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Data analytics for national innovation research: a systematic literature review

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Abstract: The aim of this systematic literature review (SLR) is two-fold: first, to examine the use of data analytics techniques in studying national innovation by providing a comprehensive analysis of this research field. Second, to inform researchers and policymakers about the state of the art and to highlight topics that merit further attention. This SLR is based on Scopus and Web of Science publications appearing between 1984 and 2023. Only 149 articles met the selection criteria, showing that this is an emerging field that requires more investigation. In addition, the SLR identified several sources of data in this field that present, if combined with machine learning techniques, a promising opening for researchers. This SLR also shows a geographical disparity in this research field. The literature mainly investigates the EU and OECD countries. In contrast, low-income countries, small economies, and African countries have received very little attention.

Keywords: data analytics techniques; national innovation determinants; national innovation capacity; national innovation performance; innovation index; machine learning in innovation.

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1 Introduction

Innovation has emerged as a key driver of economic growth, productivity, and competitiveness in the global landscape (Porter, 1990; OECD, 2015). Understanding the determinants of national innovation and accurately measuring innovation performance is critical for policymakers and researchers seeking to foster innovation-led development strategies (Lundvall, 1992; Dutta et al., 2019). Data science, on the other hand, incurred tremendous progress that spilled into most research fields. A new trend of applying Data Analytics techniques to innovation research has recently emerged, generating compelling insights into innovation system dynamics (Vassakis et al., 2018, Wu et al., 2020, Chulok, 2021, Nazemi et al., 2022). To this end, researchers have employed various Data Analytics techniques to analyse and uncover the intricate relationships between national innovation determinants and outcomes (Alnafrah and Zeno, 2019; Andrijauskiene et al., 2021; Khanin et al., 2022).

This paper aims to provide a comprehensive review of the existing literature on data analytics techniques employed to study national innovation research. By conducting a systematic literature review (SLR), this study aims to identify the range of articles that leverage data analytics techniques to uncover factors influencing a country's innovation capabilities and to develop more accurate, and dynamic, measures of innovation performance.

The employed systematic review process, described hereafter, involves rigorous search strategies, inclusion criteria, and quality assessment of the selected articles and is similar to other SLRs in the literature (Kitchenham, 2004; Bakker, 2010). By categorising the selected literature, one can gain insights into various applications of data analytics in this field.

A wide and diverse range of data analytics techniques are observed to be used in the field of national innovation determinants and innovation indices. This SLR explores how these techniques are utilised to examine innovation outcomes based on factors such as human capital, research and development investments, institutional frameworks, and Intellectual Property indicators (Bacon et al., 2019). This enables the identification of areas of improvement and the formulation of effective strategies to enhance innovation-driven growth and competitiveness at a national level.

Overall, the study of national innovation systems (NIS), combined with the utilisation of innovation indices and usage of data analytics, offers a nuanced understanding of the complex dynamics and determinants that underpin innovation at a national level. By comprehensively analysing and addressing these factors, countries can foster a vibrant and thriving innovation ecosystem, leading to sustainable economic development and enhanced global competitiveness. Therefore, the performance of national innovation can

be viewed as either a process or an outcome (Nelson, 1993; Furman et al., 2002). Otherwise, compared to other innovation fields, only a limited number of research groups have quantitatively investigated innovation performance at a national level (Świadek et al., 2022).

In this context, this study aims to improve the understanding of factors influencing national innovation using data analytics. First, this paper contributes to the literature by collecting and evaluating relevant studies and providing a formal comparison of existing works. Second, the study helps shed light on the comprehension of national innovation performance by using innovation indices and data analytics methods.

This paper is structured as follows: after the section of the related work, the research approach section presents the research methodology used for the study. The key findings are detailed in the 4th section for the descriptive analysis, and the 5th section for the analytics and scope of national innovation research. The 'conclusions' section highlights the study's major results, it is limitations, and potential directions for further research.

2 Related work

Over the last decade, there has been a growing interest in understanding innovation systems using bibliometric reviews from both regional (Doloreux and Gomez, 2017; Fernandes et al., 2021; Rubio et al., 2022) and national perspectives. Kashani and Roshani (2019) examined the evolution of innovation systems in literature and reported that after the establishment of NIS as the main framework, regional innovation system (RIS) literature emerged prominently between 2002 and 2007. In addition, technological innovation systems (TIS) developed between 2007 and 2012. Later on, the sectoral innovation systems (SIS) received some interest.

Based on 692 publications related to innovation systems, Arjune et al. (2021) also reported that innovation systems research has increased exponentially in recent decades with emerging topics ranging from theoretical aspects to more applied areas. National, regional, sectoral, and triple helix models were identified as the main innovation system approaches.

As a conceptual framework, a National Innovation System is usually viewed as a network or set of connections among the actors involved in innovation processes. The interactions between these actors often shape the performance, or efficiency, of the innovation process at a country level (Freeman, 1987; Nelson, 1993; Metcalfe, 1995; Numminen, 1996). Many scholars and policymakers working on new knowledge-based economy designs in both developed and developing nations have shown interest in this notion (Foray, 1994; Correa, 1998; Lundvall, 1998).

In any nation, overall productivity is strongly related to the national innovation system performance. An innovation system is considered to be efficient when it can produce more innovation outputs with the same amount of innovation inputs or when it can accomplish the same level with fewer inputs (Niosi et al., 1993; Hollanders and Esser, 2007; Dutta et al., 2022).

Choosing innovation inputs and outputs is not a simple issue, especially in a comparative study context. For the assessment of innovation inputs, many authors adopt the qualitative approach (Köhler et al., 2012; Cunningham and Gök, 2012; Rigby and Ramlogan, 2013). While useful, this approach can not be applied in a comparative dynamic analysis due to constraints of practicality (Jankowska et al., 2017). Additionally,

these studies are static and do not take into consideration potential global trends that may have different effects on countries. As a result, these studies are less applicable and accurate in light of the constantly changing global environment. Thus, a variety of measures and indices were created to evaluate the potential for inventiveness (Hobday, 1995; Kim, 1997; Amsden, 2001; Bell, 2007; Chen and Kim, 2023).

This study contributes to the increasing corpus of literature on NIS, policies, and a country's productivity and competitiveness. The aim is to examine the use of data analytics techniques in studying national innovation determinants and innovation indices through a SLR.

3 Research approach

This SLR is grounded on an organised, transparent, and repeatable method. Its primary goals are the identification, organisation, evaluation, and interpretation of pertinent research evidence, for a particular area of interest (Kitchenham, 2004; Crossan and Apaydin, 2010). The methodology utilised in this SLR follows the procedure advised by Kitchenham (2004). The guidelines for an SLR described by Bakker (2010) are also used to search for relevant research articles covering the literature since Scopus started in 1984, up to 2023.

As such, the planning protocol of this SLR consists of four sections detailed hereafter:

1 research questions

2 databases for literature searching

3 inclusion and exclusion criteria

4 data extraction.

3.1 Research questions

Four research questions are formulated to:

a examine what can be learned from 40 years of scientific achievement in the field of national innovation using data analytics techniques

b perform a detailed characterisation of the studies, their purposes, their outcomes, the applied data analytics approaches, as well as their data sources.

The research questions are:

1 How many earlier studies used data analytics to investigate NIS?

2 What are the emerging research areas, sources of publications, and contributing authors?

3 What techniques are frequently employed by scholars to explore innovation systems?

4 Which countries are studied when examining NIS?

3.2 Databases for literature search

Scopus and web of Science are both used in the literature search for this SLR. As the two most popular databases for bibliometric analysis, these databases enable a broad selection of high-impact, peer-reviewed journals without restriction to a particular area of study. (Singh et al., 2021; Podsakoff et al., 2005).

3.3 Inclusion and exclusion criteria

A set of inclusion and exclusion criteria are implemented to carefully select each paper, as outlined in Table 1. The inclusion criteria are designed to ensure the inclusion of high-quality articles that met specific standards for this study:

1 articles written in English were included to facilitate comprehension and accessibility for a wider audience

2 articles were required to be supported by data and/or empirical evidence to ensure the inclusion of robust and evidence-based research

3 the focus was placed on articles published in peer-reviewed journals, which ensured a level of scholarly rigor and credibility.

Conversely, exclusion criteria were employed to exclude articles that did not align with the objectives of the study. Articles related to innovation determinants and performance at the regional, sectorial, firm, individual levels and other specific contexts were excluded. This deliberate focus on national-level analysis allowed for a more concentrated examination of the factors and dynamics influencing NIS.

Table 1 Article inclusion and exclusion criteria

Inclusion criteria	*Exclusion criteria*

• Articles in English
• Articles supported by data and/or empirical evidence
• Articles in peer-reviewed journals
	• Articles related to 'innovation determinants/performance' at the:
	  • Regional level
	  • Sectorial level
	  • Firm-level
	  • individual level, etc.

3.4 Data extraction

The keywords formulated for the search are:

('national innovation system', or 'national innovation capacity', or 'national innovation performance', or 'national innovation determinants', or 'innovation indices', or 'innovation scoreboard') AND ('data', or 'empiric*' or 'machine learning', or 'analytics', or 'data mining', or 'statistical learning').

It is worth mentioning that the search was conducted between 1984 and 2023, which includes all the years available on Scopus and web of Science.

Furthermore, the process of identifying appropriate studies involved multiple steps as depicted in Figure 1; each involving preset inclusion or exclusion criteria. In the initial step, papers were checked according to their source type and subject category. Then, only journal articles were selected.

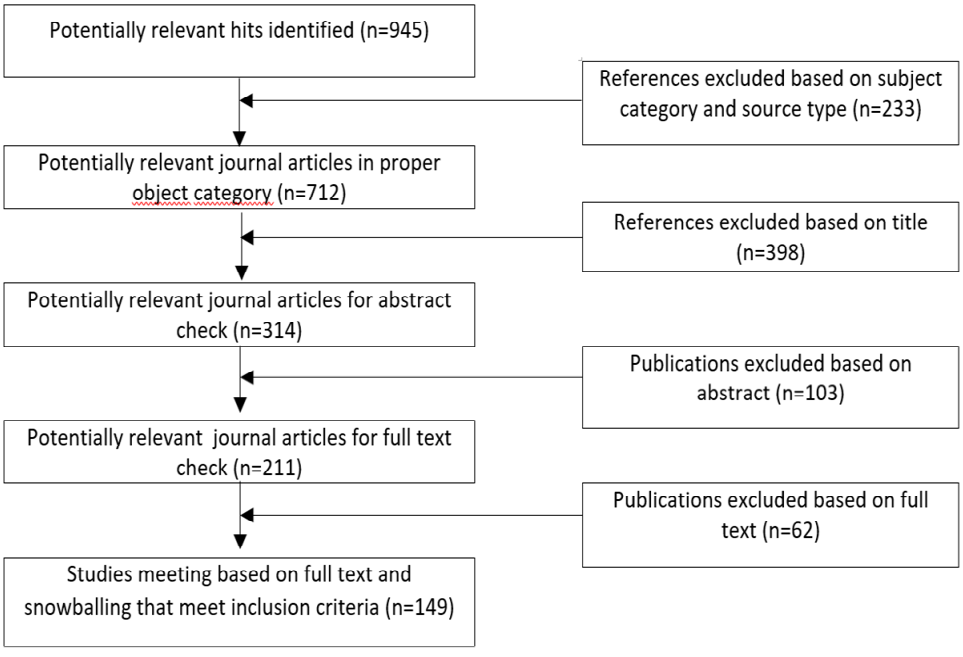
A second screening based on the titles was conducted. Subsequently, a third filter was implemented based on abstracts. The fourth and last filter required reading the complete paper.

For each selected article, the extracted information included the year of publication, the source of publication, the utilised data analytics techniques, the citation count, the institution, and the authors. The next step was synthesising and analysing the extracted articles to identify common themes, patterns, and trends across the included studies.

4 Descriptive analysis of the SLR

A total of 149 studies (detailed in Appendix 1) were collected after conducting the search procedure described in the previous section. As Figure 1 displays, in the initial step, using only the search string, 945 papers were returned. After applying the proper filters, the number of remaining articles decreased to 712, which then declined to 314 studies based on titles.

Figure 1 Literature selection process



Inappropriate articles were removed from the list of pertinent articles after reading the abstracts of all the remaining papers. The number of articles decreased to 211 at the end of this step. Finally, based on the analysis of the full text of each article, only 149 papers corresponded to the set of inclusion and exclusion criteria of this study.

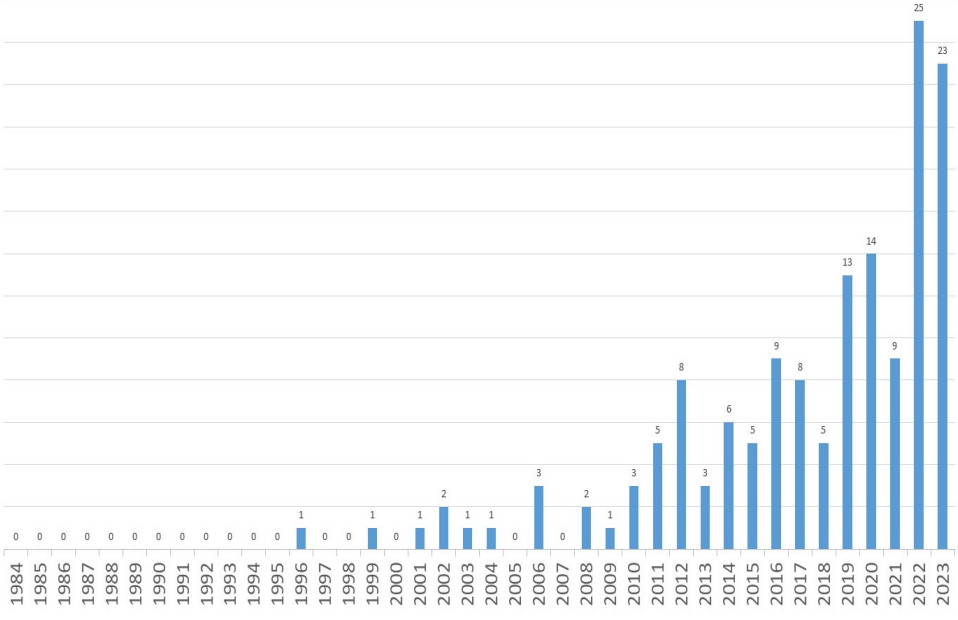
Figure 1 shows that sustained publishing in the targeted field began around 2008. NIS analysis has undoubtedly been ongoing since the early work of Lundvall (1985, 1988). However, data analytics has only recently been introduced in this field. The number of data-driven articles dealing with NIS is observed to increase exponentially after 2008 (with two publications), reaching 25 publications in 2022.

The number of published articles on national innovation analysis using data analytics is relatively small compared to articles published on national innovation as a whole during the same period, which totals 4,362 articles on Scopus and web of Science. This number underlines an expanding interest in this field of research.

The objective of this analysis step is to identify the primary data analytics for national innovation studies based on the most cited articles. Another objective is to identify journals with the biggest impact on the development of this field of study.

Overall, the 149 selected publications are published in 98 journals, indicating that there is no concentration in any particular journal. However, the top 10 publishing venues in terms of citations are shown in Table 2. These ten journals, which include only 32 papers out of 149, account for 80% of all citations.

Figure 2 Number of national innovation research publications per year (see online version for colours)



The journal '*Research Policy*' has, by far, the most articles in this field with ten publications out of 149. It also accounts for the most citation count (3,085 citations), corresponding to 62% of all citations. '*World Development*' journal is a distant second venue with only two articles and 277 citations. Third is the journal 'socio-economic planning sciences' with one article and 121 citations. Fourth is 'technovation' which published 5 articles and received 105 citations. The '*Journal of Business Research*' and '*Technology Analysis and Strategic Management*' rank fifth each with four publications, and 94 and 54 citations, respectively.

Table 2 Publications per sources and citations

Scopus source title	*Authors*	*Total articles*	*Year*	*Citations*	*Total citations*	*% of citations*
Research Policy	Furman et al.	10	2002	1,346	3,085	62%
	Muller and Zenker		2001	633		
	Fagerberg and Srholec		2008	456		
	Guan and Chen		2012	257		
	Castellacci and Natera		2013	169		
	Faber and Hesen		2004	110		
	Chaminade et al.		2012	47		
	Mate-Sanchez-Val and Harris		2014	33		
	Cirillo et al.		2019	18		
	Filippetti and Guy		2020	14		
World Development	Crespi and Zuniga	2	2012	256	277	6%
	Lee et al.		2021	21		
Socio-Economic Planning Sciences	Nasierowski and Arcelus	1	2003	121	121	2%
Technovation	Lee and Park	5	2006	64	105	2%
	Zabala-Iturriagagoitia et al.		2021	23		
	Chung et al.		2022	9		
	Barbero et al.		2021	6		
	Erzurumlu et al.		2022	3		

Table 2 Publications per sources and citations (continued)

Scopus source title	*Authors*	*Total articles*	*Year*	*Citations*	*Total citations*	*% of citations*
Journal of Business Research	Crespo and Crespo	4	2016	61	94	2%
	Ferreira and Dionísio		2016	17		
	Tekic and Tekic		2021	16		
	Yu and Huarng		2023	0		
Innovation: Management, Policy and Practice	Chen et al.	3	2011	50	87	2%
	Bartels et al.		2012	28		
	Elahi et al.		2016	9		
Expert Systems with Applications	Kou et al.	1	2016	70	70	1%
Journal of Competitiveness	Ivanová and Čepel	1	2018	56	56	1%
Technology Analysis and Strategic Management	Sohn et al.	4	2016	36	54	1%
	Zang et al.		2019	8		
	Oturakci		2023	6		
	Das		2022	4		
Innovation-Organisation and Management	Chen et al.	1	2011	50	50	1%
Total	*32*	-	-	*3,999*	*80%*	

It is also worth mentioning that although the number of data-driven publications on NIS was limited (only 149 over 40 years or less than 4 articles per year), the number of citations is quite impressive, reaching 5,012 citations or an average of about 33 citations per article. This can be explained by the fact that the findings of these studies are significant and are used in other fields.

Analysing the top three most cited articles yielded interesting results. The top-cited article in this field was published by Furman et al. in 2002 and received 1,346 citations. It proposed a new concept: 'national innovative capacity', which was defined as the capability of a nation to generate and commercialise a continuous supply of innovative technologies over a long-term period. This capacity concept depends on three main factors, namely the national innovation infrastructure, the environment of industrial clusters, and the relationship between these two elements.

The second top-cited article -with 633 citations- by Muller and Zenker was published in 2001 and discussed the role of knowledge-intensive business services (KIBS) in innovation systems at both the regional and national levels. It argued that KIBS plays an important role in knowledge production, transformation, and diffusion through their interactions with clients, especially manufacturing small – and medium-sized enterprises (SMEs).

The third top-cited article by Fagerberg and Srholec dates back to 2008 and received 456 citations. It investigated the impact of capabilities on the growth of economies. Four types of 'capabilities' were identified: innovation system, governance, political system, and openness. Statistical analysis showed strong relationships between GDP per capita and the innovation system and governance. It demonstrated little support however for the idea that differences in openness or political systems matter much for development.

The selected articles also originate from different geographic regions (The geographic repartition of universities of the authors of the selected papers). In this section, the aim is to identify countries interested in studying and examining this field of research.

Table 3 Geographic distribution of the selected papers

Countries	*Number of papers*	*Citation count*
China	13	406
USA	11	1,720
UK	9	163
Poland	9	31
Spain	8	294
South Korea	8	172
Russian Federation	8	73
Netherlands	7	402
Norway	6	701
Germany	6	753

Table 3 shows the geographic distribution (top 10) of papers selected focusing on national innovation determinants and Data Analytics, published between 1984 and 2023. Regarding the number of publications, there is no significant variation between the countries, but there is in the number of citations. China, at the top of the list with 13 articles, has a record of 406 citations, followed by the USA with 11 articles and 1,720

citations. The UK and Poland come next with 9 journals and 163 and 31 citations, respectively. Germany, on the other hand, ranks in 10th position with 6 articles and 753 citations.

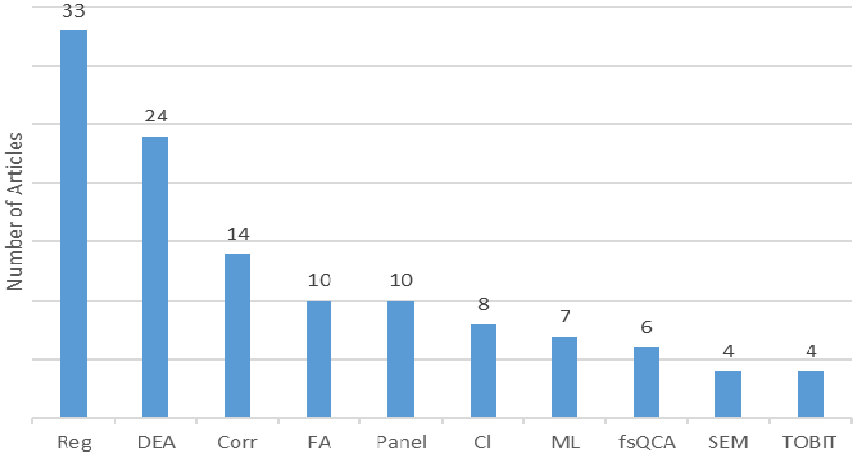
5 Analytics and scope of national innovation research

5.1 Data analytics techniques

Although investigating national innovation analysis from a data perspective, the 149 articles utilised a wide variety of data analytics techniques. Figure 3 shows the various techniques and methods utilised in national innovation data analytics. Among these articles, 33 employed regression techniques as their primary analytical approach. Additionally, 24 articles utilised the data envelopment analysis (DEA) method, while 14 articles employed the correlation method. The factor analysis (FA) and panel data analysis, on the other hand, were used in 10 articles each.

Furthermore, machine learning (ML) techniques were used in seven articles, while both the fuzzy set qualitative comparative analysis (FsQCA) and structural equation modelling (SEM) methods were employed in 6 and 4 articles, respectively. In addition, it is worth noting that a dozen other methods were also employed, each appearing only once or twice across the analysed articles (vector error correction model, Spatial Bayesian Models, …).

Figure 3 Data analytics techniques used in selected papers (see online version for colours)



Notes: Reg: regression techniques, DEA: data envelopment analysis, FA: factor analysis, Corr: correlation techniques, Cl: clustering analysis, panel: panel data analysis, ML: machine learning techniques, fsQCA: fuzzy set qualitative comparative analysis, SEM: structural equation modelling methods, CDM: Crepon, Duguet, and Mairesse (CDM) model.

ML has become an effective method to generate strong predictive algorithms in many different kinds of applications. These techniques can process various types and multidimensional data as well as extract underlying associations from data in changing and challenging environments (like NIS) (Wuest et al., 2016; Carvalho et al., 2019).

Taking this into consideration, it appears that there is a need for scholars to take advantage of these techniques to boost their studies on innovation, especially at a national level.

5.2 Countries subject of studies

The concept of a national innovation system was developed in the mid-1980s in an attempt to understand

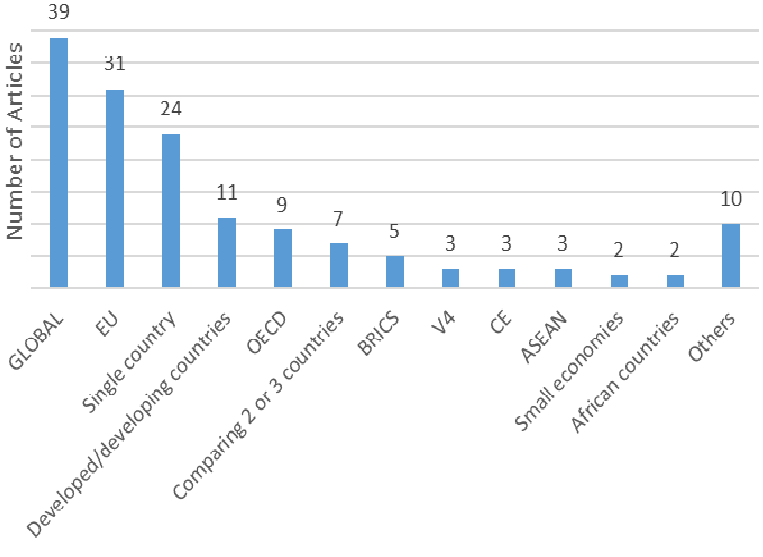
1 the wide range of variables that determine a nation's capacity for innovation

2 how these elements explain the differences between nations in terms of competitiveness and prosperity (Lundvall, 1985 and 1992; Edquist, 1997).

At first, OECD-member developed economies were the primary target of this research (Nelson, 1993). Later on, it shifted to innovation systems in the context of developing – and less-developed countries (Lundvall et al., 2009; Castellacci and Natera, 2011). More Recently, studies analysing NIS have focused on classifying countries by their income into income groups (Choi and Zo, 2019; Leontitsis et al., 2018).

As depicted in Figure 4, a striking remark is that 26% of the selected papers (39 papers) are analysing the NIS at a global level. This means that the researchers' findings applied to all economies, regardless of development level, and that the data was broadly applicable.

Figure 4 Distribution of selected papers based on the scope of national innovation analysis (see online version for colours)



Notes: EU: European Union countries, OECD: organisation for economic cooperation and development data countries, BRICS: Brazil, Russia, India, China, and South Africa, V4: Visegrad Group: the Czech Republic, Hungary, Poland, Slovakia, ASEAN: The Association of Southeast Asian Nations.

On a regional level, the region that received most of the attention in this research field is the European Union (EU). 21% of all selected papers are focused on EU countries, and how to rely on innovation at a national level, to enhance EU economic growth. This indicates a European recognition of the importance of understanding innovation dynamics on a collective level, considering global trends and regional contexts.

In contrast, 24 articles (or roughly 16%) examine NIS for a specific country. While only 11 papers out of 149 handle this topic from the perspectives of developed and developing countries. In addition, only seven articles out of the 149 comparatively investigated national innovation between countries; while nine studied national innovation in OECD countries and five studies for BRICS countries. This suggests a potential area for further exploration, as comparative studies can provide valuable insights into the variations and similarities in national innovation strategies and outcomes, and paths for improvement for countries seeking to enhance their national innovation performance.

Nevertheless, the current SLR found only four papers out of 149 that involved small economies and African countries. This is highly worrying as it shows that innovation is lagging in developing countries and calls for effective action. These results indicate that these countries need further NIS research attention, especially in identifying the causes limiting the progress of their innovation systems.

5.3 Data sources used

Data gathering is one of the most important research steps. To be able to perform their research successfully, researchers require reliable, relevant, and accessible data (primary: original data that are collected for the first time, or secondary: data that has already been gathered and statistically processed by another party) (Mazhar et al., 2021).

As Table 4 shows, the data utilised in the 149 reviewed articles are principally secondary data, originating from key sources such as the global innovation index (GII), European innovation scoreboard (EIS), World Bank surveys (WB), as well as data from organisations like OECD, UNESCO, UNCTAD, and UNDP. Another significant data source employed in the analysis of the considered articles comes from patent offices, such as the World Intellectual Property Organisation (WIPO) and the USA Patent and Trademark Office (USPTO).

For example, 39 articles use GII, of which 25 are published in the last two years, i.e., 2022 and 2023- demonstrating that this index is not only used to rank countries according to their innovativeness but presents also a powerful source of reliable data. It is worth noting that the GII is an annual global ranking of countries according to their ability and success in innovation, prepared since 2007 jointly by J. Cornell University, the INSEAD, and the WIPO (Hamidi and Berrado, 2018).

In summary, researchers in the national innovation research field rely on a diverse assortment of data sources. The utilisation of indices like the GII and European Innovation Scoreboard provides a standardised framework for benchmarking and comparing innovation performance across countries (Hamidi and Berrado, 2017). These indices incorporate multiple indicators and metrics, allowing for a comprehensive assessment of national innovation capabilities. Moreover, the utilisation of such comprehensive datasets promotes transparency and ensures the replicability of studies, reinforcing the credibility and validity of research findings. Overall, the findings highlight the importance of data-driven approaches in enhancing the understanding of

national innovation dynamics and facilitating evidence-based policymaking in this field. Moreover, the data sources presented in Table 4, can serve as a reference for researchers in the field of innovation, offering a wide spectrum of reliable, durable, and accessible data.

Table 4 Data source abbreviations and usage frequency

Abbreviation	*Data source full name*	*Usage frequency*
GII	Global Innovation Index	39
WB	World Bank	29
EIS	European Innovation Scoreboard	25
OECD	Organisation for Economic Cooperation and Development	16
USPTO	USA Patent and Trademark Office	15
WIPO	World Intellectual Property Organisation	14
UNESCO	United Nations Educational, Scientific and Cultural Organisation	11
WDI	World Development Indicators	10
GCI	Global Competitiveness Index	9
CIS	Community Innovation Survey	9
WCY	World Competitiveness Yearbook	8
EUROSTAT	Database European Commission	8
NI Survey	National Innovation Survey	7
NS	National Statistics	7
WOS	web of Science	5
WEF	World Economic Forum	5
EPO	European Patent Office	4
SCImago	SCImago Journal Rank	3
UNCTAD	United Nations Conference on Trade and Development	3
GCR	Global Competitiveness Report	3
WVS	World Values Survey	3
UNDP	United Nations Development Program	2
WEO	World Economic Outlook	2
IMF	International Monetary Fund	2
CANA	CANA Database	2
NSF	National Science Foundation	1
HD	Human Development Index	1
GCrI	Global Creativity Index	1
IEC	Index of Economic Complexity	1
NISTEP	National Institute of Science and Technology Policy (Japan)	1
NBER	National Bureau of Economic Research	1
WGI	Worldwide Governance Indicators	1

Table 4 Data source abbreviations and usage frequency (continued)

Abbreviation	*Data source full name*	*Usage frequency*
ILOSTAT	International Labour Statistics	1
TIMES	Trends in Mathematics and Science Study	1
UNIDO	United Nations Industrial Development Organisation	1
GET	Global Entrepreneurship Index	1
SCI	Science Citation Index	1
SSCI	Social Science Citation Index	1
IFS	International Financial Statistics	1
WTO	World Trade Organisation	1
UNSD	United Nations Statistics Division	1

5.4 How is the NIS examined?

NIS, in this SLR, are typically examined either:

1 based on all the indicators (inputs and outputs of national innovation)

2 by proving the impact of a single factor on the NIS.

The indicators considered in the first aspect often use the GII or the EIS framework (Cho and Park, 2022; Cavalcante, 2023; Erdin and Çağlar, 2023; Hsu, 2011; Halkos and Tzeremes, 2013; Albulescu and Drăghici, 2016; Wirkierman et al., 2023). Examples of the second aspect include a single factor such as the cultural dimension (Murswieck, 2020; Tekic and Tekic, 2021; Das, 2022; Escandon-Barbosa et al., 2022), or governance (Zupan et al., 2017; Zang et al., 2019; Bekana, 2020), or even the Foreign Direct Investment (FDI) (Qu et al., 2017; Hintošová et al., 2020; Haq, 2023).

Researchers were also interested in analysing the NIS by measuring:

1 its efficiency (Berger and Diez, 2006; Chen et al., 2011; Kou et al., 2016; Juřičková et al., 2019; Alnafrah 2021; Erdin and Çağlar, 2023)

2 its performance (Doyle and O'Connor, 2013; Elahi et al., 2016; Santos, 2020)

3 its determinants (Furman et al., 2002; Bartels et al., 2012; Zupan et al., 2017; Vokoun and Dvouletý, 2022).

This study contributes to the field of NIS (using data analytics) by shedding light on its evolution, identifying gaps, advocating for methodological advancements, offering a global perspective, and emphasising inclusivity in both research focus and policy considerations. These contributions would help enhance the understanding and potential impact of research in this dynamic and evolving field.

The implications of these findings suggest a need for a global, inclusive, and technologically advanced approach to both innovation management practices and government policies. Recognising the emerging nature of the field, leveraging AI technologies, diversifying data sources, and addressing geographical disparities are key considerations for organisations and policymakers alike.

The study's contributions extend beyond its specific findings to shape the direction of future research, inform methodological choices, and provide valuable insights for

policymakers, researchers, and practitioners in the field of national innovation using data analytics.

6 Conclusions

This SLR, based on a systematic selection of web of Science and Scopus-indexed articles for 40 years (1984 to 2023), has provided a comprehensive analysis of data analytics techniques utilised to study national innovation determinants and indices. A total of 149 articles met the selection criteria and were thoroughly examined, allowing for a detailed exploration of the topic.

The main findings of this SLR can be summarised in these main points:

- The field of studies examining national innovation using data analytics is a relatively new field with a limited research output of 149 articles over 40 years or a little less than 4 articles per year. these studies only began regularly in 2010, and more than 56% of them have been published in the last 5 years. This shows that this is an emerging field of research that needs more investigation. On the other hand, the number of citations for all these articles is quite high, which underlines the importance of their findings and that they are of interest in other research fields.
- No concentration of this field of research is observed in a specific country or journal. China, at the top of the ranking, has 13 out of 149 articles from its universities with a citation count of 406, followed by the USA with 11 articles but 1,720 citations. Norway and Germany at the 9th and 10th rank respectively, record 701 and 753 citations.
- Numerous techniques have been identified and utilised by researchers to analyse innovation at a national level, ranging from regression techniques and DEA to FsQCA and SEM methods. Nonetheless, there is a gap in the use of ML techniques, and Artificial Intelligence in general, in this field of research with only seven articles out of 149. The demonstrated ability of AI to determine proven patterns in almost all fields of research presents a huge potential for the innovation field of research and study.
- Several reliable, sustainable, transparent, and above all, available data sources have been identified, reinforcing the proposal to use AI techniques for NIS analysis and forecasting. The GII (39 articles), EIS (25 articles), and WB data (29 articles) are the primary sources of data utilised, followed by data from the Intellectual Property offices namely the USPTO (16 articles) and the WIPO (14 articles).
- The identified literature shows a geographical disparity as most research examines innovation in the EU and OECD countries. These studies are based mainly on the data and analyses offered by the European Innovation Index (EIS) and the various OECD data sources. Their results undoubtedly enlighten researchers and policymakers in these countries about the factors driving innovation and therefore economic growth. This shows the importance of having a solid, periodic data repository at the level of a country or group of countries.
- Low-income countries, small economies, African countries, and also developing countries, are rarely examined. Future studies should focus on these countries, to

help them better understand the constraints and opportunities they face in developing efficient strategies and strengthening their innovation capacities.

Future studies should target the geographical innovation disparity. There is a need to expand the scope to include low-income countries, small economies, African countries, and other developing nations. This would contribute to a more inclusive and global perspective on NIS.

Furthermore, the limited use of ML techniques and artificial intelligence in national innovation studies offers promising research opportunities. Investigating the potential of AI in analysing innovation patterns and trends at a national level could yield new insights. Exploring how ML algorithms can also provide more nuanced predictions.

Further analysis is also needed to compare the various methodologies employed in national innovation studies. Evaluating the strengths and weaknesses of other methods such as regression techniques, DEA, FsQCA, and SEM; and comparing them to ML methods would help identify the most appropriate techniques for specific contexts in this field of research.

Finally, policymakers, industry leaders, and researchers from underrepresented regions should be engaged, to incorporate diverse perspectives into the research agenda. This could help identify context-specific challenges and opportunities.

It is important to also acknowledge the potential limitations of this study's approach. While the search was conducted using the Scopus and web of Science databases, alternative search engines could have yielded different results, and thus, some relevant articles may have been missed. Although efforts were made to select comprehensive keywords, it is still possible that certain important articles were overlooked. Additionally, while inclusion and exclusion criteria were established to ensure relevance and rigor, some pertinent articles may be inadvertently excluded. Despite our best efforts to be thorough, the subjective nature of the selection process introduces the possibility of unintentional omissions.

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Appendix 1

The list of research articles meeting the selection criteria

Num.	*Paper title*	*Year*	*Journal*	*Authors*
1	The innovation gap of national innovation systems in the European union	2023	*Comparative Economic Research*	Dworak and Grzelak
2	Innovation, ICT penetration, trade and economic growth in developing and developed countries: a VECM approach	2023	*Competitiveness Review*	Singh and Siddiqui
3	Assessing the performance of national innovation systems with a helix-based composite indicator: evidence from 24 European Countries	2023	*Eastern European Economics*	Vetsikas
4	A taxonomy of European innovation clubs	2023	*Economia Politica*	Wirkierman et al.
5	The impact of innovation on economic growth, foreign direct investment, and self-employment: a global perspective	2023	*Economies*	Dempere Jet al.
6	Impact of FDI and Its absorption capacity on the national innovation ecosystems: evidence from the largest FDI recipient countries of the world	2023	*Foreign Trade Review*	Haq
7	Innovation performance and its determinants: what does it take to succeed?	2024	*Innovation and Management Review*	Costa Cavalcante
8	R&D expenditure as a determinant of the aggregate innovation index in the V4 countries	2023	*Innovative Marketing*	Ivanová and Žárská
9	National innovation efficiency: a DEA-based measurement of OECD countries	2023	*International Journal of Innovation Science*	Erdin and Çağlar
10	Drivers of creation trajectories innovation in the time: another alternative for Hofstede model in the cross-national analysis	2022	*International Journal of Innovation Science*	Salas-Paramo et al.
11	Configural analysis of GII's internal structure	2023	*Journal of Business Research*	Yu and Huarng
12	The determinants of innovation performance: an income-based cross-country comparative analysis using the Global Innovation Index (GII)	2023	*Journal of Innovation and Entrepreneurship*	Bate et al.
13	National innovation systems and the achievement of sustainable development goals: Effect of knowledge-based dynamic capability	2023	*Journal of Innovation and Knowledge*	Li et al.
14	Technological Catch-Up, innovation, and productivity analysis of national innovation systems in developing Countries in Africa 2010–2018	2023	*Journal of the Knowledge Economy*	Ndicu et al.
15	A pooled overview of the European national INNOVATION systems through the lenses of the community innovation Survey	2023	*Journal of the Knowledge Economy*	Disoska et al.
16	FORECASTING THE INNOVATION OF UKRAINE'S ECONOMIC DEVELOPMENT IN A GLOBAL DIMENSION; [Прогнозування інноваційності економічного розвитку України у глобальному вимірі]	2023	*Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*	Honcharov et al.

The list of research articles meeting the selection criteria (continued)

Num.	*Paper title*	*Year*	*Journal*	*Authors*
17	Determining the key factors of the innovation gap between EU countries	2023	*Problems and Perspectives in Management*	Polyakov et al.
18	Do politics and administration affect innovation performance? A comparative analysis;	2023	*Revista de Administracao Publica*	Cavalcante
19	Perception of scientific and social values in the sustainable development of national innovation systems	2023	*Social Sciences*	Volchik et al.
20	R&D expenditures on innovation: a panel cointegration study of the E.U. countries	2023	*Sustainability (Switzerland)*	Dritsaki and Dritsaki
21	Factors influencing innovation performance in Portugal: a cross-country comparative analysis based on the global innovation index and on the European innovation scoreboard	2023	*Sustainability (Switzerland)*	Coutinho and Au-Yong-Oliveira
22	The influence of bottlenecks on innovation systems performance: Put the slowest climber first	2023	*Technological Forecasting and Social Change*	Zofio et al.
23	Comprehensive analysis of the global innovation index: statistical and strategic approach	2023	*Technology Analysis and Strategic Management*	Oturakci
24	National innovation systems and global value chain participation: the role of entrepreneurship	2022	*European Journal of Development Research*	Ma et al.
25	Internet penetration as national innovation capacity: worldwide evidence on the impact of ICTs on innovation development	2022	*Information Technology for Development*	Xiong et al.
26	National culture and innovation: a multidimensional analysis	2022	*Innovation and Management Review*	Espig et al.
27	International, national and sectoral determinants of innovation: evolutionary perspective from the Czech, German, Hungarian and Slovak community innovation survey data	2022	*Innovation: The European Journal of Social Science Research*	Vokoun and Dvouletý
28	The study of innovation and absorptive capacity of BRICS countries by using multiple regression analysis	2022	*International Journal Of Innovation*	Usman et al.
29	The influence of non-R&D channels on innovation in a developing economy: an empirical analysis in the context of India	2022	*International Review of Applied Economics*	Kale
30	Exploring the global innovation systems perspective by applying openness index to national systems of innovation	2022	*Journal of Open Innovation: Technology, Market, and Complexity*	Cho and Park
31	Feedback effects of economic growth on innovation: a country-level empirical study	2022	*Journal of Science and Technology Policy Management*	Thangavelu et al.
32	The effect of cultural orientations (performance and sociality) on country innovation: a trajectories analysis perspective	2022	*Journal of Science and Technology Policy Management*	Ramirrez-Urraya et al.
33	The impact of innovation systems on e-commerce capacity	2022	*Journal of the Knowledge Economy*	Zygiaris

The list of research articles meeting the selection criteria (continued)

Num.	*Paper title*	*Year*	*Journal*	*Authors*
34	The efficiency of national innovation systems in post-soviet countries: DEA-based approach	2022	*Mathematics*	Ratner et al.
35	The national innovation system in a catching-up country: empirical evidence based on micro data of a triple helix in Poland	2022	*Oeconomia Copernicana*	Świadek et al.
36	Natural resource dependence and innovation efficiency reconsidered	2022	*Resources Policy*	Wilson and Vellinga
37	Comparison of national innovation systems in the European union countries	2022	*Risks*	Dworak et al.
38	The impact of national culture on innovation: a comparative analysis between developed and developing nations during the Pre-and Post-Crisis Period 2007–2021	2022	*Social Sciences*	Lee et al.
39	Fostering innovation in Romania. insights from the smart specialisation strategies	2022	*Studies in Business and Economics*	Ogrean and Herciu
40	The effect of cultural orientations on country innovation performance: Hofstede cultural dimensions revisited?	2022	*Sustainability (Switzerland)*	Escandon-Barbosa et al.
41	Investigation of E-27 and candidate countries' lifelong learning, R&D–innovation performances and gross domestic product by multidimensional scaling analysis	2022	*Sustainability (Switzerland)*	Bulut et al.
42	Assessing the dual innovation capability of national innovation system: empirical evidence from 65 countries	2022	*Systems*	Lu et al.
43	Analysis of global innovation index by structural qualitative association	2022	*Technological Forecasting and Social Change*	Huarng and Yu
44	The role of international networks in upgrading national innovation systems	2022	*Technological Forecasting and Social Change*	Petraite et al.
45	Cultural determinants of national innovativeness: a 56 country Bayesian analysis	2022	*Technology Analysis and Strategic Management*	Das
46	Global innovation efficiency assessment of EU member and candidate countries via DEA-EATWIOS multi-criteria methodology	2022	*Technology in Society*	Aytekin et al.
47	Investigating the relationship of high-tech entrepreneurship and innovation efficacy: the moderating role of absorptive capacity	2022	*Technovation*	Chung et al.
48	National innovation systems and dynamic impact of institutional structures on national innovation capability: a configurational approach with the OKID method	2022	*Technovation*	Erzurumlu et al.
49	The interplay between venture investing and innovation competitiveness of EU member-states	2021	*Academy Review*	Tokar
50	Redeveloping the national innovative capacity framework: European Union perspective	2021	*Economies*	Andrijauskiene et al.

The list of research articles meeting the selection criteria (continued)

Num.	*Paper title*	*Year*	*Journal*	*Authors*
51	Culture as antecedent of national innovation performance: evidence from neo-configurational perspective	2021	*Journal of Business Research*	Tekic and Tekic
52	Efficiency evaluation of BRICS's national innovation systems based on bias-corrected network data envelopment analysis	2021	*Journal of Innovation and Entrepreneurship*	Alnafrah
53	Examining economic complexity as a holistic innovation system effect	2021	*Small Business Economics*	Du and O'Connor
54	Methodology for calculating the European innovation scoreboard-proposition for modification	2021	*Sustainability*	Bielinska-Dusza and Hamerska
55	The productivity of national innovation systems in Europe: catching up or falling behind?	2021	*Technovation*	Zabala-Iturriagagoitia et al.
56	Is more always better? On the relevance of decreasing returns to scale on innovation	2021	*Technovation*	Barbero et al.
57	Variety of national innovation systems (NIS) and alternative pathways to growth beyond the middle-income stage: balanced, imbalanced, catching-up, and trapped NIS	2021	*World Development*	Lee et al.
58	A study on the relationship between cultural dimensions and innovation performance in the European Union countries	2020	*Applied Economics*	Murswieck et al.
59	The innovation gap between the polish economy and the European union	2020	*Comparative Economic Research-Central and Eastern Europe*	Dworak
60	National innovative capacity and knowledge creation in advanced economies: an empirical investigation	2020	*Innovation*	Afzal et al.
61	A new comparative model for national innovation systems based on machine learning classification techniques	2020	*Innovation and Development*	Alnafrah and Zeno
62	Does governance quality promote innovation in sub-Saharan Africa? An empirical study across 37 countries	2020	*Innovation and Development*	Bekana
63	Knowledge-intensive business services and innovation performance in Brazil	2020	*Innovation and Management Review*	Santos
64	National innovation performance: the role of human capital and social capital	2020	*Innovation: The European Journal of Social Science Research*	Suseno et al.
65	National innovation systems, economic complexity, and economic growth: country panel analysis using the US patent data	2020	*Journal of Evolutionary Economics*	Lee and Lee
66	Impact of innovation on economic growth: evidence from Malaysia	2020	*Malaysian Journal of Economic Studies*	Law et al.
67	Innovation indicators and the innovation process-evidence from the European innovation scoreboard	2020	*Management and Marketing*	Onea
68	Indices of innovation activity as components of macroeconomic stability assessment: how does the shadowing of investment flows affect?	2020	*Marketing and Management Of Innovations*	Tiutiunyk et al.
69	Does foreign direct investment boost innovation? The case of the visegrad and baltic countries	2020	*Quality Innovation Prosperity*	Hintošová et al.
70	Labour market regulation, the diversity of knowledge and skill, and national innovation performance	2020	*Research Policy*	Filippetti, and Guy

The list of research articles meeting the selection criteria (continued)

Num.	*Paper title*	*Year*	*Journal*	*Authors*
71	The innovation development in China in the context of globalisation	2020	WSEAS Transactions on Business and Economics	Babenko et al.
72	Understanding national innovation system (NIS) using porter's diamond model (PDM) of competitiveness in ASEAN-05	2019	Competitiveness Review	Afzal et al.
73	Fostering innovation under institutional deficiencies: formal state-business consultation or cronyism?	2019	ECONOMIA POLITICA	Sabry
74	Diffusion efficiency of innovation among EU member states: a data envelopment analysis	2019	Economies	Anderson and Stejskal
75	Assessing technical efficiency of innovations in Canada: the global snapshot	2019	International Journal of Innovation Management	Nasierowski
76	Dynamic structural comparison of BRICS national innovation systems based on machine learning techniques	2019	International Journal of Technological Learning, Innovation and Development	Alnafrah
77	Identifying enablers of innovation in developed economies: a national innovation systems approach	2019	Journal of Innovation Management	Menna et al.
78	Efficiency measurement of national innovation systems of the European Union countries: DEA model application	2019	Journal of International Studies	Juřičková et al.
79	Measuring the expected synergy in Spanish regional and national systems of innovation	2019	Journal of Technology Transfer	Leydesdorff and Porto-Gomez
80	Differences in efficiency of national innovation systems of Slovakia and selected EU countries	2019	Politicka Ekonomie	Adamovsky and Gonda
81	A cognitive model for managing the national innovation system parameters based on international comparisons (the case of the EU countries)	2022	Problems and Perspectives in Management	Khanin et al.
82	Only one way to skin a cat? Heterogeneity and equifinality in European national innovation systems	2019	Research Policy	Cirillo et al.
83	Does governance efficiency matter for national innovative capacity? One tale from different countries	2019	Technology Analysis and Strategic Management	Zang et al.
84	Simulation of the national innovation systems development: a transnational and coevolution approach	2019	Virtual Economics	Kravchenko
85	Does innovation is driving force? Analysis and control for EU, Poland and Ukraine	2018	Financial And Credit Activity-Problems Of Theory And Practice	Gajda et al.
86	The impact of innovation performance on the competitiveness of the Visegrad 4 countries	2018	Journal of Competitiveness	Ivanová and Čepel
87	National innovation system of India: an empirical analysis	2018	Millennial Asia	Mehta
88	On the meaning of innovation performance: is the synthetic indicator of the Innovation Union Scoreboard flawed?	2018	Research Evaluation	Edquist et al.

The list of research articles meeting the selection criteria (continued)

Num.	*Paper title*	*Year*	*Journal*	*Authors*
89	Does the national innovation system spur economic growth in Brazil, Russia, India, China and South Africa economies? Evidence from panel data	2018	*South African Journal of Economic and Management Sciences*	Sesay et al.
90	Transnational R&D centres and national innovation systems in host countries: empirical evidence from China	2017	*Canadian Public Policy*	Cui et al.
91	National innovation system as a model of economic development	2017	*International Journal Of Advanced Biotechnology And Research*	Anisimov et al.
92	Scientific or technological driving force? Constructing a system of national innovative capacity	2017	*International Journal of Innovation Science*	Chang and Fan
93	Investigating the relationship between information technology and innovation capability of economies: towards a virtual national innovation system	2017	*International Journal of Technological Learning, Innovation and Development*	Mohtarami
94	University spillover before the national innovation system reform in Japan	2017	*International Journal of Technology Management*	Fukugawa
95	Linking R&D strategy, national innovation system and FDI to firm performance	2017	*Journal of Chinese Economic and Business Studies*	Qu et al.
96	Learning-by-importing in emerging innovation systems: evidence from Ecuador	2017	*Journal of International Trade and Economic Development*	Fernández and Gavilanes
97	Does Decentralised Governance Lead to Less Scientific Output? A Fuzzy Set Analysis of Fiscal Decentralisation and Determinants of National Innovation Capacity	2017	*Lex Localis*	Zupan et al.
98	Do government policies foster environmental performance of enterprises from CEE region?	2016	*Comparative Economic Research*	Lewandowska
99	Measuring efficiencies of multi-period and multi-division systems associated with DEA: An application to OECD countries' national innovation systems	2016	*Expert Systems with Applications*	Kou et al.
100	Impact of common innovation infrastructures on the national innovative performance: Mediating role of knowledge and technology absorptive capacity	2016	*Innovation: Management, Policy and Practice*	Elahi et al.
101	Entrepreneurial activity and national innovative capacity in selected European countries	2016	*International Journal of Entrepreneurship and Innovation*	Albulescu and Drăghici
102	Global innovation index: Moving beyond the absolute value of ranking with a fuzzy-set analysis	2016	*Journal of Business Research*	Crespo and Crespo
103	What are the conditions for good innovation results? A fuzzy-set approach for European Union	2016	*Journal of Business Research*	Ferreira and Dionísio

The list of research articles meeting the selection criteria (continued)

Num.	*Paper title*	*Year*	*Journal*	*Authors*
104	Cultural correlates of national innovative capacity: a cross-national analysis of national culture and innovation rates	2016	*Journal of Open Innovation: Technology, Market, and Complexity*	Jang et al.
105	National innovation system and external constraint on growth	2016	*Revista de Economia Politica*	Resende and Torres
106	Re-evaluation of global innovation index based on a structural equation model	2016	*Technology Analysis and Strategic Management*	Sohn et al.
107	Examining the national innovation capacity and economic growth of Pakistan, India and Sri Lanka: a comparative study	2015	*International Journal of Technological Learning, Innovation and Development*	Usman et al.
108	National characteristics: innovation systems from the process efficiency perspective	2015	*R and D Management*	Liu et al.
109	Role of Public Research Institutes in Japan's national innovation system: case study of AIST, RIKEN and JAXA	2015	*Science Technology And Society*	Suzuki et al.
110	National innovation and knowledge performance: the role of higher education teaching and training	2015	*Studies in Higher Education*	Saad et al.
111	The role of innovation policy in the national innovation system: the case of Estonia	2015	*Trames*	Reiljan and Paltser
112	Social capital and national innovation system: a cross-country analysis	2014	*Cross Cultural Management*	Ghazinoory et al.
113	The analysis of innovation in Western Balkan countries in 2012	2014	*Economic Research-Ekonomska Istrazivanja*	Cvetanovic et al.
114	Building an innovation-driven economy–the case of BRIC and GCC countries	2014	*Foresight*	Gackstatter et al.
115	An empirical investigation of the national innovation system (NIS) using data envelopment analysis (DEA) and the TOBIT model	2014	*International Review of Applied Economics*	Afzal
116	Modelling national innovation system enabled by knowledge management	2014	*Journal of Business Economics and Management*	Chu et al.
117	Differential empirical innovation factors for Spain and the UK	2014	*Research Policy*	Mate-Sanchez-Val and Harris
118	Modelling the effect of national culture on countries' innovation performances: a conditional full frontier approach	2013	*International Review of Applied Economics*	Halkos and Tzeremes
119	Innovation capacities in advanced economies: relative performance of small open economies	2013	*Research in International Business and Finance*	Doyle and O'Connor
120	The dynamics of national innovation systems: a panel cointegration analysis of the coevolution between innovative capability and absorptive capacity	2013	*Research Policy*	Castellacci and Natera

The list of research articles meeting the selection criteria (continued)

Num.	*Paper title*	*Year*	*Journal*	*Authors*
121	ICT-integrated education and national innovation systems in the Gulf Cooperation Council (GCC) countries	2012	*Computers and Education*	Wiseman and Anderson
122	Dimensions of national innovation culture in croatia. Content validity of Hofstede's dimensions	2012	*Drustvena Istrazivanja*	Lažnjak
123	Consistency between innovation indicators and national innovation performance in the case of small economies	2012	*Eastern Journal Of European Studies*	Paas and Poltimäe
124	Determinants of National Innovation Systems: Policy implications for developing countries	2012	*Innovation: Management, Policy and Practice*	Bartels et al.
125	Modelling the relative efficiency of national innovation systems	2012	*Research Policy*	Guan and Chen
126	Measuring systemic problems in national innovation systems. An application to Thailand	2012	*Research Policy*	Chaminade et al.
127	ASEAN benchmarking in terms of science, technology, and innovation from 1999 to 2009	2012	*Scientometrics*	Rodriguez and Soeparwata
128	Innovation and productivity: evidence from six Latin American countries	2012	*World Development*	Crespi and Zuniga
129	Cross national comparison of innovation efficiency and policy application	2011	*African Journal Of Business Management*	Hsu
130	Are innovation and internationalisation related? An analysis of European countries	2011	*Industry and Innovation*	Filippetti et al.
131	An international comparison of R&D efficiency of multiple innovative outputs: role of the national innovation system	2011	*Innovation: Management, Policy and Practice*	Chen et al.
132	An international comparison of R&D efficiency of multiple innovative outputs: the role of the national innovation system	2011	*Innovation-Organisation and Management*	Chen et al.
133	Contagion effects of national innovative capacity: comparing structural equivalence and cohesion models	2011	*Technological Forecasting and Social Change*	Huang et al.
134	Dea performance measurement of the national innovation system in Asia and Europe	2010	*Asia-Pacific Journal of Operational Research*	Pan et al.
135	Modelling economic growth fuelled by science and technology	2010	*Estudos Economicos*	Ribeiro et al.
136	Measuring the relationships among university, industry and other sectors in Japan's national innovation system: a comparison of new approaches with mutual information indicators	2010	*Scientometrics*	Sun and Negishi
137	Adding meaning to measurement: evaluating trends and differences in innovation capacity among the states	2009	*Economic Development Quarterly*	Hall

The list of research articles meeting the selection criteria (continued)

Num.	*Paper title*	*Year*	*Journal*	*Authors*
138	Can host innovation systems in late industrialising countries benefit from the presence of transnational corporations? Insights from Thailand's manufacturing industry	2008	*European Planning Studies*	Berger and Diez
139	National innovation systems, capabilities and economic development	2008	*Research Policy*	Fagerberg and Srholec
140	Mapping national innovation systems in the OECD area	2006	*International Journal of Technology and Globalisation*	Balzat and Pyka
141	Do firms require an efficient innovation system to develop innovative technological capabilities? Empirical evidence from Singapore, Malaysia and Thailand	2006	*International Journal of Technology Management*	Berger and Diez
142	Research and development linkages in a national innovation system: Factors affecting success and failure in Korea	2006	*Technovation*	Lee and Park
143	Innovation capabilities of European nations: Cross-national analyses of patents and sales of product innovations	2004	*Research Policy*	Faber and Hesen
144	On the efficiency of national innovation systems	2003	*Socio-Economic Planning Sciences*	Nasierowski and Arcelus
145	Differences of innovative behaviour between national and foreign firms: measuring the impact of foreign firms on national innovation systems [1]	2002	*International Journal of Entrepreneurship and Innovation Management*	Molero and Heijs
146	The determinants of national innovative capacity	2002	*Research Policy*	Furman et al.
147	Business services as actors of knowledge transformation: The role of KIBS in regional and national innovation systems	2001	*Research Policy*	Muller and Zenker
148	A comparative macro-level assessment of New Zealand's 'national innovation system'	1999	*Prometheus: Critical Studies in Innovation*	Engelbrecht and Darroch
149	Linking technological, market and financial indicators of innovation	1996	*Economics of Innovation and New Technology*	Tidd Jet al.