibliometric studies, Bengoa *et al.* (2021) provided an overview of the evolution of the TT literature from 1969 to 2018. The authors have identified five main TT research topics, namely: university TT, international TT, intra-firm TT, absorptive capacity and public innovation policies. The TT literature has experienced a considerable increase in recent years, transforming the subject of TT into a multifaceted and complex research field (Gilsing *et al.*, 2011; De Wit-de Vries *et al.*, 2019). Accordingly, Bengoa *et al.* (2021) claim that a periodic literature review is necessary to better understand the topics studied within this research field due to the notable increase in scale and scope of TT literature in the past decades.

In fact, several literature reviews on TT have been published. Some of these studies have been general (e.g. Bengoa *et al.*, 2021; Geisler, 1993), while others have focused on TT and specific issues such as absorptive capacity (e.g. Florencio and Oliveira, 2022), intra- and inter-firm TT (e.g. Noh and Lee, 2019; Battistella *et al.*, 2016; Wahab *et al.*, 2012), university TT (e.g. Miller *et al.*, 2018), TT models (e.g. Hsieh *et al.*, 2014; Wahab *et al.*, 2009) TT in the supply chain (e.g. Da Silva *et al.*, 2019). Table 1 presents a comparative analysis summarizing the main focus of the review studies on TT identified in the literature and this present study, and the main research methods applied. Despite several literature reviews on the TT topic, no studies focusing specifically on culture in the context of TT have been developed. Therefore, this study aims to expand the analysis of the TT literature by focusing on culture as an important and commonly cited element influencing TT performance. In this context, the following research questions emerge:

RQ1. How has the literature on TT and culture evolved?

RQ2. What are the main content dimensions of the current body of knowledge encompassing culture and TT?

RQ3. What are the trends and future directions for this field of study?

In order to answer these research questions, this study aims to (1) develop a descriptive bibliometric analysis showing the top journals and authors, and the number of publications per year linking TT to latent cultural dimensions; (2) to analyze the conceptual structure of the field through science mapping using keyword co-occurrence, and bibliographic coupling analysis; (3) to review the most important articles; (4) to use the results of a co-citation analysis in multivariate statistical analyses to provide complementary insight into thematic clusters underlying the TT studies reviewed.

The remainder of this paper is organized as follows. The next section explains the research methodology. Then, Section 3 presents the results of the performance analysis. The results of the network analysis, and the hierarchical cluster and factor analysis are presented and discussed in Section 4 and 5, respectively. Finally, conclusions and directions for future researches are discussed in Section 6.

Author(s)	Title	Focus	Research method
This study	<i>A literature-based view on technology transfer and culture</i>	Culture	Systematic literature review based on bibliometric and multivariate statistical analysis
Florencio and de Oliveira (2022)	<i>The importance of absorptive capacity in technology transfer and organisational performance: a systematic review</i>	Absorptive capacity	Systematic literature review based on bibliometric analysis
Bengoa <i>et al.</i> (2021)	<i>A bibliometric review of the technology transfer literature</i>	General	Systematic literature review based on bibliometric analysis
Barros <i>et al.</i> (2020)	<i>The interaction between knowledge management and technology transfer: a current literature review between 2013 and 2018</i>	Knowledge management	Systematic literature review based on <i>Methodi Ordinatio</i> value and bibliometric analysis
Maresova <i>et al.</i> (2019)	<i>Models, processes, and roles of universities in technology transfer management: a systematic review</i>	University technology transfer	Systematic literature review based on Critical Appraisal Skills Program and Critical Review Form
Da Silva <i>et al.</i> (2019)	<i>Technology transfer in the supply chain oriented to industry 4.0: a literature review</i>	Supply chain	Systematic literature review based on <i>Methodi Ordinatio</i> value
Noh and Lee (2019)	<i>Where technology transfer research originated and where it is going: a quantitative analysis of literature published between 1980 and 2015</i>	Inter-organizational technology transfer	Systematic literature review based on topic modeling and co-authorship network analysis
Miller <i>et al.</i> (2018)	<i>A systematic literature review of university technology transfer from a quadruple helix perspective: toward a research agenda</i>	University technology transfer	Systematic literature review based on content analysis
Battistella <i>et al.</i> (2016)	<i>Inter-organisational technology/ knowledge transfer: a framework from critical literature review</i>	Inter-organizational technology transfer	Narrative literature review
Hsieh <i>et al.</i> (2014)	<i>A literature review with citation analysis of technology transfer</i>	Technology transfer models	Systematic literature review based on citation analysis
Wahab <i>et al.</i> (2012)	<i>The theoretical perspectives underlying technology transfer: a literature review</i>	Intra and inter-firm technology transfer	Narrative literature review
Wahab <i>et al.</i> (2009)	<i>A Review on the Technology Transfer Models, Knowledge-Based and Organizational Learning Models on Technology Transfer</i>	Technology transfer models	Narrative literature review
Bozeman (2000)	<i>Technology transfer and public policy: a review of research and theory</i>	Technology transfer in public institutions	Narrative literature review
Geisler (1993)	<i>Technology transfer: Toward mapping the field, a review, and research directions</i>	General	Narrative literature review

Source(s): Adapted from Battistella *et al.* (2016)

Table 1.
Previous literature review on technology transfer

2. Research method

This study uses bibliometric analysis (BA) and multivariate statistical analyses to examine the structure and conceptual nature of the literature reviewed. BA uses mathematical and

statistical methods to analyze bibliographical data from a quantitative perspective (Bengoa *et al.*, 2021). According to Zupic and Carter (2015), bibliometric methods guide the researcher to the most influential works and map the research field without subject bias, being very useful in the literature review and analysis. In addition, BA helps in dealing with the increased volume of scientific studies since the use of quantitative methods can handle this massive amount of data and can help filtering the core works and concepts.

Data for this study were collected from the Web of Science (WoS) Core Collection database. According to Zupic and Carter (2015), WoS is one of the most frequently used databases for bibliometric studies in policy, management and organization. The string used for the search is presented in Figure 1. The string was applied to the search field “Topic” in the WoS. This field was chosen because it includes the sub-fields “Title, Summary, and Keywords”. As for the time span, no limit to initial period was defined in the study, so data cover the time period available in the WoS until the end of March of 2022 when the search was executed and finalized. Following the bibliometric studies performed by Bengoa *et al.* (2021) on the TT topic, this study only considered articles and reviews, and the following research domains: *Management, Business, Economics, Operations Research, Development Studies and Public Administration*. Figure 1 summarizes the information retrieval.

The search resulted in a sample of 213 articles. After assessing the titles and the abstract of the articles identified in the literature search, 12 articles were considered not aligned with the topic studied. To confirm, the contents of these articles were analyzed and reviewed by the authors, showing that they were not aligned. Therefore, they were excluded from the sample. Finally, 201 articles were extracted from the WoS.

First, Microsoft Excel was used to analyze the articles extracted from the WoS, the publication output per year, the citation patterns, the most cited articles, and the most influential journals. Then, VOSviewer software (Van Eck and Waltman, 2010) was used for advanced science mapping, including keyword co-occurrence and bibliographic coupling analysis. The keyword co-occurrence is a co-word analysis that allows identifying the main concepts explored by a field and to uncover and describe interactions between different fields of scientific research. This content analysis deals directly with sets of terms shared by documents, mapping the literature directly from the interactions of key terms (Cobo *et al.*, 2011). Therefore, the clusters identified [. . .] *represent groups of textual information that can be understood as semantic or conceptual groups of different topics treated by the research field* (Cobo *et al.*, 2011, p. 147). The bibliographic coupling uses the number of references shared by two documents to measure the similarity between them; this method is useful to

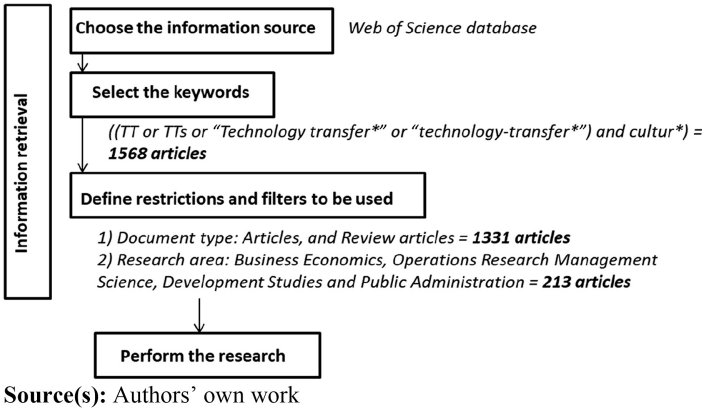


Figure 1.
Information retrieval

investigate the research stream of a topic since it uses reference lists for coupling (Zupic and Carter, 2015).

In addition, Bibexcel software was used to build a co-citation matrix. To compute the co-citation matrix, the top 100 most cited documents in the field under study were listed without publication year limitations (Cobo *et al.*, 2011; Raza, 2020). Afterward, the co-citation square matrix file was created, allowing the application of multivariate statistical analyses such as hierarchical clustering, and factor analysis using SPSS software, for clustering the articles reviewed. The purpose of the cluster analysis is to classify a sample of objects into a small number of groups based on the similarities among them, while the main purpose of the factor analysis is to condense the information contained in a number of original variables into a small set of latent factors (Hair *et al.*, 2009).

3. Performance analysis

3.1 Articles published per year

Figure 2 shows the cumulative distribution of the articles published over the time horizon. The distribution of the 201 articles over time reflects a positive trend in the development of the volume of published papers. There is a first set of articles that embraces publications from the perspective of firms (e.g. intra-firm TT, TT between MNCs and their subsidiaries), while a second set embraces the articles from the perspective of the universities (e.g. collaboration between U–I, entrepreneurial universities and academic entrepreneurs) and a third set of general articles encompasses, for instance, theoretical work that develops models that unravel TT performance relationships (Anokhin *et al.*, 2011), articles that discuss the managerial challenges in TT (Levin, 1997), and government policies related to TT (Martinsons, 1998). The first article highlighting the role of culture in TT was published in 1980 focusing on international TT (Hill and Still, 1980), while a first one to approach the topic from the perspective of the university was published in 1993. Samson and Gurdon (1993) studied university scientists as entrepreneurs and discuss clashes between business and

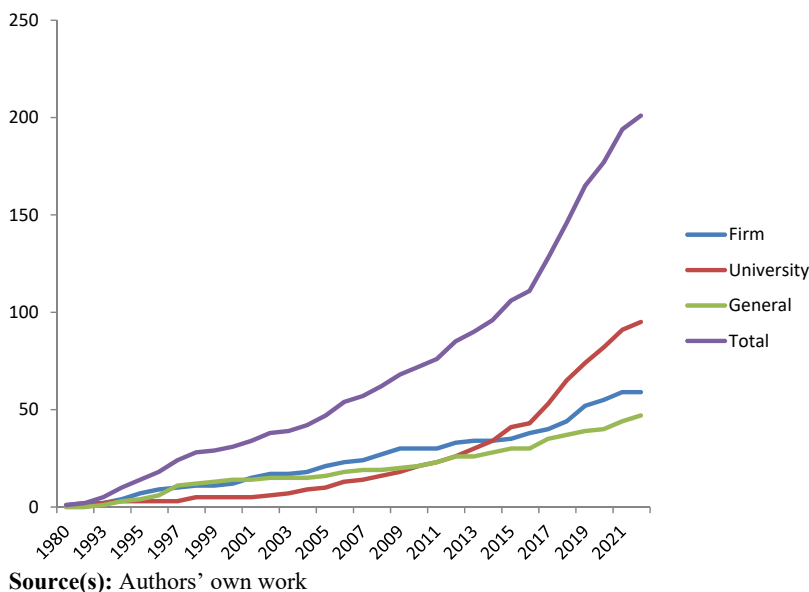


Figure 2.
Articles on TT and
culture published over
the time period
considered

scientific cultures leading to difficulties in collaborative working relations between the partners in the early 90s, the pioneering period of many U–I collaborative endeavors.

The distribution of the 201 articles over time in Figure 2 reflects a clear growth in the evolution of published papers. Analyzing the total amount of published papers it is possible to observe a substantial growth from 2005 onwards, accelerating in 2015, driven mainly by articles published from the perspective of the universities. In general, up to 2013, most articles published about culture and TT were based on the context of firms. The results show that, first, culture has been a relevant dimension of TT in the extant literature; while second, the bibliometric data demonstrate a great dynamism regarding the different contexts in which culture is studied in the TT literature, and third, over the last couple of years, the interest of culture in the context of universities has continuously grown.

3.2 The most influential journals

The relevance of journals was measured based on the number of articles published, and the number of citations. Table 2 presents the top 20 most influential journals for the publication outlet on TT and culture, the total articles per journal, number of citations, average citations per article, and the impact factors as obtained from the Journal Citation Report (JCR) in 2021.

According to Table 2, the sources *Journal of Technology Transfer*, *Research Policy* and *Technovation* have published the largest number of papers on TT and culture. The articles published in *Research Policy* have the highest average citation rate per article (350.1), and some journals such as *Information and Management* and *Organization Science* despite having published 4 and 3 articles, respectively, also present a high number of total cites and citation average per article. It is interesting to notice that the list of top journals presents a variety of journals that have been published on this topic, especially related to business and

Source title	Total articles	Times cited	Average per article	JCR
<i>The Journal of Technology Transfer</i>	18	340	18.9	5.337
<i>Research Policy</i>	12	4,201	350.1	9.473
<i>Technovation</i>	10	555	55.5	11.373
<i>International Journal of Technology Management</i>	7	107	15.3	1.526
<i>Technological Forecasting and Social Change</i>	7	239	34.1	10.884
<i>Journal of Business Research</i>	6	268	44.7	10.969
<i>IEEE Transactions on Engineering Management</i>	4	136	34.0	8.702
<i>Information and Management</i>	4	665	166.3	10.328
<i>Journal of World Business</i>	4	369	92.3	8.635
<i>Journal of Knowledge Management</i>	4	33	8.3	8.689
<i>Technology Analysis Strategic Management</i>	4	112	28.0	3.745
<i>European Journal of Innovation Management</i>	3	32	10.7	4.75
<i>Journal of International Business Studies</i>	3	128	42.7	11.103
<i>Organization Science</i>	3	731	243.7	5.152
<i>R&D Management</i>	3	77	25.7	5.962
<i>Energy Policy</i>	2	23	11.5	7.576
<i>European Planning Studies</i>	2	20	10.0	3.777
<i>Futures</i>	2	4	2.0	3.788
<i>Global Strategy Journal</i>	2	6	3.0	7.393
<i>Industry and Innovation</i>	2	10	5.0	3.819

Table 2.
The top 20 most
influential journals

Note(s): JCR – Journal impact factor™ (2021)
Source(s): Authors' own work

management areas. As stated by Bengoa *et al.* (2021), it demonstrates the importance of the subject to explain business phenomena, behaviors and relationships.

3.3 The most influential papers

Table 3 lists the top 20 most influential articles on culture and TT, including the number of citations, year of publication and source title. Many of these articles have a high number of citations per year showing their relevance and contribution to the development of the field. It is also interesting to notice that most of these articles were published in journals such as *Research Policy*, *Journal of Technology Transfer*, *Technovation*, *Information and Management and Organization Science* which appear in Table 2 of the most influential journals with high research impact proving the quality of the studies.

4. Network analysis

Network (or sociometric) analysis is an important methodology to identify the structural relationships between documents in a bibliometric analysis. According to Zupic and Carter (2015), network analysis produces the visualization of the scientific field under study while the network ties represent similarity in the connections. In this study, two analyses were performed. Keywords co-occurrence analysis, and bibliographic coupling.

4.1 Keyword co-occurrence

Keywords analysis is useful as a first approximation to reveal the knowledge structure of a research domain since keywords listed in the same paper are linked and can be used to represent the core of a research paper (Bengoa *et al.*, 2021; Zupic and Carter, 2015). Only those keywords that appeared in more than five articles were considered, and it was analyzed based on “All keywords”. A total of 61 keywords were identified and using keyword co-occurrence in VOSviewer, five clusters were defined. All the keywords identified by the software in each cluster were included in the analysis. Figure 3 presents the clusters and the number of keywords in each cluster.

Upon examining the title, the abstract and the keywords of the 201 articles, they were grouped into the five clusters defined according to the keyword co-occurrence analysis. Therefore, considering the set of the keywords clustered in the keywords co-occurrence analysis, and in the content of the articles expressed in its title, abstract and keywords, the clusters were labeled by the authors (Skute *et al.*, 2019). The five most cited articles were examined in every cluster, in order to provide a first insight into the concepts explored in the culture and TT research domain.

Cluster 1 (79 articles). The importance of cultural awareness to the TT

Table 4 shows that the five most cited articles in this cluster refer to international TT and highlights the importance of cultural awareness and the influence of culture in the TT process. For instance, authors as Walsham (2002) and Murovec and Prodan (2009) argue that managers have to be highly sensitive to the cultural differences among the partners since the fit between characteristics of cultures is essential to facilitate the TT processes.

Cluster 2 (43 articles). Institutionalization of TT at the university

Table 5 presents the top five most cited articles in Keywords co-occurrence Cluster 2. This cluster is formed by articles that present organizational factors that influence the institutionalization of TT cultures in universities. In general, the articles highlight the changes that are happening in the universities regarding their mission and the importance of the development of an entrepreneurial culture to fostering entrepreneurial behavior

Authors	TC	Article title	Source title
Siegel <i>et al.</i> (2003a, b)	824	<i>Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study</i>	<i>Research Policy</i>
Straub <i>et al.</i> (1997)	488	<i>Testing the technology acceptance model across cultures: A three country study</i>	<i>Information and Management</i>
Bercovitz and Feldman (2008)	455	<i>Academic entrepreneurs: Organizational change at the individual level</i>	<i>Organization Science</i>
Siegel <i>et al.</i> (2004)	409	<i>Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies</i>	<i>Journal of Engineering and Technology Management</i>
Almeida <i>et al.</i> (2002)	247	<i>Are firms superior to alliances and markets? An empirical test of cross-border knowledge building</i>	<i>Organization Science</i>
Hansen and Lovas (2004)	239	<i>How do multinational companies leverage technological competencies? Moving from single to interdependent explanations</i>	<i>Strategic Management Journal</i>
Murovec and Prodan (2009)	232	<i>Absorptive capacity, its determinants, and influence on innovation output: Cross-cultural validation of the structural model</i>	<i>Technovation</i>
Walsham (2002)	232	<i>Cross-cultural software production and use: A structural analysis</i>	<i>MIS Quarterly</i>
Guerrero <i>et al.</i> (2015)	211	<i>Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom</i>	<i>Research Policy</i>
Buckley <i>et al.</i> (2006)	160	<i>Cultural awareness in knowledge transfer to China – The role of guanxi and mianzi</i>	<i>Journal of World Business</i>
Powell and Owen-Smith (1998)	158	<i>Universities and the marker for intellectual property in the life sciences</i>	<i>Journal of Policy Analysis and Management</i>
Martinsons and Westwood (1997)	150	<i>Management information systems in the Chinese business culture: An explanatory theory</i>	<i>Information and Management</i>
Carlsson and Fridh (2002)	147	<i>Technology transfer in United States universities—A survey and statistical analysis</i>	<i>Journal of Evolutionary Economics</i>
Prodan and Drnovsek (2010)	132	<i>Conceptualizing academic-entrepreneurial intentions: An empirical test</i>	<i>Technovation</i>
Guerrero <i>et al.</i> (2014)	113	<i>Entrepreneurial universities in two European regions: a case study comparison</i>	<i>Journal of Technology Transfer</i>
Lillrank (1995)	113	<i>The transfer of management innovations from Japan</i>	<i>Organization Studies</i>
Colyvas (2007)	100	<i>From divergent meanings to common practices: The early institutionalization of technology transfer in the life sciences at Stanford University</i>	<i>Research Policy</i>
Hughes and Kitson (2012)	94	<i>Pathways to impact and the strategic role of universities: new evidence on the breadth and depth of university knowledge exchange in the UK and the factors constraining its development</i>	<i>Cambridge Journal of Economics</i>
Brannen and Peterson (2009)	92	<i>Merging without alienating: interventions promoting cross-cultural organizational integration and their limitations</i>	<i>Journal of Technology Transfer</i>
Huyghe and Knockaert (2015)	90	<i>The influence of organizational culture and climate on entrepreneurial intentions among research scientists</i>	<i>Journal of Technology Transfer</i>

Table 3.
The top 20 most
influential articles on
culture and TT

Note(s): TC – Times cited, WoS core (March, 2022)
Source(s): Authors' own work



Figure 3.
Keyword
co-occurrence clusters
and numbers of
keywords per cluster

Table 4. The top five most cited articles in keywords co-occurrence **Cluster 1**

Note(s): March, 2022
Source(s): Authors' own work

Table 5.

The top five most cited articles in keywords co-occurrence [Cluster 2](#)

Author(s)	Citation WoS ¹	Article title	Main findings
Siegel et al. (2003a, b)	824	<i>Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study</i>	<i>Reward systems for faculty involvement in TT, compensation and staffing practices in the TTO and actions taken by administrators to extirpate informational and cultural barriers between universities and firms are critical factors for diminish the gap between U-I.</i>
Bercovitz and Feldman (2008)	455	<i>Academic entrepreneurs: Organizational change at the individual level</i>	<i>The organizational culture of the university affects the person's entrepreneurial behavior and is influenced by the individual's exposure to relevant peer behaviors.</i>
Siegel et al. (2004)	409	<i>Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies</i>	<i>Differences in the motives, actions, and organizational cultures among university administrators, academics and firms underscore the potential importance of organizational factors in the TT between U-I.</i>
Powell and Owen-Smith (1998)	158	<i>Universities and the marker for intellectual property in the life sciences</i>	<i>The relationship between U-I has changed as a result of the transformation in the nature of knowledge and a redefining of the mission of universities, influencing the capacity to change the culture of academic life</i>
Colyvas (2007)	100	<i>From divergent meanings to common practices: The early institutionalization of technology transfer in the life sciences at Stanford University</i>	<i>The assumptions codified into well-understood practices was crucial to the institutionalization of technology transfer in the university studied</i>

Note(s): ¹March, 2022
 Source(s): Authors' own work

among academics, as well as a market orientation vision. The increasing interest of the university in patenting and licensing activities has been reflected in different initiatives to promote the institutionalization of TT with special attention to the development of Technology Transfer Offices (TTO). In this context, some authors such as [Siegel et al. \(2003a, b\)](#) and (2004) pointed out the importance of the TTO in bridging the cultural gaps between universities and firms.

Cluster 3 (42 articles). Economic impact of TT and determinants of the results

The top five most cited articles in Keywords co-occurrence Cluster 3 is presented in [Table 6](#). Cluster 3 bundles articles that deal mainly with the embeddedness of the triple helix culture in the mission of the university and the factors that influence the number of patents, spin-offs, and success of TT between the university and firms. Cluster 3 complements Cluster 2 by supporting the importance of the development of an entrepreneurial culture in the university focusing on intellectual property and patenting as well as the economic impact of the TT activities. The authors of the publications in this cluster highlight that universities and firms must overcome cultural and organizational barriers to improve the results from the TT process.

Author(s)	Citation WoS ¹	Article title	Main findings
Guerrero et al. (2015)	211	<i>Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom</i>	<i>Findings show that in the majority of the United Kingdom's universities, research and entrepreneurial activities have contributed to economic growth</i>
Guerrero et al. (2014)	113	<i>Entrepreneurial universities in two European regions: a case study comparison</i>	<i>Findings show that the entrepreneurial universities in most countries remain distinct from one another by their institutional arrangements, traditions, and unique characteristics</i>
van Burg et al. (2008)	84	<i>Creating university spin-offs: A science-based design perspective</i>	<i>The authors suggest two fundamentally different phases for the spin-off development, the first phase involves the creation of an infrastructure for spin-off creation that provides conditions for a subsequent phase focusing on spin-off support</i>
Baldini (2009)	46	<i>Implementing Bayh-Dole-like laws: Faculty problems and their impact on university patenting activity</i>	<i>Results show that most obstacles to university patenting are related to a lack of support mechanisms (e.g. insufficient reward for researchers, lack of a TTO), commercialization problems, too heavy teaching, and administrative duties and personal/cultural issues</i>
Di Berardino and Corsi (2018)	30	<i>A quality evaluation approach to disclosing third mission activities and intellectual capital in Italian universities</i>	<i>Findings show a positive impact of intellectual capital on the development of the third mission in Italian universities also, a positive impact of third mission activities in the university ecosystem</i>

Note(s): ¹March, 2022

Source(s): Authors' own work

Table 6.
The top five most cited
articles in keywords co-
occurrence [Cluster 3](#)

Cluster 4 (18 articles). Mechanisms of connectivity among the different partners on TT

[Table 7](#) presents the top five most cited articles in Keywords co-occurrence Cluster 4. This cluster represents articles that discuss mechanisms of connectivity among the different partners to enhance TT. Dimensions beside geographical proximity are important to favor TT between university and industry. Authors such as [Cantu \(2010\)](#) cite the technological, cognitive, and vision proximity required to increase the interaction between the partners. Several authors pointed to the importance of overcoming cultural and organizational barriers to successful collaboration and highlight the role of boundary spanners to mitigate these barriers (e.g. [Kyoung-Joo Lee et al., 2010](#); [Taylor and Bhasme, 2018](#); [De Simone and Manchin, 2012](#)).

Cluster 5 (19 articles). The culture of the university

Finally, [Table 8](#) presents the top five most cited articles in Keywords co-occurrence Cluster 5. The articles in this cluster focus on the culture of the university and discuss several aspects of the university systems, and structure such as bureaucracy and institutional fragmentation that jeopardize the improvement of collaboration. Many authors put the culture as a central pivot that influences the university mission, the mechanisms of performance and academic engagement.

Author(s)	Citation WoS ¹	Article title	Main findings
Cantu (2010)	39	<i>Exploring the role of spatial relationships to transform knowledge in a business idea – Beyond a geographic proximity</i>	<i>The evolution of spatial relationships is generated by a firm's boundaries and leads to a transformation of network context openness, allowing a focal firm to strengthen relationships with new actors increasing innovation potential. The development of long-term relationships is influenced by the shared vision and gradual convergence of objectives</i>
Kyoung-Joo Lee et al. (2010)	32	<i>Formal boundary spanning by industry liaison offices and the changing pattern of university-industry cooperative research: the case of the University of Tokyo</i>	<i>Findings show that universities and industries need to overcome high cultural and organizational barriers to successful collaboration. In this context, formal boundary spanning by TTO could facilitate the formation of inter-organizational alliances between both parties</i>
Chew and Yeung (2001)	31	<i>The SME advantage: Adding local touch to foreign transnational corporations in Singapore</i>	<i>Findings show that local SME are more capable to transfer technology than their foreign transnational customers in aspects such as local knowledge including local technical specifications, standards, management styles and local culture</i>
Taylor and Bhasme (2018)	30	<i>Model farmers, extension networks and the politics of agricultural knowledge transfer</i>	<i>Model farmers are used as local agents that facilitate the production and transfer of knowledge horizontally to community members and vertically through linkages with extension agents, research institutions and private sector interests</i>
De Simone and Manchin (2012)	19	<i>Outward Migration and Inward FDI: Factor Mobility between Eastern and Western Europe</i>	<i>The migration of workers can enhance technology transfer since they can reduce the informational, cultural and reputational barriers through taking part in the business networks or improve the awareness of foreign employers about the characteristics of the labor force in their country of origin</i>

Table 7.
The top five most cited articles in keywords co-occurrence [Cluster 4](#)
Note(s): ¹March, 2022
Source(s): Authors' own work

4.2 Bibliographic coupling

Next, bibliographic coupling techniques were used aiming to analyze publication scientific mapping patterns and to evaluate the themes related to TT and culture. According to [Zupic and Carter \(2015\)](#), the use of bibliographical coupling that exploits citation data to construct measures of influence and similarity allows mapping the structure of a research field.

The results of the bibliographic coupling analysis that outlines current research perspectives in TT and culture are presented in [Figure 4](#). This study has considered articles with a minimum number of citations of 50 to guarantee that the most important and relevant articles were considered.

In total 33 articles were identified from the bibliographic coupling analysis, after examination of the full article, four articles were disregarded due to the lack of connection

Author(s)	Citation WoS ¹	Article title	Main findings
Galán-Muros et al. (2017)	29	<i>Nurture over nature: How do European universities support their collaboration with business?</i>	<i>Results show that transforming a university into a more entrepreneurial organization requires changes in organizational infrastructure as well as the adaptation of the university's culture and mission</i>
Saad and Zawdie (2005)	28	<i>From technology transfer to the emergence of a triple helix culture: The experience of Algeria in innovation and technological capability development</i>	<i>Findings highlight the need for technology transfer and the development of an innovation culture in developing countries. Bureaucracy and institutional fragmentation were identified as the main constraints on the development of the triple helix culture</i>
Sung and Gibson (2005)	27	<i>Knowledge and technology transfer grid: empirical assessment</i>	<i>Results indicate four important social factors for technology transfer, namely: communication, distance (physical and cultural), equivocality (degree of concreteness of TT) and motivation (incentives for TT)</i>
McAdam et al. (2017)	20	<i>University business models in disequilibrium – engaging industry and end users within university technology transfer processes</i>	<i>To progress of the university TT from a Triple to Quadruple helix is limited by path-dependent behavior where the internal culture, which reflects the academic mission, performance mechanisms and norms, seems to dictate the legitimacy of changes</i>
Grzegorzczuk (2019)	12	<i>The role of culture-moderated social capital in technology transfer – insights from Asia and America</i>	<i>Culture can influence relationships with external stakeholders in technology transfer (industry, governmental bodies) and internal relationships and management styles in TT offices (influences on organizational culture)</i>

Note(s): ¹March, 2022

Source(s): Authors' own work

Table 8.
The top five most cited
articles in keywords co-
occurrence [Cluster 5](#)

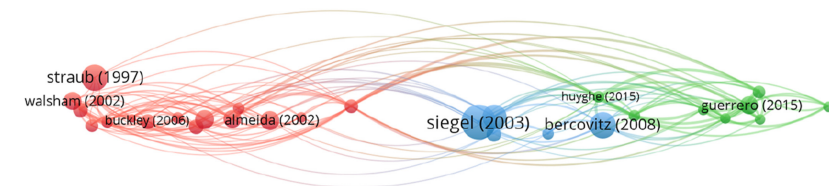
with the subject investigated. Therefore, 29 articles were clustered into three groups as follows.

Cluster 1 (16 articles). The importance of cultural awareness to TT

This cluster is mainly formed of the articles that encompass international TT between companies located in different countries, and companies and their subsidiaries, totalizing twelve articles. The four remaining articles refer to the TT between universities and firms.

The first published articles from this cluster call attention to the importance of understanding the cultural factors in the TT process in a general way. [Lillrank \(1995\)](#), for instance, argues that in a TT process the core idea of the innovation can be abstracted but it is important to evaluate how this core can be better applied to fit local conditions. In the same way, [Martinsons and Westwood \(1997\)](#) argue that firms that intend to transfer technology across countries must take into account the management practices adopted in each one.

Figure 4.
Bibliographic coupling
analysis



Source(s): Authors' own work

In this context, [Straub *et al.* \(1997\)](#) conclude that there is a growing need to understand how cultural factors might affect the TT processes between different countries.

The studies try to identify important aspects of the culture as well as aspects to mitigate the cultural differences in the TT process between firms located in different countries. [Walsham \(2002\)](#), for instance, argues that there is a need for practitioners to be highly sensitive to cultural differences when working in a cross-cultural context. The author highlights some important aspects to be considered in the TT process such as the cross-cultural contradictions, the heterogeneity and dynamic nature of culture and the work patterns in different countries. As a way to mitigate the incongruence of values and attitudes between countries, they suggest cross-cultural communication through ICT applications as good practice. However, [Almeida *et al.* \(2002\)](#) show that the challenge of knowledge management for MNCs extends beyond the creation of international information systems. [Almeida *et al.* \(2002\)](#) argue that is necessary to design organizational structures, systems and cultures capable of supporting the flow of knowledge. For the authors, the success of TT in MNCs lies in its ability to standardize procedures and formats, to administer coordination between national units, to develop interpersonal relationships between employees and to create a common culture to facilitate communication and cooperation.

[Hansen and Lovas \(2004\)](#) conclude that formal and informal integrative mechanisms contribute to mitigate the effects of large spatial distances in jeopardizing a TT to operating subsidiaries. In addition, [Buckley *et al.* \(2006\)](#) performing four case studies in MNCs operating in China found that the handling of cultural differences between firms can affect TT and firms' performance because cultural differences directly impact management practices. This is in accordance with the findings from [Martinsons and Westwood \(1997\)](#). According to [Buckley *et al.* \(2006\)](#), the success in knowledge transfer depends on the business strategy of the foreign partner, the teamwork between foreign and local partners and the trust building between partners.

[Kiessling *et al.* \(2009\)](#) argue that organizational knowledge management effectively influences the organizational culture to either foster or hinder knowledge development, assimilation, and intra-organizational transfer. Accordingly, [Murovec and Prodan \(2009\)](#) state that the capacity of an organization in acquiring, assimilating, transforming and exploiting knowledge is influenced by organizational culture since it influences people's behaviors. For this reason, [Vlajcic *et al.* \(2019\)](#) argue that the opportunities related to improved creativity and innovation from knowledge transfer among different countries and organizations are challenged by the barriers that emerge from cultural differences. In this context, the authors highlight the importance of cultural intelligence as an enabler for a person to effectively acclimatize to unfamiliar and culturally diverse settings. For the authors, the knowledge transferred across borders is often tacit, embedded in the environment and in

the culture in which it is developed. Therefore, cultural awareness improves the success of the TT. As a consequence, authors such as [Brannen and Peterson \(2009\)](#) and [Vlajcic et al. \(2019\)](#) highlight the importance of boundary spanners to a well-succeed TT process.

In turn, [Cui et al. \(2006\)](#) take organizational and national culture into account in their study and show the direct effects of cultural and environmental factors on international TT. Their findings show that organizational culture has more influence on TT than national culture since organizational culture has a higher impact on the practices that are more directly related to the behavior and activities performed by the employees. So the authors conclude that communication and information sharing are more directly affected by organizational culture differences than by national culture differences.

A next group of articles in this cluster studies the TT process from the university to business. [Tho and Trang \(2015\)](#), for instance, analyzed the knowledge and skills acquired by students, their intrinsic motivation to knowledge transfer, and the innovative culture of business organizations, and found that intrinsic motivation and acquired knowledge are determinants of knowledge transfer, while innovative culture enhances intrinsic motivation and acquired knowledge. The authors argue that innovative culture stimulates the organization's employees to transfer their knowledge and skills to the rest of the organization, at the same time motivating them to acquire knowledge and skills from universities.

In this context, [Prodan and Drnovsek \(2010\)](#) found that entrepreneurial self-efficacy highly influences the academics' entrepreneurial intentions, and conclude that academic institutions should actively promote cooperation between academics and industry to foster an entrepreneurial culture at universities. In the same direction, [Carlsson and Fridh \(2002\)](#) suggest that the success of the TT depends on the interface between the university and the business community as well as the culture and organization of the university.

[Gopalakrishnan and Santoro \(2004\)](#) have investigated the role of culture in facilitating knowledge transfer and TT activities from the perspective of the industry. They conclude that firms with more mechanistic structures and more stable direction-oriented cultures were associated with higher levels of knowledge transfer. Conversely, firms with more organic structures, more flexible change-oriented cultures and more customized university policies for intellectual rights policies, patent ownership and licensing were associated with higher levels of TT. The firm's trust in its university partner was equally important for both types of transfer activities.

To summarize, this cluster resonates quite some similarities to [Cluster 1](#) in the keyword co-occurrence analysis since most articles in this cluster show the importance of cultural awareness to the TT processes. The authors defend that formal and informal integrative mechanisms can contribute to mitigating cultural differences among partners. In the case of MNCs, the authors cite factors such as standardized procedures, communication, coordination between national units, development of interpersonal relationships between employees to grow trust as facilitator in the TT process. In addition, it is important to notice that organizational culture seems to be more important in the context of TT than national culture as demonstrated by [Cui et al. \(2006\)](#).

In the case of articles that investigate TT from the perspective of the universities, the authors pointed out the importance of fostering an entrepreneurial culture at the university to influence and shape the academics' entrepreneurial intentions, and their collaboration with business. Finally, they conclude that the success of TT between universities and companies is related to the culture and organization of the university.

Cluster 2 (8 articles). Economic impact of TT and determinants of the results

This cluster refers to the TT from the perspective of universities, and its content highlights similarities to Cluster 3 identified in the keyword co-occurrence analysis. The articles in this

cluster encompass the importance of the third mission in the university and the impacts of TT as well as the aspects that influence the results. More specifically, the authors highlight that universities and firms have to overcome cultural and organizational barriers to improve the results from the TT process.

Guerrero *et al.* (2014) studying universities in two similar regions conclude that entrepreneurial universities could present similarities in environmental conditioning factors related to support measures and entrepreneurial education programs, and differences in environmental conditioning factors related to the governance structures, attitudes toward entrepreneurship, and rewards systems. In addition, they also found similarities in internal conditioning factors related to financial, technological and social capital and differences in internal conditioning factors related to human capital. Next, Guerrero *et al.* (2015) studied the economic impact of each entrepreneurial university's core activity, namely: teaching, research and entrepreneurial activities on economic growth. The results show that the economic impact is evident on research (e.g. collaboration, consultancy, facilities and IP), teaching (e.g. employment rate) and entrepreneurial activities (e.g. spin-offs), with the highest impact associated with research and knowledge transfer. Therefore, the authors highlight the importance of an entrepreneurial culture at the university to foster its ability to innovate, to recognize and create opportunities, to work in teams, to take risks and to respond to challenges.

Hsu *et al.* (2015) identified human capital such as skilled scientists and faculty quality; and institutional/cultural resources such as the entrepreneurial-oriented culture and tradition of the university as the most emphasized resources for the improvement of university TT in Taiwan. According to the authors, to enhance the outcome of university TT it is important to improve internal administration processes and procedures in the university. Along similar lines, Berbegal-Mirabent *et al.* (2013) studied Spanish universities' efficiency in incorporating knowledge transfer activities in the university's objective function. Their findings reveal that regional factors related to technological development and entrepreneurial culture strongly influence universities' efficiency and their involvement in knowledge transfer activities. According to the authors, universities should promote entrepreneurial mindsets inside their organizational structures to foster TT, develop more attractive incentives for faculty members and adjust their processes and structures recognizing that knowledge transfer activities must be fully integrated with teaching and research activities.

Moreover, Huyghe and Knockaert (2015) show that the extent to which universities articulate entrepreneurship as a fundamental element of their culture fosters research scientists' intentions to engage in spin-off creation and intellectual property rights. In addition, the presence of role models that exemplify a specific type of academic entrepreneurship leads to stronger intentions among research scientists to imitate the same commercialization mechanism.

Hughes and Kitson (2012) have identified several elements that constrain the interaction between academics and other partners. They evaluated how important academics perceive these constraints. Their findings show that, for academics, the most important constraints on interactions include lack of time, university bureaucracy and insufficient rewards in supporting their research and teaching. While for businesses, they perceive as main constraints: the insufficient internal resources to manage the interactions, insufficient information to identify partners and insufficient rewards regarding the results on business performance. The authors conclude by suggesting the need for improved boundary-spanning skills or institutions that improve the connectivity of academia to other partners.

Smith and Ho (2006) evaluating the performance of spin-off companies from the public sector research base in Oxfordshire, United Kingdom, found that their number has increased rapidly over recent years, as the result of evolving national policy, and the development of an entrepreneurial culture at the universities and laboratories. Accordingly, Van Burg *et al.*

(2008) argue that in order to build and increase their capacity for creating spin-offs, universities should develop processes and structures that help the university to shape a culture that fosters academic entrepreneurship.

To summarize, this cluster identifies several performance determinants of the TT process such as incentives for entrepreneurial behavior, creating university-wide awareness of entrepreneurship opportunities, and the need to create a collaborative network organization of investors, managers, and advisors (Van Burg *et al.*, 2008). Several authors such as Hsu *et al.* (2015), Huyghe and Knockaert (2015), Berbegal-Mirabent *et al.* (2013), Smith and Ho (2006), Van Burg *et al.* (2008), reinforce the importance of the development of an entrepreneurial-oriented culture at the university. Other performance determinants cited were regional factors such as specific infrastructures related to technology development in the region where the university is located (Bergal-Mirabent *et al.*, 2013). Aspects related to processes and infrastructures at the university, and social factors such as human capital were also cited as important determinants of TT performance (Guerrero *et al.*, 2014; Hsu *et al.*, 2015). This finding is related to the constraints identified by Hughes and Kitson (2012) such as lack of time, university bureaucracy and insufficient rewards for academics in supporting their research and teaching activities.

Cluster 3 (5 articles). Institutionalization of TT at the University

In the third bibliographic coupling-based cluster, the studies of Bercovitz and Feldman (2008) focus on the challenges of the universities in the process of organizational change towards an entrepreneurship culture. Powell and Owen Smith (1998) also state the importance of universities' capacity to change the culture of academic life. The authors conclude that the changes in universities were the result of a transformation in the character and nature of knowledge creation and development, as well as in the mission of universities. Those changes are fundamental to institutionalizing TT at the university as shown by Colyvas (2007) who concludes that [...] *the construction of conventions that are codified into well-understood, enforceable practices is crucial to the institutionalization of technology-transfer in the university* (p. 474).

In addition, Siegel *et al.* (2003a, b, 2004) call attention to the importance of administrators being aware of some managerial practices that could contribute to the institutionalization of TT in the university such as reward systems for TT engagement and success, staffing practices in the TTO and the design of flexible university policies on TT. According to the authors, boundary spanning on the part of TTO managers could involve network building which could help to facilitate effective communication with different groups involved and stimulate the connections between scientists and firms.

In sum, Cluster 3 is similar in its content to Cluster 2 discussed in the keyword co-occurrence analysis. The cluster is formed by articles that present organizational factors that influence the institutionalization of TT cultures at universities. In general, the articles highlight the importance of the development of a culture to foster entrepreneurial behavior among academics, as well as a market orientation vision. The increasing interest of the university in patenting and licensing activities has been reflected in different initiatives to promote the institutionalization of the TT with special attention to the development of Technology Transfer Offices (TTO) and the reinforcement of best practices.

5. Multivariate statistical analysis

In this section, multivariate statistical analyses were applied to a co-citation analysis. The co-citation matrix is explored using hierarchical cluster and factor analysis. The use of multivariate analyses to investigate co-citation data is interesting to complement the keyword and bibliographic coupling analyses discussed earlier. Co-citation analysis matches

articles in the dataset that are jointly cited by another article. Therefore, the original file extracted from the WoS (201 articles) was put into Bibexcel and a new list of the 100 most cited articles by these 201 articles was extracted and used to compute a co-citation square matrix (Raza, 2020). In SPSS software v.24, a Pearson correlation matrix was estimated to avoid potential scale effects (Fernandes *et al.*, 2017), and then, Ward's hierarchical cluster method was applied to first identify the number of clusters in the sample. The results show three clusters of articles in the first level (see Appendix figure), and depicted in Table 9.

The articles grouped in cluster 1 are related to TT from the university's perspective. This cluster is formed mainly by studies that investigate the TT between universities and firms pointing out factors such as cultural and informational barriers to effective collaboration between them (Bruneel *et al.*, 2010); articles that encompass academic entrepreneurship and how the individual and social factors as university's culture shape the decisions of academics to engage in entrepreneurial activities (Kenney and Goe, 2004; Bercovitz and Feldman, 2008; Clarysse *et al.*, 2011; D'Este and Perkmann, 2011); articles that emphasize university's engagement in the commercialization of intellectual property and necessary changes that could drive to an entrepreneurial university like infrastructural and cultural changes (Feldman *et al.*, 2002; Jacob *et al.*, 2003; Guerrero and Urbano, 2012); and studies that focus on the role of the TTO how its structure and practices affect the TT (Siegel *et al.*, 2003a, b; Debackere and Veugelers, 2005; O'Kane *et al.*, 2015). Therefore, this cluster covers the content of the different clusters obtained from the co-word analysis and bibliographic coupling analysis. Cluster 2 contains articles that study specifically the impact of culture on the entrepreneurial intentions of academics (Huyghe and Knockaert, 2015); the influence of organizational structure and culture on the TT between universities and firms (Santoro and Gopalakrishnan, 2000; Santoro and Chakrabarti, 2002); in addition this cluster presents books that highlight institutions and mechanisms that support technical innovation (Nelson, 1993; Lundvall, 1992), as well as articles and books related to research methods and analysis relevant to TT (Yin, 1994; Eisenhardt, 1989; Hair *et al.*, 2009; Gioia *et al.*, 2013). Cluster 3 is mainly formed by articles that encompass international TT. The articles highlight for instance the influence of cultural variation in cross border TT activities (Bhagat *et al.*, 2002), and how companies absorb and share their knowledge with subsidiaries and other companies (Hamel, 1991; Mowery *et al.*, 1996; Gupta and Govindarajan, 2000). In addition, this cluster presents seminal books and articles in the area of national culture (Hofstede, 1980, 1991) and organizational knowledge creation relevant to TT (Nonaka, 1994; Nonaka and Takeuchi, 1995).

To further explore the underlying dimensions of the TT culture concept, factor analysis was applied. Factor analysis using principal component analysis as the extraction method considers the total variance and derives factors that contain portions of unique variance (Hair *et al.*, 2009). Therefore, it is useful to analyze the presence of interrelationships among a large number of variables and to explain them in terms of their common underlying (latent) components (Hair *et al.*, 2009). Factor analysis was applied to the computed co-citation matrix of the article set under examination to identify the sets of articles that constitute each of the factors based on their factor loadings and based on the articles' content, to understand the meaning of each of the factors identified (Fernandes *et al.*, 2017). Factor analysis was performed using the SPSS v.24 software applying the Principal Component and Varimax rotation method to improve the resolution of the items onto the factors. This resulted in a three factor solution being the most efficient one in terms of total variance explained (amounting to 90,4%). Papers with loadings over 0.5 are used to explain the corresponding factor (with a special emphasis on the papers with loadings over 0.7), while papers with loadings less than 0.3 were disregarded since they are not strongly associated with the factors (Fernandes *et al.*, 2017; Hair *et al.*, 2009). The three factors explain 90.4% of the total variance showing the relevance of the solution obtained. Table 10 shows the results of the factor analysis.

Cluster 1	Guerrero <i>et al.</i> (2015)	Shane (2004)	Cluster 3
Agrawal and Henderson (2002)	Haeussler and Colyvas (2011)	Siegel <i>et al.</i> (2003b)	Barney (1991)
Arvanitis <i>et al.</i> (2008)	Henderson <i>et al.</i> (1998)	Siegel <i>et al.</i> (2003a, b)	Bhagat <i>et al.</i> (2002)
Bekkers and Freitas (2008)	Jacob <i>et al.</i> (2003)	Siegel <i>et al.</i> (2004)	Cohen and Levinthal (1990)
Bercovitz and Feldman (2008)	Jain <i>et al.</i> (2009)	Siegel <i>et al.</i> (2007)	Davidson and McFetridge (1985)
Bozeman (2000)	Jensen and Thursby (2001)	Stuart and Ding (2006)	Gupta and Govindarajan (2000)
Bruneel <i>et al.</i> (2010)	Kenney and Goe (2004)	Thursby and Thursby (2002)	Hair <i>et al.</i> (1998)
Caldera and Debande (2010)	Klofsten and Jones-Evans (2000)	Vohora <i>et al.</i> (2004)	Hamel (1991)
Chapple <i>et al.</i> (2005)	Krueger <i>et al.</i> (2000)	Wright <i>et al.</i> (2008)	Hofstede (1980)
Clark (1998)	Lam (2011)	Wright (2014)	Hofstede (1991)
Clarysse <i>et al.</i> (2005)	Lee (2000)	Wright <i>et al.</i> (2007)	Jaffe <i>et al.</i> (1993)
Clarysse <i>et al.</i> (2011)	Link <i>et al.</i> (2007)	Cluster 2	Kogut and Singh (1988)
Debackere and Veugelers (2005)	Lockett and Wright (2005)	Decter <i>et al.</i> (2007)	Kogut and Zander (1992)
D'Este and Patel (2007)	Lockett <i>et al.</i> (2005)	Eisenhardt (1989)	Kogut and Zander (1993)
D'Este and Perkmann (2011)	Louis <i>et al.</i> (1989)	Gioia <i>et al.</i> (2013)	March (1991)
Di Gregorio and Shane (2003)	Merton (1973)	Glaser and Strauss (1967)	Mowery <i>et al.</i> (1996)
Dimaggio and Powell (1983)	Mowery <i>et al.</i> (2001)	Hair <i>et al.</i> (2009)	Nelson and Winter (1982)
Etzkowitz and Leydesdorff (2000)	O'Kane <i>et al.</i> (2015)	Huyghe and Knockaert (2015)	Nonaka (1994)
Etzkowitz <i>et al.</i> (2000)	O'Shea <i>et al.</i> (2005)	Lundvall (1992)	Nonaka and Takeuchi (1995)
Etzkowitz (2003)	O'Shea <i>et al.</i> (2007)	Nelson (1993)	Simonin (1999)
Feldman <i>et al.</i> (2002)	Owen-Smith and Powell (2001)	North (1990)	Szulanski (1996)
Friedman and Silberman (2003)	Perkmann and Walsh (2007)	Podsakoff <i>et al.</i> (2003)	Teece (1977)
Goktepe-Hulten and Mahagaonkar (2010)	Perkmann <i>et al.</i> (2013)	Santoro and Gopalakrishnan (2000)	Uzzi (1997)
Goldfarb and Henrekson (2003)	Powers and McDougall (2005)	Santoro and Chakrabarti (2002)	Von Hippel (1988)
Grimaldi <i>et al.</i> (2011)	Rasmussen <i>et al.</i> (2006)	Siegel and Wright (2015)	Williamson (1975)
Guerrero and Urbano (2012)	Rothaermel <i>et al.</i> (2007)	Yin (1994)	

Source(s): Authors' own work

Table 9.
Ward's hierarchical
clusters

Factor 1 – Entrepreneurial universities: The articles in this factor focus on the culture of the commercialization of universities' intellectual property, emphasizing patents and licenses. In this context, the studies expose the changes in the universities' paradigm from a perspective of the ivory towers to entrepreneurial universities. In addition, many studies encompass the important role of the different intermediaries in developing U-I linkages, special the role of TT offices to increase the success of TT among universities and firms. Factor 1 is therefore related to a TT culture dimension of openness to entrepreneurial behavior.

Author	Article title	Factor 1	Factor 2	Factor 3
Louis <i>et al.</i> (1989)	<i>Entrepreneurs in academe: An exploration of behaviors among life scientists</i>	0.954		
Henderson <i>et al.</i> (1998)	<i>Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965–1988</i>	0.929		
Agrawal and Henderson (2002)	<i>Putting Patents in Context: Exploring Knowledge Transfer from MIT</i>	0.909		
Feldman <i>et al.</i> (2002)	<i>Equity and the Technology Transfer Strategies of American Research Universities</i>	0.906		
Owen-Smith and Powell (2001)	<i>To Patent or Not: Faculty Decisions and Institutional Success at Technology Transfer</i>	0.896		
Jensen and Thursby (2001)	<i>Proofs and Prototypes for Sale: The Licensing of University Inventions</i>	0.894		
Etzkowitz and Leydesdorff (2000)	<i>The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm</i>	0.862		
Thursby and Thursby (2002)	<i>Who Is Selling the Ivory Tower? Sources of Growth in University Licensing</i>	0.861		
Dimaggio and Powell (1983)	<i>The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields</i>	0.825		
Friedman and Silberman (2003)	<i>University Technology Transfer: Do Incentives, Management, and Location Matter?</i>	0.809		
Debackere and Veugelers (2005)	<i>The role of academic technology transfer organizations in improving industry science links</i>	0.798		
Jacob <i>et al.</i> (2003)	<i>Entrepreneurial transformations in the Swedish University system: the case of Chalmers University of Technology</i>	0.775		
Mowery <i>et al.</i> (2001)	<i>The growth of patenting and licensing by US universities: an assessment of the effects of the Bayh–Dole act of 1980</i>	0.775		
Goldfarb and Henrekson (2003)	<i>Bottom-up versus top-down policies towards the commercialization of university intellectual property</i>	0.764		
Kenney and Goe (2004)	<i>The role of social embeddedness in professorial entrepreneurship: a comparison of electrical engineering and computer science at UC Berkeley and Stanford</i>	0.762		
Siegel <i>et al.</i> (2004)	<i>Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies</i>	0.748		
Krueger <i>et al.</i> (2000)	<i>Competing models of entrepreneurial intentions</i>	0.747		
Siegel <i>et al.</i> (2003a, b)	<i>Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study</i>	0.713		
Rothaermel <i>et al.</i> (2007)	<i>University entrepreneurship: a taxonomy of the literature</i>	0.707		
Klofsten and Jones-Evans (2000)	<i>Comparing Academic Entrepreneurship in Europe – The Case of Sweden and Ireland</i>	0.704		

Table 10.
Factor analysis results

(continued)

Author	Article title	Factor 1	Factor 2	Factor 3
Lee (2000)	<i>The Sustainability of University-Industry Research Collaboration: An Empirical Assessment</i>	0.704		
Chapple <i>et al.</i> (2005)	<i>Assessing the relative performance of UK university technology transfer offices: parametric and non-parametric evidence</i>	0.703		
Etzkowitz (2003)	<i>Research groups as “quasi-firms”: the invention of the entrepreneurial university</i>	0.700		
Siegel <i>et al.</i> (2007)	<i>Technology transfer offices and commercialization of university intellectual property: performance and policy implications</i>	0.678		
Bercovitz and Feldman (2008)	<i>Academic Entrepreneurs: Organizational Change at the Individual Level</i>	0.677		
Rasmussen <i>et al.</i> (2006)	<i>Initiatives to promote commercialization of university knowledge</i>	0.674		
Wright <i>et al.</i> (2008)	<i>Mid-range universities’ linkages with industry: Knowledge types and the role of intermediaries</i>	0.666		
Etzkowitz <i>et al.</i> (2000)	<i>The dynamics of innovation: from National Systems and “Mode 2” to a Triple Helix of university–industry–government relations</i>	0.653		
Stuart and Ding (2006)	<i>When Do Scientists Become Entrepreneurs? The Social Structural Antecedents of Commercial Activity in the Academic Life Sciences</i>	0.642		
Link <i>et al.</i> (2007)	<i>An empirical analysis of the propensity of academics to engage in informal university technology transfer</i>	0.636		
Grimaldi <i>et al.</i> (2011)	<i>30 years after Bayh–Dole: Reassessing academic entrepreneurship</i>	0.614		
O’Kane <i>et al.</i> (2015)	<i>University technology transfer offices: The search for identity to build legitimacy</i>	0.543		
Haeussler and Colyvas (2011)	<i>Breaking the Ivory Tower: Academic Entrepreneurship in the Life Sciences in UK and Germany</i>	0.504		
Siegel and Wright (2015)	<i>Academic Entrepreneurship: Time for a Rethink?</i>		0.865	
Clarysse <i>et al.</i> (2005)	<i>Spinning out new ventures: a typology of incubation strategies from European research institutions</i>		0.821	
Huyghe and Knockaert (2015)	<i>The influence of organizational culture and climate on entrepreneurial intentions among research scientists</i>		0.802	
Wright (2014)	<i>Academic entrepreneurship, technology transfer and society: where next?</i>		0.790	
Clarysse <i>et al.</i> (2011)	<i>The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship</i>		0.753	
Vohora <i>et al.</i> (2004)	<i>Critical junctures in the development of university high-tech spinout companies</i>		0.743	
Lockett and Wright (2005)	<i>The creation of spin-off firms at public research institutions: Managerial and policy implications</i>		0.690	
Guerrero <i>et al.</i> (2015)	<i>Economic impact of entrepreneurial universities’ activities: An exploratory study of the United Kingdom</i>		0.687	

(continued)

Table 10.

Author	Article title	Factor 1	Factor 2	Factor 3
Powers and McDougall (2005)	<i>University start-up formation and technology licensing with firms that go public: a resource-based view of academic entrepreneurship</i>		0.683	
Lockett and Wright (2005)	<i>Resources, capabilities, risk capital and the creation of university spin-out companies</i>		0.670	
O'Shea <i>et al.</i> (2005)	<i>Entrepreneurial orientation, technology transfer and spinoff performance of US universities</i>		0.665	
Di Gregorio and Shane (2003)	<i>Why do some universities generate more start-ups than others?</i>		0.660	
Caldera and Debande (2010)	<i>Performance of Spanish universities in technology transfer: An empirical analysis</i>		0.658	
Lam (2011)	<i>What motivates academic scientists to engage in research commercialization: "Gold", "ribbon" or "puzzle"?</i>		0.616	
Guerrero and Urbano (2012)	<i>The development of an entrepreneurial university</i>		0.608	
Santoro and Gopalakrishnan (2000)	<i>The institutionalization of knowledge transfer activities within industry–university collaborative ventures</i>			0.936
Santoro and Chakrabarti (2002)	<i>Firm size and technology centrality in industry–university interactions</i>			0.901
Siegel <i>et al.</i> (2003a, b)	<i>Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration</i>			0.892
Bekkers and Freitas (2008)	<i>Analysing knowledge transfer channels between universities and industry: To what degree do sectors also matter?</i>			0.838
Arvanitis <i>et al.</i> (2008)	<i>University-industry knowledge and technology transfer in Switzerland: What university scientists think about co-operation with private enterprises</i>			0.807
Bruneel <i>et al.</i> (2010)	<i>Investigating the factors that diminish the barriers to university–industry collaboration</i>			0.723
D'Este and Patel (2007)	<i>University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry?</i>			0.706
D'Este and Perkmann (2011)	<i>Why do academics engage with industry? The entrepreneurial university and individual motivations</i>			0.695
Perkmann <i>et al.</i> (2013)	<i>Academic engagement and commercialisation: A review of the literature on university–industry relations</i>			0.662
Goktepe-Hulten and Mahagaonkar (2010)	<i>Inventing and patenting activities of scientists: in the expectation of money or reputation?</i>			0.654
Perkmann and Walsh (2007)	<i>University–industry relationships and open innovation: Towards a research agenda</i>			0.623
Decter <i>et al.</i> (2007)	<i>University to business technology transfer—UK and USA comparisons</i>			0.611
Bozeman (2000)	<i>Technology transfer and public policy: a review of research and theory</i>			0.603
Jain <i>et al.</i> (2009)	<i>Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity</i>			0.586
% of total variance explained		39.8	29.8	20.8
Source(s): Authors' own work				

Table 10.

Factor 2 – Economic impact of TT: The articles in this group discuss the economic impacts of TT: several authors highlight that the entrepreneurial university serves as a conduit of spillovers contributing to economic and social development. They signal a TT culture dimension of openness to the creation of economic and societal spillovers. Papers in this factor investigate a culture that leads to the development of university spinout companies and spin-off companies. Papers adopt a resource-based perspective to understand why some universities are more successful than others at generating technology-based spinoff companies. In addition, the studies examine how academics' entrepreneurial capacity influences their likelihood of starting a company by investigating individual and social environment factors. Many underlying articles have highlighted the interrelations among environmental and internal factors that conditioned the economic development at entrepreneurial universities. Factor 2 is therefore related to a TT culture dimension of openness to generate economic and societal spillovers from the university's science base.

Factor 3 – U-I relationships: Articles in this group deal with the relationship between universities and firms. The studies investigate the different channels through which knowledge and technology are transferred between universities and industry, as well as the institutionalization of TT between firms and universities. Some results show that knowledge transfer is facilitated when firms have more mechanistic structures and stable and direction-oriented cultures. In addition, the studies indicate significant differences in the motivation of the universities in collaborating with firms depending on the country where it is located, its policies, and the accessibility of university technologies to business. In addition, the studies also explore the barriers such as culture clashes, bureaucratic inflexibility, poorly designed reward systems and ineffective management of TT activities by the university, to an effective TT between universities and firms. Based on those insights, Factor 3 is related to a TT culture dimension of organizational and relational openness between university and firm.

6. Conclusions

TT has gained prominence in the global knowledge economy as can be noticed from the substantial increase in the number of studies published in the last decades. This paper focuses on culture as an important element that influences the success of TT and presents a systematic literature review on the subject aiming to map the intellectual structure of the TT domain with a focus on the cultural component in TT. Using bibliometric analysis methods and multivariate statistical analysis, 213 peer-reviewed articles identified in the TT and culture domain were analyzed systematically.

The exploratory analysis of the articles shows that first, culture is an important topic for TT in the current literature; second, the publication data demonstrate a great dynamism regarding the different contexts in which culture is covered in the TT literature, and third, in the last couple of years the interest of a TT culture in the context of universities has continuously grown. Using network analyses, five important topics were preliminarily identified using keywords co-occurrence analysis: (1) *The importance of cultural awareness to the TT*; (2) *Institutionalization of TT at the University*; (3) *Economic impact of TT and determinants of the results*; (4) *Mechanisms of connectivity among the different partners on TT*; (5) *The culture of the university*. The bibliographic coupling reinforces the research streams identified in the keywords co-occurrence analysis, and identifies three streams that overlap the first three topics already identified in the keywords occurrence analysis.

It is possible to conclude that the culture is embedded across these five topics and has been studied from different perspectives. The first topic deals with the importance of cultural awareness to TT and encompasses mainly TT activities among firms located in the same country; TT among firms located in different countries, and intrafirm transfer. It therefore deals with differences in national and organizational cultures. The second topic covers

several studies that have concentrated on investigating the organizational factors that could influence the institutionalization of a TT culture in the university such as reward systems for TT, and the design of flexible university policies. The studies highlight the importance of developing an entrepreneurial culture at the university as well as the role of the TTO to institutionalize TT at the university. The third topic is related to the second one since it also highlights the importance of organizational factors to TT activities. However, this group emphasizes the economic impacts of TT as well as the aspects that influence its results. In special, the authors highlight that university and firms have to overcome cultural and organizational barriers to improve the results from the TT process. These topics were also identified in the bibliographic coupling analysis.

Moreover, the keyword co-occurrence analysis has also identified a research stream that deals with mechanisms of connectivity among the different partners involved in TT. In this stream, the importance of overcoming high cultural and organizational barriers through connectivity among partners is highlighted in fostering a successful collaboration. Finally, a research stream that encompasses the culture of the university is identified. From this perspective, the studies discuss several aspects of the university systems, and structure such as bureaucracy and institutional fragmentation that jeopardize TT.

In addition, multivariate statistical methods were applied to a co-citation analysis matrix. The factor analysis led to an efficient 3-factor solution. Factor 1 is related to a TT culture dimension of openness to entrepreneurial behavior. Factor 2 is related to a TT culture dimension of openness to generate economic and societal spillovers from the university's science base. While Factor 3 relates to a TT culture dimension of organizational and relational openness between university and firm. These results confirm the importance of TT in the academic environment as highlighted by several authors such as [Galan-Muros and Plewa \(2016\)](#), [Ghauri and Rosendo Rios \(2016\)](#), and [Huyghe and Knockaert \(2015\)](#).

Factor rotations can be orthogonal, like Varimax rotation, or oblique. With oblique factor rotations, the new factors are correlated. With orthogonal rotation, the factors are *not* correlated. Of the two types, orthogonal rotations have the greatest scientific utility, consistency, and meaning. Varimax, along with Quartimax, are two of the most common types of orthogonal rotations. As we applied Varimax (and hence orthogonal) rotation, the latent factors are judged sufficiently independent from one another not to cause collinearity problems. How they might intervene and interact in determining dimensions of TT performance is the object of further research.

Taking a wider perspective of the culture concept as it appears in the articles reviewed and in the research streams identified, the results of the present study indeed show that often culture is not treated as the sole element in the TT studies, with some exceptions such as the research by [Straub *et al.* \(1997\)](#), [Martinsons and Westwood \(1997\)](#), [Walsham \(2002\)](#) and [Pratono \(2020\)](#) that emphasize national culture. TT culture is quite often discussed as a relevant factor alongside various other factors that impact the performance of TT. Some studies emphasize organizational culture (e.g. [Gopalakrishnan and Santoro, 2004](#); [Huyghe and Knockaert, 2015](#); [Ghauri and Rosendo-Rios, 2016](#); [Nguyen and Aoyama, 2014, 2015](#); [Grzegorzczuk, 2019](#)). However, even in these studies, there is a not always a clear definition of the dimensions and elements that constitute culture. The present paper provides a first insight into what those elements could be. However, based on this first insight, obtained through more detailed bibliometric and multivariate analyses, it is now important to develop and validate a theory on TT culture, emphasizing the dimensions of organizational culture, entrepreneurial culture and a culture of openness that fosters economic and societal spillovers and to link those dimensions to the performance of TT activities.

The present study provides an onset to such theoretical contribution since it focuses on culture in the context of TT and identifies the main contents of the body of knowledge in the area based on a literature review supported by analytical methods. The use of quantitative

methods guides the researcher to the most influential works and enables mapping the research field without subject bias. From the practical point of view, the managers in the companies and the university should be aware of the importance of identifying those dimensions of culture that contribute most to the success of their TT activities.

6.1 Future research

This paper provides a preliminary analysis for future research on the relationship between TT and culture. Based on the findings discussed previously, future research on culture and TT should consider developing more comprehensive empirical studies to operationalize, measure and diagnose the multifaceted impacts of the cultural dimensions and culture profiles in the universities and important institutions such as the TTO, and to relate the characteristics of the culture's profile to the different mechanisms and outcomes of TT. A special emphasis should be given to the TT culture of the companies involved in TT activities with academic counterparts. Identifying the main characteristics of the TT culture in the companies will be useful in matching these firm characteristics to the culture of the other science partners involved in the TT activities, fostering the design and the adoption of practices more suitable to the specific cultural context thereby leading to optimized results. In addition, comparative studies could be conducted in different contexts (e.g. firms' size, economic sector and countries) to better understand the effects of culture on TT success.

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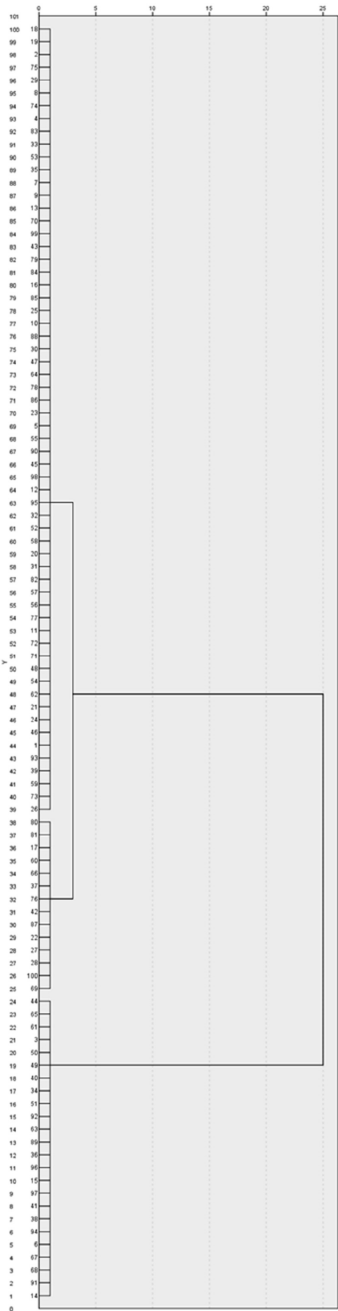
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Figure A1.
Ward's hierarchical
cluster



Source(s): Authors' own work