# Chapter 13 / Capítulo 13

*Applied bibliometrics. From data to publication (English Edition)*
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# Academy, Government, And Industry / Academia, Gobierno E Industria

Bibliometric analysis has transcended its traditional application in academia to become a fundamental strategic tool in the three key sectors of the innovation system. This expansion responds to the growing need for quantitative evidence to inform decision-making across science policy, research and development management, and business innovation strategies. Each sector has distinct objectives, specific institutional logics, and evaluation criteria that profoundly shape how bibliometric information is used and interpreted. Understanding these sectoral differences is essential for designing appropriate evaluation systems.

The growing interconnection between these three areas through public-private partnerships, translational research projects, and evidence-based innovation policies has placed complex demands on bibliometric systems. These demands require indicators that capture not only traditional academic excellence but also social impact, technology transfer, and economic value creation. This chapter critically examines the particularities of bibliometric use across sectors, the tensions that emerge at their interfaces, and the opportunities to develop integrated approaches that respect the distinctive missions of each field.

## 13.1. Differences in objectives and indicators by sector

Academia has traditionally favored indicators of scientific excellence focused on the production of basic knowledge and its validation through the peer review system. The most widely used bibliometric indicators include citations, journal impact factors, and international collaboration indices, reflecting core values such as originality, methodological rigor, and contribution to disciplinary advancement. However, significant tensions persist across academic subsectors, with the humanities and social sciences exhibiting substantially different publication patterns than the natural sciences. These internal differences complicate the standardization of evaluation criteria even within the same academic sector.

The government sector uses bibliometrics primarily to inform science policy, allocate resources strategically, and evaluate the return on investment in research and development. The preferred indicators include volume of scientific production, participation in international networks, comparative thematic specialization, and contribution to national development objectives. Here, aggregate performance metrics at the institutional or national level predominate, with less emphasis on individual impact.

The fundamental tension lies in balancing indicators of international excellence with national relevance, especially in contexts where scientific internationalization may conflict with local needs.

Industry uses radically different bibliometric approaches, primarily geared toward competitive intelligence, technology watch, and intellectual property management. Typical indicators include patent analysis, mapping of technological environments, identification of key players, and detection of innovation opportunities. The time horizon is considerably shorter than in academia, with an emphasis on immediate commercial applicability and protection of competitive advantages. The characteristic tension arises between the need for business secrecy and open science practices, creating methodological challenges in capturing contributions that are not published in traditional scientific literature.

Collaborations between sectors generate specific needs for hybrid indicators that capture contributions to both knowledge advancement and technological development. These

partnerships require metrics that document academia-industry co-authorship, citations of scientific literature in patents, and researcher mobility between sectors. However, significant measurement challenges remain, particularly in capturing unpublished contributions, tacit knowledge transfer, and indirect impacts on value chains.

Developing meaningful indicators for these interfaces constitutes a crucial methodological frontier for contemporary bibliometrics.

The evolution of evaluation systems reflects divergent institutional pressures in the three sectors. While academia faces criticism over impact factors, the government sector faces demands for greater accountability, and the industrial sector requires more agile tools to navigate rapidly evolving technological environments.

These pressures are generating innovations in indicators such as alternative metrics, social impact measurements, and responsible innovation indicators. The risk of mechanically adopting indicators designed for another sector underscores the importance of developing contextualized evaluation frameworks.

The harmonization of indicators across sectors represents an ongoing challenge that requires careful balances between the standardization necessary for comparability and the flexibility essential for contextual relevance. International initiatives seek to establish common languages while recognizing legitimate differences in sectoral objectives. Recent advances in the analysis of large data sets offer opportunities to develop more nuanced indicators that capture multiple dimensions of value across different application contexts. This evolution toward multidimensional approaches promises to overcome the limitations of traditional systems while respecting the diversity of missions that characterize modern innovation ecosystems.

## 13.2. Evidence-based national science policies

National science policies based on bibliometric evidence represent a significant advance in the strategic management of research systems. These policies use quantitative analyses of scientific output to identify national strengths, areas of opportunity, and knowledge gaps that require priority attention. Bibliometrics provides decision-makers with objective indicators on the performance of the scientific system, the country's thematic specialization, and its relative position in the international context. This data-driven approach enables optimizing resource allocation to areas with the most significant potential for impact and aligning research investments with national development priorities. Comprehensive bibliometric diagnoses form the basis for designing effective, context-specific science policies.

These analyses examine research productivity by region, institution, and discipline, identifying clusters of excellence and emerging niches. The evaluation of international collaboration networks reveals strategic alliances and opportunities to strengthen the country's global insertion in world science. The detection of thematic trends through diachronic analysis enables the anticipation of future development and the prospective investment in areas with growth potential. These multidimensional diagnostics provide a complete snapshot of the national scientific system.

Bibliometrics critically informs scientific planning processes by identifying installed capacities and comparative advantages. The analysis of relative thematic specialization allows resources to be concentrated in areas where the country shows distinctive strengths or can develop competitive advantages. The evaluation of scientific impact through citations and other

indicators of intellectual influence guides the prioritization of funding toward research of higher quality and international relevance. These bibliometric criteria, combined with considerations of social significance, allow for the design of national research agendas that balance scientific excellence and national relevance.

The monitoring and evaluation of implemented science policies represents another crucial application of bibliometrics in public science management. Continuous bibliometric monitoring enables measuring progress toward established objectives, evaluating the return on investment in specific programs, and making evidence-based adjustments during implementation. Post-implementation impact studies reveal changes in publication patterns, collaboration, and scientific influence attributable to particular interventions.

This continuous evaluation facilitates institutional learning and iterative improvement of national science policies. International comparisons using bibliometric indicators place national performance in a global context. These comparative analyses identify countries with similar characteristics that have implemented successful policies, providing benchmarks for the design of national strategies. The evaluation of international scientific competitiveness using standardized indicators allows for the establishment of realistic goals and the monitoring of a country's relative progress. These informed comparisons avoid cognitive isolation and facilitate the learning of international best practices adapted to the specific national context.

National scientific information systems integrate multiple bibliometric sources to provide comprehensive dashboards for decision-makers. These platforms consolidate data on scientific output, patents, collaborations, and impact in accessible and visually intuitive formats. Interoperability among national and international databases enables integrated analyses that capture multiple dimensions of scientific performance and output. These visualization tools facilitate the interpretation of complex data by non-specialist audiences, democratizing access to strategic information for science policy.

Methodological challenges in applying bibliometrics to science policy include appropriately contextualizing international indicators to specific national realities. It is crucial to adapt global metrics to capture local relevance, regional impact, and contributions to national development. Complementing bibliometric indicators with qualitative data and case studies enriches the analysis and prevents quantitative reductionism.

This mixed approach produces more balanced assessments that inform comprehensive and socially responsible science policies. The evolution toward science policies based on bibliometric evidence represents a step toward more transparent, accountable, and effective management of national research systems. The growing sophistication of analytical tools enables the development of more precise, better-targeted, and evaluable policies using robust indicators. This data-driven approach helps legitimize science policy decisions among the public and the academic community, building consensus around national priorities based on objective diagnoses and rigorous analysis of the scientific landscape.

## 13.3. Institutional ranking and evaluation

As mentioned in Chapter 1, institutional rankings based on bibliometric indicators have become influential tools for the comparative evaluation of universities and research centers. These systems use standardized metrics that allow the performance of institutions to be placed in national and international contexts, facilitating the identification of relative strengths and areas for improvement. However, the proliferation of diverse methodologies and different emphases

on evaluation criteria generates results that must be interpreted with an understanding of their methodological foundations.

Transparency in calculation procedures and clarity about the objectives of each ranking are essential for their proper use in institutional management.

The central global ranking systems, such as the SCImago Institutions Rankings, the CWTS Leiden Ranking, and the QS World University Rankings, employ distinct methodological and y approaches that reflect different conceptions of institutional excellence. While some favor indicators of productivity and scientific impact, others emphasize academic reputation, internationalization, or social impact.

These methodological differences explain the variations in the positions that the same institution may occupy in different rankings. A thorough understanding of the indicators that make up each ranking enables institutions to identify improvement strategies aligned with their particular missions and contexts.

Bibliometric-based institutional evaluation must carefully account for disciplinary differences to avoid bias against areas with distinctive publication and citation practices.

The humanities, arts, and certain social sciences exhibit bibliometric patterns that differ from those of the natural sciences and engineering, requiring methodological adjustments in evaluation systems. The normalization of indicators by field of knowledge, the use of percentiles instead of absolute values, and the consideration of diverse academic products beyond scientific articles are necessary practices for equitable institutional evaluations.

These methodological refinements enable fairer comparisons across institutions with different disciplinary profiles.

The responsible use of rankings in institutional management requires avoiding an obsession with numerical rankings and focusing on trend analysis and relative progress. Diachronic monitoring of performance on specific indicators provides more valuable information for strategic planning than mere attention to position in rankings. Identifying comparable institutions that serve as benchmarks allows for setting realistic goals and learning from successful experiences. This analytical approach transforms rankings from instruments of competition into tools for continuous improvement and institutional learning.

Complementing bibliometric indicators with other sources of information substantially enriches institutional evaluation. Integrating data on innovation, technology transfer, social impact, and student satisfaction provides a more comprehensive view of institutional performance. Multidimensional evaluation systems that balance research metrics with indicators of teaching, outreach, and management capture the complexity of contemporary university missions. This comprehensive approach prevents distortions in the allocation of resources and incentives within higher education institutions.

Well-founded criticism of ranking systems is a healthy practice that drives methodological improvements and more responsible uses.

Limitations in database coverage, geographical and linguistic biases, and excessive simplification of complex institutional realities are valid objections that must be considered

when interpreting results. The development of alternative rankings with innovative approaches, such as those that prioritize sustainability, inclusion, or teaching innovation, enriches the evaluation ecosystem and responds to emerging social demands. This diversification of evaluative approaches benefits the entire higher education system.

Institutional evaluation based on bibliometric evidence, when practiced with methodological rigor and awareness of its limitations, contributes to the transparency and improvement of higher education and research systems.

The challenge lies in developing institutional cultures that leverage the perspectives these instruments offer without falling into quantitative reductionism or an obsession with ranking positions. The balance between the informed use of metrics and the preservation of institutional diversity and academic autonomy is the key to an evaluation that genuinely serves the progress of science and higher education.

### 13.4. University-business knowledge transfer

Knowledge transfer between universities and businesses is a fundamental process for converting scientific knowledge into innovation and economic development.

This two-way flow allows advances generated in academia to find practical applications in the productive sector, while business needs inform new directions for university research. Bibliometrics offers valuable tools for measuring, analyzing, and optimizing these transfer processes, providing indicators of the intensity, characteristics, and impact of collaborations between the two sectors. The study of these interactions using specific metrics allows for the design of more effective technology transfer policies.

Scientific publications with multiple authors from both university researchers and business professionals are a direct indicator of collaboration in research and development. Analysis of these co-authorships reveals patterns of thematic specialization, collaborative intensity, and the evolution of university-business relationships over time. Identifying the most active institutions and companies in these collaborations allows for the recognition of best practices and successful models of linkage. An examination of co-authorship networks reveals how these collaborative ecosystems are structured and which actors serve as bridges between the two sectors, facilitating the flow of knowledge.

Citations of scientific literature in patents represent another crucial bibliometric indicator for measuring the transfer of scientific knowledge to the productive sector. This analysis enables tracking how findings from basic and applied research inform the development of new technologies and products. Identifying influential scientific publications in patent law reveals the areas where university research has the most significant impact on business innovation. The study of the technological fields that make the most intensive use of recent scientific knowledge helps to prioritize areas of research with high potential for technology transfer.

Indicators of researcher mobility between universities and companies complement the analysis of collaborations, showing how human capital facilitates knowledge transfer. Tracking career paths that alternate between both sectors reveals patterns of expert circulation. The identification of researchers who maintain scientific productivity during periods in companies demonstrates the compatibility between research activity and industrial technological development. This mobility favors the creation of informal networks and the transfer of tacit knowledge, crucial dimensions of the innovation process.

Assessing the economic and social impact of transfer requires combining bibliometric indicators with other data sources.

The creation of university spin-offs, research contracts with companies, and participation in public-private consortia represent tangible results of transfer that can be correlated with bibliometric indicators. The integrated analysis of these metrics allows for the development of more comprehensive models to evaluate the return on investment in university research and its contribution to the regional and national innovation ecosystem.

Methodological challenges in measuring university-business transfer include capturing unconventional forms of collaboration and attributing causality to research and innovation outcomes. Many valuable interactions, such as consulting, specialized training, or equipment sharing, are not reflected in traditional bibliometric indicators. Complementing these with qualitative studies, researcher surveys, and specific case analyses enriches our understanding of these complex processes. This mixed methodological approach produces more balanced and beneficial evaluations for knowledge transfer management.

The evolution toward more sophisticated indicators of university-business transfer represents an important frontier for applied bibliometrics. The development of metrics that capture the bidirectionality of knowledge flow, the diversity of transfer mechanisms, and the impacts at different time scales will enable more strategic management of these collaborations. This specialization responds to the growing importance of knowledge-based innovation for business competitiveness and socioeconomic development, positioning bibliometrics as an essential tool for science, technology, and innovation policy.

## 13.5. Bibliometrics for social impact assessment

Assessing the social impact of research using bibliometric tools represents a significant step toward more comprehensive evaluation systems. Traditionally, bibliometrics has focused on measuring academic impact through citations, but there is a growing demand to capture how research influences society beyond the educational sphere.

This evolution responds to the need to demonstrate the social value of public investment in science and to align research activity with urgent social challenges. The development of social impact indicators is an emerging field that complements traditional metrics of scientific excellence.

Mentions in public policy documents are a valuable indicator for measuring the influence of research on government decision-making. Analyzing how scientific publications are cited in legislation, parliamentary reports, and strategic planning documents reveals the path of knowledge from academia to the public sphere. Identifying research that is particularly influential in specific policies provides insight into the characteristics that facilitate the use of scientific knowledge in public management. This analysis informs strategies for making research more accessible and relevant to decision-makers.

Presence in the media and on social networks adds another dimension to assessing the social reach of research. Alternative metrics capture how scientific findings are discussed, shared, and commented on in digital platforms and traditional media.

This analysis reveals which research topics generate the most public interest and how science is integrated into social debate. Identifying researchers and institutions that effectively

communicate their work to the general public provides models for improving scientific outreach and engagement with civil society.

Collaborations with non-governmental organizations and local communities represent another facet of social impact that can be measured through adapted bibliometric indicators. Co-authorship with representatives of civil society, participatory research, and projects co-designed with communities demonstrates forms of socially rooted research. Analysis of these collaborations reveals more inclusive and socially responsible models of knowledge production. Identifying successful participatory action research practices informs strategies for building stronger bridges between academia and society.

Contributing to the Sustainable Development Goals provides an emerging framework for assessing the social impact of research. Mapping scientific publications to specific sustainable development goals allows us to visualize how research addresses global challenges such as climate change, inequality, and public health. This analysis identifies thematic gaps where more research is needed to address urgent social problems. Evaluating the contribution of research to global development agendas provides a contextualized perspective on the social value of science.

Methodological challenges in measuring social impact include causal attribution, the temporal diversity of impacts, and consideration of local contexts. The social effects of research may manifest years after publication and through indirect pathways that are difficult to trace. Complementing quantitative indicators with case studies, impact narratives, and participatory methodologies enriches the assessment. This mixed approach better captures the complexity of social impact and avoids reductionist measurement.

The evolution toward evaluation systems that equally value academic and social impact represents a necessary transformation in research culture.

The development of multidimensional frameworks that recognize different types of contributions to advancing knowledge and social well-being promotes more diverse and relevant science. This evolution responds to social demands for more responsible research that is aligned with the values and needs of the communities it serves, positioning bibliometrics as a tool for science that is more aware of its social role.

## 13.6. Metrics-based intellectual property management

Strategic intellectual property management has progressively incorporated bibliometric tools to optimize decisions on protection, commercialization, and technological development. These metrics enable evaluating innovation potential, identifying patenting opportunities, and prioritizing investments in research with a higher probability of generating valuable intellectual property rights. Bibliometric analysis applied to intellectual property transcends the traditional approach focused on patent counting, developing more sophisticated indicators that capture quality, impact, and competitive positioning. This quantitative approach complements traditional legal expertise in technology management.

The analysis of citations between patents and scientific publications is a fundamental metric for measuring knowledge transfer between science and technology. Citations of scientific literature in patent documents indicate how basic research feeds technological development, while citations of patents in scientific articles reveal reverse flows where technology influences research. The identification of publications that are particularly cited in patents points to research with high potential for technological application. Mapping these cross-citation

networks allows us to identify fields where science and technology interact most intensely, informing innovation-oriented research strategies.

Patent value indicators based on bibliometric metrics offer insights into the commercial and technological potential of inventions. The geographic breadth of protection, measured by the number of countries in which a patent is filed, reflects perceptions of global commercial value. Citations received from subsequent patents reflect technological influence and importance for the field's further development. Provide claim density and additional indicators of value. These combined indicators enable prioritization of intellectual property portfolios and informed decisions about maintenance, licensing, or abandonment of rights.

The analysis of technological landscapes using bibliometric techniques enables mapping of competitiveness and innovation opportunities. The aggregation and analysis of large patent datasets reveal technological trends, key players, and gaps in technological development. The identification of emerging technology clusters and converging technologies informs competitive positioning strategies. Analyzing the technological diversity of specific actors allows for the identification of opportunities for collaboration or acquisition. These tools support strategic research and development decisions by providing data-driven competitive intelligence.

Evaluating the innovative performance of institutions using intellectual property metrics requires specific methodological adjustments. Normalization by institutional size, thematic specialization, and research intensity allows for fairer comparisons.

The integration of patent indicators with scientific publication metrics provides a more complete view of innovation performance. The analysis of transfer efficiency, measured through the relationship between research investment and intellectual property generation, informs the productivity of the institutional innovation system. These comprehensive assessments support the strategic management of research and innovation.

Methodological challenges in applying bibliometrics to intellectual property include differences in patenting practices across sectors and countries, as well as temporal variability in protection strategies. Pharmaceutical technologies exhibit patterns different from those of information technologies, while patenting strategies vary significantly between companies and universities. Complementing this with qualitative analysis, case studies, and specific sector expertise enriches the interpretation of metrics.

This contextualized approach avoids erroneous conclusions drawn from direct comparisons across institutional or sectoral realities.

The integration of intellectual property information systems with bibliometric platforms represents the current frontier in data-driven technology management.

The development of dashboards that combine metrics on publications, patents, collaborations, and impact provides powerful decision-making tools. The application of artificial intelligence techniques for predictive analysis of innovation potential allows opportunities to be identified before they become apparent. This evolution toward comprehensive knowledge management systems positions bibliometrics as an essential component in modern technological innovation management systems.

You have now mastered the fundamentals of bibliometrics and have the methodological

tools, analytical skills, and critical perspective necessary to undertake rigorous and meaningful bibliometric research. This knowledge places you on the threshold of a vast territory to explore, where each study will represent both a practical application of what you have learned and an opportunity to contribute to the advancement of this constantly evolving discipline. The real journey begins now: take these foundations to new research questions, innovative contexts, and original contributions that expand the frontiers of quantitative analysis of science, always balancing metric rigor with the interpretive depth and ethical responsibility that characterize outstanding bibliometrists.

**Recap**

- The Triple Helix model describes the interaction between universities, industry, and government.
- Co-publications are indicators of scientific collaboration.
- National innovation systems measure technological efficiency.
- Technology transfer requires university liaison offices.
- Public policies guide research priorities.
- Patents reflect the practical application of knowledge.
- Entrepreneurial universities promote spin-offs and startups.
- Combined indicators (publications + patents) show innovation.
- Ethical governance prevents conflicts of interest.
- Transparency in intellectual property ensures trust.
- Tax incentives encourage public-private collaboration.
- Balanced evaluation values basic and applied research.
- Technology parks promote knowledge transfer.
- International networks strengthen global innovation.
- University-industry agreements require precise regulation.
- Investment in R&D correlates with national competitiveness.
- Socioeconomic impact is an emerging criterion in evaluation.
- Measurement systems must incorporate social value.
- Equitable partnerships with developing countries reduce gaps.
- The Triple Helix is evolving toward quadruple helix models with civil society.

**Self-assessment questions**

1. What does the Triple Helix model describe?
2. What combined indicators can you use to measure university-industry transfer?
3. What ethical risks exist in academia-industry collaboration?
4. What public policy instruments promote innovation (subsidies, loans, tax incentives)?
5. How can you measure the socioeconomic impact of scientific research?
6. What role do spin-offs and technology parks play in knowledge transfer?
7. Why is it important to distinguish between fundamental and applied research in evaluation systems?
8. What factors define an entrepreneurial university?
9. What criteria allow for the evaluation of equitable international collaborations with developing countries?
10. What metrics capture the triple helix (publications + patents + contracts)?

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