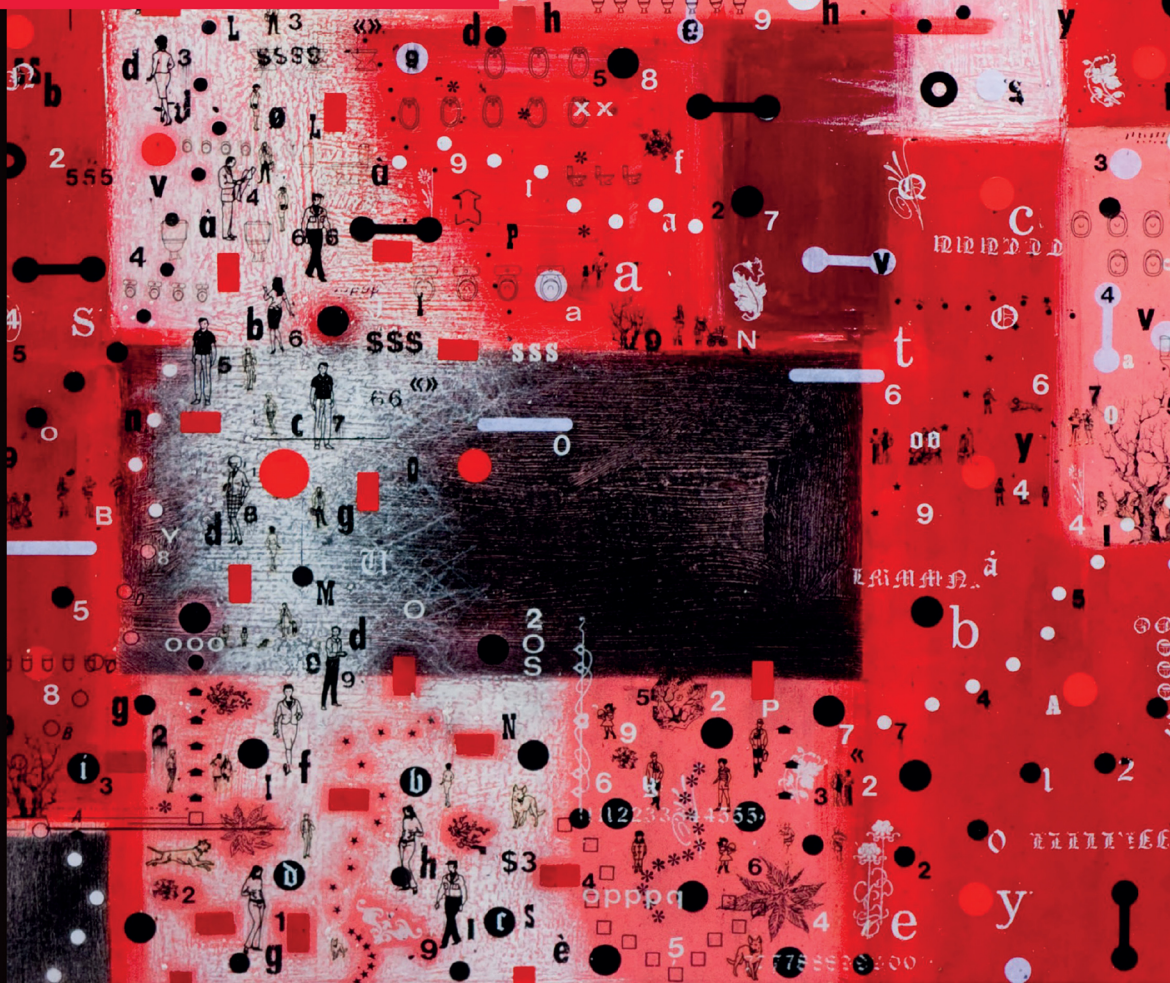




ROUTLEDGE
HANDBOOKS



Routledge Handbook of Academic Knowledge Circulation

Edited by Wiebke Keim and Leandro Rodriguez Medina
with Rigas Arvanitis, Natacha Bacolla, Chandni Basu, Stéphane Dufoix,
Stefan Klein, Mauricio Nieto Olarte, Barbara Riedel, Clara Ruvituso,
Gernot Saalman, Tobias Schlechtriemen and Hebe Vessuri

ROUTLEDGE HANDBOOK OF ACADEMIC KNOWLEDGE CIRCULATION

Knowledge is a result of never-ending processes of circulation. This accessible volume is the first comprehensive multidisciplinary work to explore these processes through the perspective of scholars working outside of Anglo-American paradigms. Through a variety of literature reviews, examples of recent research and in-depth case studies, the chapters demonstrate that the analysis of knowledge circulation requires a series of ontological and epistemic commitments that impact its conceptualisation and methodologies.

Bringing diverse viewpoints from across the globe and from a range of disciplines, including anthropology, economics, history, political science, sociology and Science & Technology Studies (STS), this wide-ranging and thought-provoking collection offers a broad and cutting-edge overview of outstanding research on academic knowledge circulation. The book is structured in seven sections: (i) key concepts in studying the circulation of academic knowledge; (ii) spaces and actors of circulation; (iii) academic media and knowledge circulation; (iv) the political economy of academic knowledge circulation; (v) the geographies, geopolitics and historical legacies of the global circulation of academic knowledge; (vi) the relationships between academic and extra-academic knowledges; and (vii) methodological approaches to studying the circulation of academic knowledge.

This handbook will be essential reading for academics, researchers and postgraduate researchers in the humanities and social sciences interested in the circulation of knowledge.

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In a book with more than 80 authors from different parts of the world, the question of language is not a minor issue. From the planning meetings to the chapter review sessions, through the call for contributions and the hundreds of emails, English was the *lingua franca* of all our communication (which, by the way, is not the mother tongue of any of the members of the editorial team). At the end of this process, however, it became clear that professional copy-editing of each chapter was necessary and, in this context, Rosemary Sebastian Tharakan joined our team. Her professionalism and dedication were key to ensuring that each chapter was of the standard expected of a publication of international quality and that deadlines were met in a timely manner. Thank you very much, Rosemary!

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TOWARDS A COLLECTIVE INTRODUCTION

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The circulation of knowledge has been embedded for millennia in the very practices that have shaped the experiences of human sociability. However, the type of circulation that interests us here has its origins in the profound changes associated with modernity and the birth of the idea of science as a distinct domain of society. Numerous authors have given accounts of this process of construction of modern science from the changes in the European West, making possible the “triumph of reason” and empirical knowledge over dogma and faith.¹ The backdrop to these cultural changes, however, was also rooted in powerful economic, political and territorial dynamics that drove what some authors have called the first globalisation (Nieto Olarte, 2019). Throughout this history of modernity, various experiences have accelerated the circulation of knowledge. These experiences brought into contact knowledge of different origins and natures, contributed to the development of that same science that was not as Western as it was presented (Hogendijk, & Sabra, 2003; Raj, 2006) and steered inventiveness in order to respond to new challenges and dangers. Thus, explorations with ambitions of conquest and colonisation of “unknown” territories and their populations drove the construction of fields of knowledge – as what happened with botany, for example. War contexts accelerated or occluded these exchanges; the great wars of the twentieth century indirectly contributed to the development of computer and communication sciences or other technologies in inter-allied collaborations (Bernstein, this volume). The Cold War conditioned a lack of communication between the so-called “Soviet science” and capitalist science. This era has also generated new scientific disciplines, such as Area Studies (Kwaschik, 2018). The scientific highlight of “the man on the moon” was also directly related to this geopolitical context that favoured non-circulation, rather than free movement of knowledge, between the East and the West. Social and political movements have also been great catalysts of circulation – the political philosophy in the Atlantic revolutions of the late eighteenth century, the reformism of the late nineteenth century or the political and sociological models of the postwar period after World War II make this evident.

While we are writing this collective introduction, several major societal issues steer debates around the circulation of knowledge: the Black Lives Matter movement; the COVID-19 pandemic and the accompanying discussions around scientific cooperation to develop vaccines; open access, lifting of patents and unequal access to scientific innovations; military

technology and its global trade; as well as the food and energy crises related to the multiple wars, the latest of which is taking place in Ukraine. Far from presenting simple contexts, these phenomena serve to show the limits of our understanding of knowledge circulation. At the same time, they also point to the continuities and regularities that historically and geopolitically sensitive understandings allow us to observe.

Why Study Academic Knowledge Circulation?

This Handbook deals with the circulation of a specific type of knowledge, namely academic knowledge, produced in specific institutions dedicated to research and teaching. The meaning of academic knowledge has been subject to historical changes throughout time. Contrary to the caricature of the university as an “ivory tower”,² academic knowledge has always been connected to, and in dialogue with, wider cultural, societal, political and economic dynamics. Knowledge is, therefore, profoundly relational. Academic knowledge is collectively produced through methodological procedures embedded in scholarly disciplines. Its circulation is a precondition for academic knowledge production.

Applied to knowledge, the term “circulation” competes with many other related terms, such as transfer, diffusion, mobility and travel. Across a range of disciplinary communities and debates, circulation has become the umbrella concept that brings together research on this topic.³ In a book project that precedes this Handbook (Keim et al., 2014), we observed that different disciplinary and language backgrounds shape the making of “important” or “key” texts on knowledge circulation. While in the context of Anglo-American and cultural studies, Edward Said’s *Traveling Theory* (1983) is perceived as the “first” important text, in francophone sociology, it is Pierre Bourdieu’s *Les conditions sociales de la circulation internationale des idées* (2002) that holds this status. In Science and Technology Studies (STS), Bruno Latour’s concept of “immutable mobiles”, developed in his book *Science in Action* (1987), is repeatedly used to think about knowledge that travels. The concept of “boundary object” (Star & Griesemer, 1989, further developed for knowledge circulation in the social sciences by Rodriguez Medina, 2014a, 2014b) allows for a more elaborate analysis of circulation inside specific social structures.

While other terms may be more suitable for describing the movement of persons or goods or for explaining unidirectional flows, the notion of circulation acknowledges that movement is always an action that produces a reaction. There are no passive receivers or appropriators. One of the major contributions of the sociology of scientific knowledge is to have removed the traditional distinction between the context of discovery and the context of justification, showing that the production and the diffusion of knowledge are inseparable processes (Kuhn, 1962; Latour, 1987; Schickore & Steinle, 2006; Latour and Callon, 1991). Speaking of circulation, rather than diffusion or transfer, is to insist on the possibility of reciprocities, competition and socialisation in different social spaces. In its simplest understanding, pieces of academic knowledge move from one place to another, from one person to another, within a given time frame. In more complex forms, knowledge, places and people are transformed during the process of circulation. What remains stable or changes cannot be decided theoretically but has to be empirically studied.

As far as we can see, there is no possibility of establishing a single general theory of the circulation of academic knowledge. Whatever the chosen approach, something always falls out of the picture or remains hidden. If the focus is on ideas, infrastructures are often out of sight. If materiality is emphasised, then it is at the expense of its symbolic dimension. Knowledge products are seen as mere outcomes if processes and practices are put at the centre. If

political factors are presented as central, then academic specificities are subsumed into a logic of power. In this sense, this Handbook presents an overview of a variety of alternative approaches that are sometimes contradictory because we have decided to show many possible paths to understanding academic knowledge circulation rather than favouring one. We have hesitated to provide readers – many of whom we imagine to be emerging researchers who enter this domain of study and seek orientation in the field – with a sort of reading list on the topic but finally abandoned this idea. The reference list to this editorial introduction contains some of the literature we have personally found useful in our own work. But readers will observe that each book chapter mobilises different references. We refuse to work towards a canon. Readers are encouraged to search for those approaches that they find useful for their own research and to let themselves be guided by each of the contributing authors.

How circulation is understood depends not least on the metaphors that shape its understanding (Lakoff & Johnson, 1980). One key metaphor is the circulation of blood in the body. It implies the body as a closed system and the heart as the driving force at its centre (Maasen et al., 1995). The metaphor of the network, in contrast, assumes decentralised and open connections (Schlechtriemen, 2014). Instead of closedness and centrality, it asks for connected nodes, hubs and holes. One can also emphasise flow and, thus, the circulation of fluids or air. Here, too, one can ask for pipelines and channels. The metaphor of traffic circulation and its focus on transport infrastructures emphasise the technical aspect. Analyses of the circulation of capital (and labour), in turn, highlight the political economy aspect and the accumulation of economic value through circulation. It is thus important to consider the metaphorical meaning of circulation because the global circulation of knowledge is not a closed system, and the naturalness suggested by the “natural” circulation metaphor could be misleading. In contrast, the emphasis on movement, the materiality of infrastructures and the relative connectedness of nodes can lead the way towards meaningful research questions. Finally, metaphors are themselves elements that circulate and whose meaning is adapted in this process (see Pál’s contribution in this volume).

The study of knowledge circulation needs to consider the fact that the spaces through which academic knowledge moves structure it. It is the researcher’s task to understand the conditions under which an idea manages to receive the support necessary for broader use. The movement of knowledge, either embodied or materialised, is always part of ever longer and larger loops in which actors, temporally and spatially circumscribed, engage in coproduction by recirculating such knowledge. Even when knowledge seems to move unidirectionally, this is merely an unintended consequence of the analytical tools and pragmatic choices through which researchers position themselves in relation to the studied phenomenon. This also explains why so many concepts and methods have been developed in the last decades to deal with specific aspects of knowledge circulation.

Because circulation has become an umbrella term, the concept of academic knowledge circulation often acts as an empty signifier or a liquid concept, provoking research in vast and disparate fields. To make sense of a very complex, multilayered, scattered, patterned, long-term and large-scale process, research needs to (1) *identify particular instantiations of academic knowledge circulation and provide adequate conceptualisations for them*; (2) *isolate, dissect and situate knowledge spaces and actors*; (3) *identify and ground channels of knowledge circulation*; (4) *determine historically limited moments or sequences*; and (5) *remain sensitive to the power dynamics at play*. These five requirements also apply to the study of academic knowledge that circulates beyond the academic realm, though there are other additional logics that also come into play here. Wherever one starts, and regardless of how the study of knowledge circulation is conceptualised, it is always an incomplete exploration. The need for a specific focus for each

investigation is the justification for the diversity of methodological and theoretical decisions by scholars. These five requirements for research on academic knowledge circulation shape the structure of the book and the editorial choices about the works to include in it. Therefore, we consider it relevant for the understanding of the theoretical and methodological discussion that this Handbook aspires to briefly provide a sort of archaeology of the project that laid its foundations.

How to Assemble a Handbook on Academic Knowledge?

The editorial team that took on the task of assembling this Handbook consists of scholars from different disciplines (anthropology, history, sociology, political science, economics and STS), countries and linguistic backgrounds outside of the anglophone academic worlds (Argentina, Brazil, Colombia, France, Germany, India, Mexico and Venezuela). This group initially met in Freiburg in 2012 in the context of a large research project on the circulation of knowledge and then had different occasions to further its academic exchanges, with meetings taking place in Strasbourg (2014), Buchenbach (2016), Brasilia (2018) and Puebla (2019). The last scheduled meeting, which was to take place in Porto Alegre in 2020, had to switch to a virtual format because of the COVID-19 pandemic. Throughout these years, the members of the team, along with other colleagues, engaged in a lively debate about conceptualisations, theories, cases, problems and methodological approaches to studying knowledge circulation.

After various meetings in Freiburg at the end of 2018 and the beginning of the following year, the editorial team first developed a book outline in a 2019 workshop held in Puebla. It was decided to publish an open call for contributions to the Handbook to reach out to colleagues working in the field whom we had not known before, as well as turn the group of authors as plural as possible, despite the known inequalities that characterise knowledge production. We aimed to collaborate with a large variety of individual scholars and groups working on knowledge circulation, in particular upcoming scholars as well as those working in non-hegemonic places and not just established scholars in the field. The editorial team decided to structure this call for contributions along thematic dimensions arrived at through a collective brainstorming and structuring exercise.

Our next step was to allocate the received and retained abstracts to the seven book sections that we developed based on our call and that correspond to the five research requirements outlined in the last paragraph: (i) conceptualising circulation of academic knowledge, (ii) spaces and actors of circulation, (iii) media of circulation, (iv) the political economy of knowledge circulation, (v) historical legacies, geography and geopolitics, (vi) academic/extra-academic knowledge, and (vii) methodological approaches to studying the circulation of academic knowledge. The collective initiative also continued through dialogue with all authors: in 2021, after the first selection, we had an online workshop to which all authors were invited. This presented some challenges – for example, the fact that the wide array of countries of residence would not enable us to find a suitable time slot for everyone. Still, discussing several matters and receiving inputs from the whole group undoubtedly contributed towards the current outcome, especially after further online workshops with authors that took place by section to enable dialogue and cross-fertilisation among chapters.

What does this approach to the collective development of the Handbook mean for its scope? Researchers often produce reference books to delimit the legitimate boundaries of a field of research, set standards, eventually create consensus around a canon of texts or authors and establish themselves as the authorities within this field. Studying the circulation

of knowledge is an emerging field, and our ambition has not been to either delimit or standardise it. Instead of boundary work, we understand this Handbook as structuring or organising work. It serves as a work-in-progress depiction of current debates within the field and will inform its subsequent development. More fundamentally, we believe that the study of the circulation of knowledge as an emerging field is at a stage where case studies will proliferate and concepts will also abound to focus on what is unique in each case. Achieving consensus around generic aspects of studying knowledge circulation will be the task of future endeavours and will require additional circulations of academic knowledge.

How to Structure a Handbook on Academic Knowledge Circulation?

In the following subsections, we present the general structure of the Handbook, outlining some premises that allow systematising the presented studies.

Section I: Key Concepts in Studying the Circulation of Academic Knowledge

The circulation of academic knowledge is a multifaceted phenomenon. It is a process that consists of several particular processes, which the concepts dealt with in the first section try to grasp. Although these concepts may have different backgrounds concerning the original intent in their propagation or disciplinary preferences for their use, we selected them because they help to understand the circulation of knowledge. The section tried to guarantee plurality, reflected not only at the conceptual but also at the authorial level, with contributors from China and Latin America to Europe.

The section crosses what could be understood as concepts in a strict sense – e.g., *reception*, *enacting* and *translation* – with what were seen as central processes towards enabling circulation, as is the case with *writing*, *contextualising* and *consecration*. As our examples already show, this does not mean that it is effectively possible to separate conceptual and process-specific aspects: in fact, the different chapters point towards how these traits are intertwined. For instance, writing and reading are closely related. Reception or localisation often includes translation. In all this, the most basic process taking place is interpretation, which relates to the universal human competence to use symbols as vehicles for meanings.

The main challenge was how to deal with key concepts through concrete, empirical cases while avoiding a simple case study treatment. Therefore, each chapter illustrates a conceptual framework through an in-depth case study opening up a conceptual dialogue with the objectives of the section. The examples have been selected based on broad appeal to the expert community. There are, however, differences in the disciplinary traditions that accompany the concepts and the foci of interest and guiding questions. Those interested in circulation as transfers and international movement of ideas have often used reception as a key concept. Others, who deal with the local appropriation of academic knowledge in peripheries, have preferred the idea of localisation or indigenisation. While the same process could be conceived of as reception, the terms localisation and indigenisation indicate a greater awareness of micro-processes with local relevance. The notion of translation focuses on the agency of a mediator. Researchers who focus on circuits and fields are interested in understanding the accumulation of prestige, academic capital and its recognition and validation. Inequalities and power struggles appear in most of the instances where the concepts are used.

Thus, the selection of concepts presented here should allow the reader to identify problems and find orientations in the different processes that allude to the circulation of academic knowledge. Conceptual choices should function as a product of the research, not as blinders.

Reading the contributions of Section I will help to understand the multidimensionality of the phenomenon and the different analytical foci that this field can offer.

Section II: Spaces and Actors of Circulation

A long tradition of the history of ideas and knowledge formulated its research problems on an almost axiomatic assumption regarding the immateriality of knowledge or, rather, the irrelevance of the spaces of production or its actors (Nagel, 1986). One exception has been the life of great scholars, such as the “founding fathers”, thus giving a markedly individual and isolated character to the production of scientific knowledge and putting emphasis on the significance of original works and their subsequent interpretations and utilisations.⁴ This traditional approach also assumed that the mechanisms of circulation were not a problem: true scientific knowledge was by itself universal, and hence the rigour of the Western scientific method had been the condition that allowed its diffusion on a global scale.⁵

In recent decades, advances in various disciplines that deal with the study of science have turned these premises upside down. They have focused the discussion on the materiality at the centre of their inquiries, giving flesh to the description of where, how and by whom knowledge is produced, communicated and eventually set in motion on a global scale (Cook, 2007; Raj, 2006; Schaffer et al., 2009; Secord, 2004).

One of these paths was opened by works which have shown that place does matter in the world of knowledge, both for understanding its production and reception (Livingstone, 2003, 2005; Murdoch, 1997). Based on case studies of how scientific theories have been produced and received in different places, such studies powerfully illustrate how knowledge moves around the world, making clear the futility of explaining the history of science without careful attention to the places and practices of circulation. This also means considering the national anchoring of science adequately (Kleiche-Dray, 2018).

Section II of this Handbook presents some examples of ways to address these issues based on the figures or roles involved in academic knowledge circulation, as well as some of the most important spaces where we can observe it. These contributions open a range of research problems constructed based on the preceding premises. First, whether we speak of an individual actor or of collective actors, the focus is on what makes them act, i.e., the action of displacement of knowledge. Sometimes, these movements are motivated by causes external to personal and professional decisions. Wars and political oppression are specific conditions that lead to the circulation of knowledge through forced emigration. The structural conditions of certain national spaces can condition mobility. The policies of governments or religious institutions constitute another framework from which to study what, sometimes unintentionally, sets knowledge in motion or hinders it (Diouf and Mamdani, 1994). Migration and mobility studies are closely linked to the study of the circulation of knowledge (Jöns, 2007; Zloch et al., 2018). Second, the watershed of modernity constitutes here an inescapable landmark. The process of secularisation establishes the conditions of the possibility of scientific knowledge and changes its relationship with religious faith. Modernity also incarnates in specific roles and institutions that progressively consolidate the fields of knowledge and their rules of operation. Technological change accelerates – from the invention of the printing press onwards – and links cultural goods with the logic of another expanding institution, the market. Simultaneously, the complex entanglement between the modern state and supra-state organisations delineates a place for academic knowledge as expertise while transforming the relationship between the local and the global. Section VI further pursues the significance of these developments for the circulation of academic knowledge beyond academia.

Finally, the research questions around the actors and spaces of knowledge circulation lead us to the critical deconstruction of their imbrications with power relations (which will be deepened in Section V). International scholarly communication can be traced through its conventional spaces, such as scientific associations and conferences and international organisations. They appear hierarchical and gendered. More recently, museums have come into focus as significant spaces (Cornish et al., 2021; Driver et al., 2021). For instance, the emerging field of Andean archaeology was a result of the circulation of Andean pre-Columbian antiquities and artefacts across the Americas and the Atlantic during the late nineteenth century along the contours of intellectual networks. It linked communities of owners, brokers, losers, including private collectors and museums (Gänger, 2013). Libraries are another central space of knowledge circulation through their physical collections and the access they grant users to digital collections. Using their “privilege to select” (Schmidt, 2020), libraries curate knowledge. Critical analyses highlight how they render some intellectual products accessible and why they obfuscate the circulation of others. Thus, when speaking about international knowledge circulation, the adjective “international” must not hide the imbalances between places that do not enjoy the same degree of visibility and recognition. Though such inequalities are not new and are at the basis of the association of the idea of science with the European and Christian West, the logic of the digital era has deepened it. A panorama emerges in which a huge amount of literature is barely covered in bibliographic databases, self-constituted as the spaces that give relevance and international character to academic knowledge (Beigel, 2017; Beigel & Salatino, 2015; Schmidt, 2020; Vessuri, 2016; Wagner & Wong, 2012).

The sheer number and varied nature of the actors involved in producing and circulating knowledge should be noted. In this section, we find not only key actors but also many that are absent. Spaces with undoubted epistemic value are mentioned but many, although they have it too, are not. Small businesses in home garages can revolutionise computer knowledge. Government departments with a handful of experts can reshape the way we think about social problems. Isolated geniuses intermingle with corporate conglomerates. Conferences foster academic communication but phone calls (now replaced by Zoom) between colleagues who shared rooms while studying for their PhDs are also important. In sum, the list of actors and spaces we present here cannot be considered exhaustive but we are convinced of its relevance.

Section III: Academic Media and Knowledge Circulation

For academic knowledge to circulate, it requires material infrastructures. The contributions to sections III and IV emphasise the importance of grounding knowledge circulation in its material dimension. Section III highlights key media of circulation and their transformations throughout history – from print to digital culture. These media could be considered black boxes transporting knowledge from one location to another. However, each chapter challenges this view and opens the boxes to describe them in all their complexity and structuring effects throughout time.

Codices, manuscripts and the modern book have played a fundamental role in modern culture that has been maintained for centuries. Only in the twenty-first century, with the irruption of the digital world, do we see a change in the traditional methods of disseminating knowledge. Surely the printed book will not give way to the digital world but it will have to coexist with new forms of communication, which, like the printing press, will have considerable consequences on the history of knowledge. The introduction of new communication

technologies in recent years has stimulated curiosity about possible historical precedents and has given the printing revolution an unexpectedly long lease of life.

After Gutenberg, successive technological innovations appeared that made the printing press an increasingly powerful actor. These were suitable for printing not only written texts but also images, large maps and posters. Mechanical, steam and, later, electric printing presses made the process very fast and inexpensive, leading to the modern world being flooded with texts.

The function of the printing press was decisive, and a necessary condition for what we now understand as modern science to exist (Eisenstein, 2012 [1979]). The crux lies in the potential of the printing press to produce multiple identical prints of the same image or text. Hundreds and sometimes thousands of copies of the same image or text on paper had a definitive effect on knowledge. The dissemination of identical data, presented in the same way to a hitherto culturally and geographically isolated audience, allowed knowledge, as we understand it today, to evolve through standardisation, preservation and accumulation. Anatomy, for example, as understood today, is only possible to the extent that medical students and professors share the same language and way of understanding and representing the human body. Multiple copies of a treatise or drawing, the consistent reading of the same text by many readers and the collection of diverse opinions on a particular topic facilitate debate and the development of a critical culture within ever-widening communities.

A book or article in a journal with multiple readers now has a different audience and reception. It is no small thing that the scientific societies of the seventeenth century, such as the Royal Society of London or the different science academies had their own printing presses and periodicals. Specialised serial publications – as those of us who are part of the academic and scientific world well know – are to this day the main means of disseminating knowledge, sifted through in turn by the institutions of evaluation and the indexing and measuring of the impact factor.

This does not mean that the appearance of the printing press led to the disappearance of other means of communication but, rather, that different means of communication, such as manuscripts or oral communication, began to interact with printed materials. Similarly, oral and printed forms of communication subsist and interact today, in which various media are used, such as radio, television, cinema or the internet and, of course, teaching in institutions such as universities (Scolari, 2012).

It is not possible to give printing a determining importance outside the cultural and social context that led to its development and impact. The visions of technological determinism, which saw in the printing press an agent triggering social changes, must be explained in the precise context in which the printing revolution took place (Johns, 1998). To begin with, the success of the publishing industry occurred in the context of a growing demand for written materials. In Russia and the Orthodox Christian world, for example, the penetration of the printing press, with similar machines, was notoriously slower. In the East, the printing press had been known for several centuries before Gutenberg but its impact was never level with that of modern Europe. This shows us that the printing revolution cannot be reduced to a matter of technological innovation.

As such, books did not escape the growing consumerism and desire to accumulate possessions that marked several generations of the European Renaissance, and, by the early sixteenth century, it was already a robust industry with millions of copies in circulation. An important consequence was the interest and participation of entrepreneurs in the dissemination of knowledge and the production of books or newspapers. Put differently, the information and dissemination of knowledge have become a profitable business. With these new

entrepreneurs of knowledge, the notion of *copyright* and publication rights also appeared. A phenomenon of interest was the appearance of the idea of intellectual property, which arose as a response to consumption and the expansion of the printing press. Closely related to the above, the idea of the *author* was also consolidated since, thanks to writing, it was possible to achieve individual fame in a way that had not been seen during the Middle Ages. At the same time, they gave an important place to the linguistic skills of translation and to the agents who, through cultural diplomacy, made global circulation increasingly possible.

The emergence of the periodical press, for its part, transformed information into a commodity – it even incorporated forms of financing through advertisements from the seventeenth century onwards. Newspapers thus became a media for popularising and disseminating the new developments made possible by the scientific revolution (see also Section VI), not only informing but also stimulating popular and literary imagination around the power of scientific knowledge. In addition, the printing press facilitated the emergence of new writing and reading styles according to formats: chapters, paragraphs, bibliographical references and indices. A modern reader is familiar with certain text structures that determine a particular way of reading and learning. Summaries, reviews, footnotes and citations are part of our form of acquiring knowledge.

As the contributions in this section illustrate, in addition to written and visual artefacts, other media and infrastructures – such as objects, technologies and procedures, made possible by practices that go back in time (Gänger, 2014; Nieto Olarte, 2000) – also enable knowledge circulation. More contemporary interconnections based on associations between research groups, universities or financing programmes (Vinck, 1996) are also crucial to understand that knowledge not only moves and communicates but is also transformed in the very act of circulation. Finally, the very research objects scientists study circulate as well, in more controlled ways in some disciplines than in others. Biologists have created a largely shared agreement to study, for example, fruit flies or specific rats that have been bred specifically for this purpose and require adequate infrastructures to keep, feed, transport and reproduce them. Funding in such disciplines is often conditioned in such a way that the same kind of organism, called a model case, is used as the empirical object of research, resulting in the global circulation of such organisms. Literature, in quite similar ways, has agreed on a canon of texts for distinct genres. In the social sciences, on the contrary, the convention to study certain model cases, such as the French revolution for the epistemic object “revolution” or Chicago for “city”, is less explicit, resulting in an inability to take stock of the advantages of such collective conventions, while largely ignoring its negative effects, now increasingly voiced under criticisms such as critiques of Eurocentrism (Krause, 2021).

Section IV: The Political Economy of Knowledge Circulation

Circulation has always been a central concept in the political economy of science. But economics focused on science only lately (Mirowski & Sent, 2008; Stephan, 1996) and its understanding of circulation was limited to awards, prestige and academic recognition, distinct and separate from economic resources, manpower or the publication system that sustains them (Merton & Storer, 1973). Moreover, the dominant view was that academic exchanges were reciprocal rather than competitive (Hagstrom, 1965; Merton, [1942] 1973). This Mertonian view of scientific ethos was dismissed when laboratory studies and the anthropology of science examined how research was effectively done (Callon et al., 1986; Knorr-Cetina, 1981; Latour & Woolgar, 1979). In the making of science, scientific practices are shaped by external conditions and not only driven by epistemic considerations “internal”

to science (Latour, 1987). Thus, scientific communities and institutions became central actors in the proposed historical and sociological analysis and, consequently, the resources needed to create these institutions were regarded as necessary (Arvanitis and Gaillard, 1992; Gaillard et al., 1997). In the second half of the twentieth century, the reference was the national states and spaces (Crawford et al., 1993a,b; Kleiche-Dray, 2018). Particularly for developing economies, policy considerations were related to the construction of national scientific communities and national research institutions. In Latin America, science was an essential component of development policies, so much so that a book called *Science and Politics in Latin America* (Herrera, 1971) became a bestseller and scientific policies were an integral part of the rebellious “dependency theory”. In Asia, additionally to the early scientific development in China (Needham, 1954), the Islamic worlds (Hogendijk & Sabra, 2003) and India (Raj, 2006), all of which are stand-alone models of worldwide circulation of knowledge, science and technology policies were central to the early nation states like Thailand, Indonesia and Malaysia. In Africa, after the political independence of the former colonies, the creation of a national research policy was on the agenda (Chatelin & Waast, 1996; Gaillard & Waast, 1988; Waast & Gaillard, 2017). International organisations played an important role in discussions and comparisons of national experiences. These international institutions, mainly the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Organisation for Economic Co-operation and Development (OECD) (for its member countries), proposed and provided models of policymaking in every continent (Elzinga, 1996; Henriques & Larédo, 2013; Latour & Woolgar, 1979; Petitjean, 2009; Selcer, 2018; Sewell, 1975).

International scientific collaborations were growing everywhere, instituting the practice of calls for projects, seen not only as incentive policy instruments that permit guidance for the scientific agendas, but also as opportunities for additional research beyond the limits of national borders (Alom Bartrolí et al., this volume). These were practices that also permitted to extend the scope of “big science” projects, adding multinational partners. But when partners from poorer countries were engaged, it was usually related to a rather limited range of activities, often linked to high-level training or executing research teams and institutions that serve as local providers of access to fieldwork (Hountondji, 1990, 1994), thus integrating peripheral scientists to world science but in a state of subordination (Kreimer & Zabala, 2008). Circulation of people was limited but, above all, “brain drain” rapidly appeared as a consequence of the training of young scientists in the powerful hegemonic countries (Barré et al., 2003; Kapur & McHale, 2005). Moreover, publications were controlled by powerful “gatekeepers” in all academic disciplines.

This world system of science was stable and growing until the debt crisis in Latin America and Asia in the 1980s and Africa in the 1990s, resulting in a deinstitutionalisation of science (Mouton & Waast, 2009). National budgets in a wide number of countries were unable to sustain investments in research and development (R&D) in public institutions, while private R&D was limited to large corporations. Cooperation agreements were marginally useful in maintaining some activity within the national institutions but they also perpetuated the unequal North-South partnerships funded under the chapters of aid for development (Gaillard, 1999).

The new century dawns on an entirely different scenario. Private foundations have become the main funders of research internationally (Vessuri, 2017). Many countries formerly considered peripheral are now regional hubs for scientific exchanges. The BRICS (Brazil, Russia, India, China and South Africa) countries appeared at the forefront as active protagonists of science and technology policies. Moreover, knowledge infrastructures become

central to the wider circulation of ideas and intellectual productions, and their complexity continues to grow (Bowker, 2001). Hypertexts and the internet are examples of these engines of knowledge (Bernstein, this volume). The network becomes a central figure and an analytical tool in the organisation of collective work. It was not until the end of the twentieth century that scientifically small countries, many of whom are located in former colonies, were “invited” to join the international networks under the assumption that linking to wide international scientific networks would cost less than creating their own autonomous scientific institutions and community (Schott, 1993; Wagner, 2008). Moreover, many regional policy experiments, embodied in projects, platforms or “excellence centres”, and interdisciplinary ventures (Hamman et al., this volume), trying to create large scientific networks and pooling competencies over many countries on topics such as the environment, climate, coastal zones, biodiversity, global health and other similar global topics, go well beyond the usual national or disciplinary limits. But large networks are also networks of power and inequalities observed by comparing nations can now be identified inside these large networks of science (Arvanitis & O’Brien, 2019).

In this radical paradigm change, the circulation of knowledge and ideas has also been affected by two unexpected and contradictory tendencies. The first one is institutional and relates to the consolidation of research in certain universities that respond to the call for excellence (Paradeise & Thoenig, 2015). Universities adopt internationalisation policies where the university’s value relies on its capacity to attract foreign students, develop post-graduate research programmes and participate in international research consortia (Mihut et al., 2017; Musselin, 2008). Institutional prestige becomes a cardinal value of knowledge production and international rankings become a world currency of knowledge. Evaluation by the number of publications and citations is crucial and allows for comparisons of the value and quality of a university or a research unit, let alone a researcher. This “government by numbers” has profoundly affected the circulation of knowledge. At the same time, it offers possibilities for smaller countries or medium-sized cities to consolidate their research capabilities. As has been demonstrated by geographers of world scientific activity (Maisonobe et al., 2016), the end result is that “intermediate” cities progress more rapidly than the large metropolises which were considered “engines of globalisation” (Sassen, 2007) in the twentieth century.

It also moves the lines of centre-periphery analysis: in order to mobilise foreign funding resources, governments tend to be more active on the front of science diplomacy and policymaking (Losego & Arvanitis, 2008). Incentives and subsidies towards research activities come along with competitive calls and structuring of academic research units in lists of recognised units as legitimate research groups targeted by public policies. In the global research system, contrary to the internationalised national research systems, national state representatives are in constant exchanges with funders from private foundations, among which the Bill & Melinda Gates Foundation and Wellcome Trust are the undisputed leaders (Vessuri, 2017). The greater complexity in funding mechanisms (Alom Bartrolí et al., this volume) challenges the strict division between research funding and research-performing entities since both of them launch their own competitive calls and since a variety of international programmes cluster NGOs, public research and private organisations into a complex financial and organisational mix. Universities play a central role in these alliances (Georghiou & Larédo, 2015; Soysal and Baltaru, 2021). International organisations (the European Union, World Bank, UN organisations and other international bodies) are often collaborating instead of only advancing their own proposals. Large international or multisite projects include mobility of research staff and training, further enhancing international collaborations and, at

the same time, multiplying the spaces for knowledge-making. In non-hegemonic countries, public funding, including what is traditionally provided in the framework of development aid, has not disappeared but is integrated into these new schemes and belongs to this new political economy of research.

The intellectual challenge for the academic and artistic worlds is to keep a critical stance within these large global webs of institutions: is there nothing more than a vast global market for skills and funding (Busch, 2017; Shinn et al., 2010)? The marketisation of knowledge, reflected in our use of the expression “knowledge production”, tends to confirm what every academic considers as a potential danger to the “ethos of science” (Berman 2012). Some authors would also defend the notion that barriers to the internationalisation of science relate to the nature of scientific objects (Dubois et al., 2016). These new interactions also create conditions for reconsidering the forms and criteria of publications in academic journals (Mills and Boncourt, this volume), which continue to be the ultimate, although imperfect, legitimisation instrument for research.

Globalisation has certainly modified the way knowledge circulates. Global urgencies such as climate change, pandemics and loss of biodiversity need a mix of knowledge beyond instituted disciplines. The resulting hybridisation of knowledge sources and practices that are in permanent interactions or tensions in the concrete networking of people, institutions and ideas should lead to the emergence of new topics that encourage the institutionalisation of new academic disciplines and establish new interdisciplinary fields. Thus, different moments and different spaces of knowledge circulation will inevitably appear and will interrogate new forms of legitimisation of academic knowledge.

Section V: The Geographies, Geopolitics and Historical Legacies of the Global Circulation of Academic Knowledge

Academic knowledge circulation is not only embedded in a material and institutional political economy as outlined in previous sections but also carries historical legacies that affect its epistemology as much as its actors, spaces and institutional infrastructures do (Waast, 1996). Global history has been an ongoing process of mingling and movements of peoples, goods, knowledges, cultures and religions. This process extends far into the past and hardly ever was smooth or even. Besides historical legacies regarding colonial pasts, current political constellations also call for a sensitivity to the power relations that shape global geopolitics of knowledge circulation.

In 1967, George Basalla published a seminal and repeatedly commented article: “The Spread of Western Science” (1967), which advanced the argument that Western science extended beyond Europe in three consecutive stages: a period in which places with non-scientific societies provided sources for European science (phase 1), a period of “colonial science” (phase 2) and, finally, a process of “transplantation” involving a struggle to achieve an independent, national and scientific tradition (phase 3). Such a linear approach to the study of the history of science has been the target of repeated criticism (Lafuente et al., 1993; Mac Leod, 1982) but what Basalla made clear was the importance of the history of science to pay attention to global processes of knowledge circulation. For the most part, the criticisms refer to a problematic assumption in the diffusion model: the idea that modern science left the confines of Western Europe as a finished and irresistible product that was then disseminated naturally from its origin to the rest of the planet without undergoing major alteration.

Such a process of diffusion implies the unity of Western science: its superior and ahistorical character entails a process involving the elimination of other ways of representing

and interacting with nature and the homogenisation of culture. These assumptions have played an important role in strengthening a world order centred on Europe. The belief in the natural spread of Western science is not only an obvious expression of Eurocentrism but also presupposes that non-Western cultures and traditions are obstacles to the development of knowledge. In this view, their only effect on European science would be to interrupt the natural progress of a truly rational system of thought.

The very idea of a “Western science” creates a dichotomy between science and other, purportedly inferior, forms of knowledge or belief, often referred to as local knowledge. This opposition of the scientific and local community implies that European science is not bound to any place or to any culture but belongs to every place and culture on earth. Thus, the dichotomy between science on the one hand and local knowledge on the other is inadequate since it assumes the universal character of Western civilisation, in opposition to the particular, local (and hence partial) nature of all non-European knowledge (Moity-Maïzi, 2011).

The attempt to escape a Eurocentric account of history, and the need to make other voices heard, cannot be reduced to denying the importance of Europe in modern history or neglecting the central role of Western science. Instead, its success and the consequences of this success for the geopolitical transformation of the world must be explained historically, socially, culturally and politically (Nieto Olarte, 2019). This effort must not neglect the fact that since the late nineteenth century, similar attempts were made within various non-Western sociological communities to break the “slavery of the mind” (Altbach, 1977) or to free the “captive minds” (Alatas, 1974) trained in Western knowledge for such a long time that this vision of science and the social sciences became naturalised and incorporated. Consequently, epistemic decolonisation is certainly one of the most difficult to achieve, even decades after the access to independence (Mignolo, 2012; Santos, 2014). The fight for the indigenisation of local – regional, national, continental, ethnic or religious – social sciences has been going on for a long time in diverse and separate parts of the world before gaining momentum in the late 1970s. Under different names (indigeneity, endogeneity, autonomy, relevance, authenticity, etc.) – the hypernym of which remains indigenisation – this quest for a more complex relationship between universality and particularity has fuelled some further circulation of theories, ideas and concepts, not only between non-hegemonic countries but also from there to the centres: in India, with the early contribution of Chekki (1990/91 [1987]), in Africa (Adésinà, 2002; Akiwowo, 1990, 1999; Hountondji, 1994, 1997; Lawuyi & Taiwo, 1990; Makinde, 1990; Sitas, 2004), in Islamic countries on the Islamisation of knowledge (Abaza, 2002; Edipoğlu, 2008; Hanafi, 2021; Keim, 2017b) and in North America’s first nations (Mihesuah, 2006).

An enormous amount of research on the history and sociology of science has made the contingent nature of scientific knowledge evident and questioned the traditional conception of a single, unique, neutral and ahistorical way of understanding nature or society. Once the premise that knowledge is communication was accepted, Basalla’s diffusion model became problematic and insufficient to explain the complexities of knowledge circulation.

Historians of science have also shown the impact of Eastern and other cultures on the history of Western science, and the idea that the origins of science are purely Western has become problematic (Hobson, 2004; Hogendijk & Sabra, 2003; Raj, 2006). Research on the history of science shows an intricate relationship between European expansion and the emergence of modern science. The scientific practices involved in the European exploration of “new” lands in the early modern period were related to the emergence of a new European self-perception that Christian Europe was a legitimate sovereign of the world (Said, 1978).

Knowledge becomes legitimate only once a particular way of explaining the world has been shared and accepted by a large community. Therefore, “discovery” and justification, or the production of knowledge and its communication, are not separable. That is to say, the universal truth is only possible once it is recognised as such by many. This has been made particularly clear by Syed Hussein Alatas (1974) when he suggested that the “transplantation of thought” from the West to the rest was at the heart of the emergence of “captive minds” that did not challenge the authority of such science since it had been naturalised by the very process of substituting all previous forms of knowledge with a single universal one, a process also referred to as epistemic violence (Brunner, 2020) or epistemicide (Santos, 2014). The triumph of Western science, then, was not a consequence of its nature and its privileged epistemological status, and the scientific hegemony of the West cannot be explained simply by the rigour of a specific method. Very much to the contrary, its status and success as a universal form of knowledge should be explained in terms of the actual practices that made the European claim of universality possible. It is no coincidence that the emergence of what is understood today as modern science occurred during the same period as the rise of the global European empires and simultaneously with the emergence of a global economy (Cook, 2007).

Section VI: The Relationships between Academic and Extra-Academic Knowledge

While academic knowledge is produced and validated within the scholarly community, it is also associated with the ideas of impact and transformation of society as a whole and with its potential technical or economic usefulness while simultaneously being affected by its societal contexts. The forms and functions in which these relations between the academic and the non-academic have historically developed have varied. The popularisation of academic knowledge in the nineteenth century had specific functions in the creation of nation states, their identities and educational projects (Crawford et al., 1993a, 1993b; Vessuri, 2002; Waast & Krishna, 2003). The means of dissemination ranged from bulletins and textbooks to newspapers. In the first decades of the twentieth century, the function of the public intellectual increased the prestige of the knowledge produced in academia but this was intermingled with political and ethical functions. The end of the century and the beginning of the twenty-first has brought new challenges and demands, such as environmental degradation and digital transformation.

The circulation of knowledge beyond academia raises the question of the autonomy or heteronomy of science vis-à-vis society, especially regarding state interference and the forces of the market. Related to this is the question of peer control versus social control of science. The Mertonian perspective of a unified, integrated, autonomous and homogeneous science, practised in institutions with rigid borders and offering specific rewards according to the norms established by the scientific community, i.e., the idea of a social system of science (Merton & Storer, 1973), has been increasingly challenged. Various counter-positions bring to the front transdisciplinarity (Fam et al., 2018; Sass et al., 2019) while questioning the autonomy of scientific disciplines and institutions. The actor-network approach (see Bolz et al. in this volume) has been particularly powerful in dissolving the boundaries between scientific institutions and society (Callon 1986, Latour 2005). The opposing views of “Mode 2” (Gibbons, et al., 1994) versus “Triple Helix” (Etzkowitz, 2018) both argue that science in our conventional understanding is disappearing and that relationships among university, expertise, social demand and industry are reconfiguring. Under the conditions of neoliberal capitalism, science must respond to the logic of the private enterprise; scientific

disciplines are disintegrated; university, government and industry are increasingly interdependent; and actors are evermore mobile between academic and extra-academic domains.⁶

At the same time, however, dialoguing with the broader public, with clients of demand-driven, commissioned research, with strategic partners or opponents or with learners in extra-academic teaching activities can also have challenging epistemic effects on the academic knowledge produced. Extra-academic actors are likely to question and confront it based on their experiences. To do research for, with or in discussion with extra-academic actors, to confront academic insights with their viewpoints and judgements and to take responsibility for research results that may be practically used or that may serve as an orientation for the agency and decision-making of social actors can favour the development of alternative knowledges and thus be of innovative potential (Keim, 2017a). Conventional epistemology has hardly considered the cognitive effects of this kind of “reality check”. Exchange with extra-academic groups also favours institutional and informal networks that go beyond the boundaries of the academic institution, as well as intersectoral mobility. This may lead to corresponding opportunities for funding, such as institutional cooperation or commissioning of research, and can make academic professions attractive because they are perceived as socially, politically or economically relevant. However, research with actors located outside academia faces challenges as the institutional logic to which academics are accountable may conflict with alternative agendas in terms of timing, agenda-setting, ethical stances or publication formats and outlets (Meckesheimer & Williams, 2016). In addition, the question of representation – “speaking on behalf of” – and the usage of collectively produced results for academic career advancement have become increasingly critical (Cabrera & Meckesheimer, 2015).

Currently, public and private funding institutions emphasise the visibility of results in formats and media that are more accessible to the non-specialist public, with more significant transfer and dialogue with civil society, companies and social movements. But how are academic results communicated to the “outside”? What media are used to transfer academic knowledge to “others” and what happens when academic results and knowledge are contested by other groups or types of knowledge? The simplistic idea of science and “the lay public” – consisting of an undifferentiated, unorganised, passive and less knowledgeable audience that merely receives scientific input – on which conventional views of popularisation relied, is increasingly questioned, as the empirical cases studied in this section illustrate.⁷

This section analyses tensions and negotiations between academic and non-academic realms, looking at media and actors in different arenas: it addresses experts, politicians, indigenous knowers, entrepreneurs, children and activists disputing and negotiating power and legitimisation in engaging and exchanging with knowledge produced in the academy. The chapters look at the strategies and media used by academics to communicate and thus transform the most varied political and social arenas. Some actors move across both arenas, between academic and non-academic spaces. Thus, academic and extra-academic knowledge appear intrinsically intertwined and interconnected. Focusing on the interactions between them reshapes our understanding of each of them as they can shift the very boundaries in and out of academia.

Section VII: Methodological Approaches to Studying the Circulation of Academic Knowledge

Scholars working on knowledge circulation rely on divergent – and sometimes incompatible – theoretical, ontological, epistemological and methodological assumptions. Indeed, the multiplicity of available methodological approaches does not constitute, together,

one single, coherent system (Abbott, 2004: 13). Instead, each methodology constitutes a specific approach to studying reality that brings into light certain features and obscures others. Concerning how these different methodologies relate to each other, the section claims no privileged view but instead emphasises the multiplicity of approaches that fosters creativity (Pestre, 2012: 435).

Such a heuristic take on methodological pluralism also corresponds to the now widely shared epistemological stance, which consists in accepting that there is no “view from nowhere” but that scholarly knowledge is always produced from a definite standpoint and social position. While methods had long been taken for granted as general, context-free principles for research and have therefore appeared as the most strongly globalised, as unquestioned knowledge (Gobo & Ryen, 2011), now calls for decolonisation have also reached methodology (Smith, 1999).

Section VII presents and contrasts the most common methods in studying knowledge circulation. It aims to orient newcomers to the research landscape, setting out the substantial criteria that inform these methodological choices and outlining the concrete steps towards realising a study within a given methodological framework. This Handbook also makes two broader points regarding methodology. First, research affects and, to some extent, modifies methodology. This is particularly true for the study of knowledge circulation. For instance, the empirical study of circulation processes has been key in questioning methodological nationalism. Or, from traditional “laboratory studies” (Latour & Woolgar, 1979) as a starting point for studying knowledge circulation, research has moved on to multisite ethnography, following a moving target. Similarly, in metaphor analysis, the movement of a metaphor is now traced not just between two fields/contexts but as a migration through many fields/contexts. Second, methodological approaches also circulate and can constitute the object of studies of knowledge circulation. They appear as being strongly anchored in certain research traditions, contrary to a view held until recently, that methodology was a neutral part of research. Prosopography, for instance, appears as a favoured approach within francophone research. Bibliometrics has diffused widely into institutions and science policy, as can be shown by their frequent use to produce quantitative indicators, rankings and quantitative evaluations. Approaches along the conceptual lines of centres and peripheries are widely accepted within Latin America, whereas they often require justification elsewhere. The subaltern perspective is closely linked to the works of researchers in and from India. Additionally, circulating methods and methodologies change during their circulation and are creatively appropriated in different places.

This section identifies two dominant perspectives on methods: actor-centred and text-based approaches. This distinction is straightforward: is it people or texts that circulate? But it relates also to the process: what are the carriers of circulating knowledge? Does it circulate in embodied form, i.e., through actors, as tacit knowledge? Or does it circulate in various material forms – textual, digital or visual? The section on media of circulation also contains a chapter by Vinck and Pérez-Martelo on circulation of knowledge through objects as an alternative approach.

Actor-centred approaches follow actors, delving into their spaces of activity. Many of these studies in STS rely on *ethnographic approaches*, from classic laboratory studies to multisite ethnographies, including qualitative interviews. Specific approaches towards interviewing in foreign languages should be highlighted here (Chalhoub-Deville & Fulcher, 2003; Kruse et al., 2012). *Biographic* methods trace the mobility of scholars, their life stories and career paths. The aim here is to uncover how these individuals connect to one another and

their relationship to different disciplines, spaces of knowledge and world regions. Those actor-centred approaches are of necessity small scale, situated, and localised. Such in-depth studies may discover unexpected actors and account for the materiality of knowledge circulation. One step removed from concrete loci, *prosopography* focuses on scholarly collectives. This approach can reveal underlying patterns that might not be visible through interviews, following single actors or ethnographic methods. Prosopography uncovers power relations, hidden aspects of knowledge circulation and the networks of influence on which it relies.

Actor-centred approaches can also attend to infrastructures (research centres, university departments, training facilities, publication channels and conferences). They can uncover the effects of power and geopolitics within given spaces or through the trajectories of key actors. In this tradition, two more strongly theory-centred approaches have been particularly influential for research on academic knowledge circulation. Actor-Network Theory (ANT) stands out as a distinct approach that comes with its own methodological principles and a unique ontological perspective that focuses on relationships, including with nonhuman actors. The ANT focus on materiality includes the technologies required to make knowledge circulate: ethnographies or biographic approaches can also be part of its repertoire. Field theory has informed important studies on knowledge circulation. It applies Bourdieu's relational concepts of actors, fields and capitals to the analysis of the academic field, nationally and transnationally, and extends in innovative ways beyond the scope of Bourdieu's works.

Text-based approaches focus on one key medium of knowledge circulation: publications. Bibliometrics measure research output by using bibliographic databases. Using numbers of co-authorships as a proxy for scientific cooperation, or citations as a proxy for influence, they draw images of how knowledge circulates on a global scale. Several chapters throughout the book critically examine the use of such methods in research assessment and global rankings. Digital text-based approaches offer a large-scale analysis of the content of circulating texts. This generates insight into changes in focus and shifts in meaning in scholarly debates, analysing large numbers of contributions over time through semi-automatic text mining. Quantitative approaches analyse enormous data sets. A significant body of research has developed that suggests various forms of visualisation of results (Shin et al., 2019). Finally, qualitative text-based methods take the precise and often multiple meanings of single circulating texts seriously (Keim, 2016). Hermeneutic approaches uncover the multilayered nature of circulating texts. The qualities of texts can enhance productive circulation, such as wandering metaphors that allow for metaphorical switching.

Notes

- 1 For a detailed overview, see the Cambridge History of Science in eight volumes: Jones and Taub (2018); Lindberg and Shank (2013); Park and Daston (2006); Porter (2003); Nye (2002); Bowler and Pickstone (2009); Porter and Ross (2003); Sloten et al. (2020).
- 2 For the alternative vision of liberal arts education and a pigeon tower, see Goessinger (2019).
- 3 See the contributions to the special issue by Gugerli et al. (2011).
- 4 A critical review of these aspects can be found in Daston (2017).
- 5 For a critical discussion, see Gareau (1985); Lafuente et al. (1993); Petitjean et al. (1992); and Polanco (1990).
- 6 For a critical discussion, see Shinn and Ragouet (2005), Vessuri (2000) as well as the contributions to Section IV of this Handbook.
- 7 See also Kretschmann (2003) and Shinn and Whitley (1985).

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