# The transformation of science systems in the Middle East and North Africa

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# Chapter 7

Discussion and conclusions

## 7.1 Introduction

The Middle East and North Africa region (MENA) has historically had a strong tradition of knowledge production. Scientometrics analyses provide valuable insights into the current state of scientific research in this specific region and how science systems have evolved recently. Although this region has a common history, partly shaped by how the region was portrayed in and colonized by the West, it also holds a high level of diversity (scientific capacity, funding, languages...). The MENA region is composed of countries that show distinct bibliometric patterns. To provide an adequate interpretation of these patterns, it is essential to consider them from the context of scientific development.

Funding capacity, research policies, research management and evaluation systems, collaboration and mobility partnerships all contribute to the development and transformation of national science systems. More importantly, such transformations are informed by various standards of quality (Paradeise, 2016; Paradeise & Thoenig, 2013). Scientometric data and indicators are increasingly used in research management and evaluation in national and institutional contexts. This opens up a range of opportunities to depict how scientometric data is used in various contexts for various purposes and over time, to understand how science systems have evolved through the influence of scientometrics.

Based on several independent studies introduced in chapter 1, this PhD dissertation presents an overview of how MENA institutions have tried to become part of the so-called 'global science system', which is the English-language based science system that is visible in Nobel prizes and university rankings and in which Harvard is always presented as the best university of the world. MENA research institutions have in various ways tried to adapt to this system to make themselves seen on the global stage. This happened through adapting research evaluation methods developed in the West or setting research policies and incentives. By exploring the recent transformation of national science systems in MENA through a scientometric lens, this dissertation seeks to unravel their diversity and describe their characteristics in a systematic manner. Furthermore, on the basis of a better understanding of the characteristics of the science systems in MENA, this dissertation reflects on current and future implications and discusses the possibility of establishing more fine-grained analyses to assess the transformation of national systems in more depth.

As the discussion and conclusions part of this thesis, this chapter summarizes the main findings under each research question proposed in chapter 1. Also, this chapter further discusses the implications of the main findings of the transformation of science systems in the MENA region and presents several future research opportunities.

## 7.2 Summary of main findings, implications and future research prospects

This PhD dissertation provides answers in chapters 2 to 6 to the five primary research questions proposed in chapter 1. The research findings are framed around the transformation of science systems in the MENA region. This section summarizes the main findings under each research question (RQ). Building on a better understanding of the diversity and characteristics of national science systems in MENA, this section also discusses the implications of the main findings in the context of scientific development and proposes future research prospects.

### 7.2.1 Scientific mobility and collaboration as a catalyst of scientific development in MENA

**RQ1.** *What are the main characteristics of the scientific mobility and collaboration networks at the regional and country levels in MENA? What are the personal characteristics of the mobile scientific workforce in MENA, particularly in terms of academic age and gender?*



To answer this research question, chapter 2 presents an extensive analysis of scientific publication meta data, in particular author names, author affiliations and publication dates.

For a total of 1 million Web of Science (WoS) indexed scientific papers published between 2008 and 2017, chapter 2 examines the scientific mobility flows and collaboration linkages. Changes in affiliations are used to define a taxonomy of different types of scientific mobility. And co-authorship is used as a proxy indicator of scientific collaboration. Also, the names of the authors along with their suspected country of origin are used to infer a gender to researchers. The date of the first publication is then used to determine the academic age of a researcher.

Overall, collaboration and mobility in MENA align closely, with MENA showing greater mobility compared to other studies (Chinchilla-Rodríguez et al., 2018). 12% of identified researchers display international mobility, predominantly as *Directional Travelers* (5.6%) and *Migrants* (3.2%). Chapter 2 highlights MENA's scholar circulation patterns, with Europe being the primary destination and origin for mobility, followed by North America, MENA, and Asia. Oceania, Africa, and South America have lower scholar circulation. Specific countries can be categorized as *attracting* (Qatar, Saudi Arabia, United Arab Emirates, Kuwait), *balanced* (Turkey, Egypt, Pakistan, Morocco, Algeria, Jordan, Lebanon), or *sending* (Iran, Tunisia, Iraq, Syria) countries.

The main non-MENA destinations and origins for scholars are the United States, France, United Kingdom, Germany, Canada, China, Malaysia, Italy, Japan, and Australia, reflecting geographic, cultural, historical, linguistic, and socio-political proximities. Male researchers dominate almost all MENA countries, while Tunisia, Lebanon, and Turkey have a balanced male-to-female ratio. Gender disparities are more pronounced among migrant scholars, with men representing 66% and women 12% of all migrants in MENA. MENA's academic age of migrant scholars ranges from 6 to 20 years, with the 6-10 and 11-15 age groups comprising the majority. The MENA region's policies, influenced by demographic trends, aim to improve the quality and relevance of higher education systems. Collaborations in MENA have a stronger international focus, with the United States and United Kingdom playing significant roles. Different countries exhibit varied collaboration patterns, with some focusing more on regional mobility and others on international collaboration.



Historically, from the 1960s to the 1990s, the MENA region could be classified into two categories: host countries and source countries of international migrants, with the differentiating factor being the presence or absence of oil (Fargues, 2006). On one hand, the oil-rich states possessed abundant capital but lacked a sufficient workforce, leading them to import labor. Consequently, the Gulf States and Libya, as a combined entity, became the world's third-largest recipient of immigration flows, following North America and the European Union. On the other hand, the non-oil-exporting states faced a capital deficit and an excess of labor, resulting in them exporting their workforce to Arab oil-producing countries and other regions globally. Algeria and, to some extent, Iraq deviated from this pattern as they generated substantial income from hydrocarbon exports but struggled to convert this revenue into full employment opportunities. However, in recent years, the Gulf

Cooperation Council (GCC) states set policies to attract highly-skilled professionals with required expertise and know-how to transform GCC economies into knowledge-based economies (Fargues & Shah, 2018).

Over three decades, this relatively clear and stable pattern of international migration within MENA has recently undergone noticeable changes, blurring the once distinct line between sender and receiver states. While oil-rich countries still attract foreign labor—particularly as oil prices resurged in the early 2000s—they now also face alarming levels of unemployment among their own citizens. In response, they have adopted increasingly restrictive policies regarding the admission and settlement of migrants. Non-oil-exporting countries continue to be departure points for many of their nationals, but they have also emerged as new destinations or transit countries along the global pathways of international migration. They too have implemented restrictive immigration measures in light of the evolving situation. Concurrently, they have recognized the value of their own expatriate populations as a source of wealth that can be leveraged for national objectives. Accordingly, they have devised policies aimed at strengthening the bonds between expatriates and their countries of origin (Fargues, 2006).

More recently, during the so-called 'Arab Spring,' the younger generation asked for more and better development opportunities. Although the MENA countries find themselves at different stages of economic development, they all share a vested interest in the dynamics of higher education supply and demand. From the internationalization perspective, policies enacted in this context have far-reaching implications across these three distinct domains, as extensively discussed by a group of authors affiliated with the World Bank in relation to the MENA region (Jaramillo et al., 2011). One of their significant conclusions consists of examining the policy framework for student and skilled labor migration as a way to enhance the pertinence and the quality of higher education systems in MENA which need to cope with large populations of young people in MENA and an increasing number of students. These demographic trends should be seen as fundamental catalysts in the internationalization context. For instance, a recent meeting of Arab states acknowledged the unprecedented transformations of the higher education systems, the policies and notably, international collaboration and student mobility (UNESCO, 2022).

As a consequence, cross-border collaboration and mobility has become more widespread in recent years. For instance, traditional university partnerships, widely recognized as the most prevalent form of international mobility in higher education, also contribute to the mobility of PhD-students, postdoctoral scholars, and more experienced researchers. Broadly speaking, both collaborative endeavors and mobility demonstrate a greater emphasis on international connections rather than regional ones, as seen from the perspective of the MENA region. It is worth reminding that the United States and the United Kingdom play pivotal roles as influential actors driving collaboration with the majority of MENA countries. In contrast, Saudi Arabia, Iran, Egypt, and Turkey emerge as the primary drivers of international cooperation within the region. However, it is important to acknowledge that their respective partnerships exhibit variations. While Iran, Egypt, and Saudi Arabia possess strong collaborative ties with Asian nations, Turkey's main collaborative partners include several European countries such as Germany and France.

Chapter 2[1] provides a blueprint for using scientometric studies to understand mobility dynamics in specific countries and regions. While scientometric data provides informative insights into scientific mobility, its limitations necessitate combining it with other sources of mobility information. However, there is no established method for determining global scientific mobility flows. Therefore, scientometric data should be seen as an informative but conservative approach, with limitations that need to be considered. This blueprint should be supplemented with other sources of mobility information. Chapter 2 aims to contribute useful material for analyzing scientific mobility in the MENA region and addressing issues raised by the Observatory of International Migration in the Arab Region in collaboration with the United Nations (2002-2018). Chapter 2 builds upon previous studies limited to OECD countries as destinations for scientists (Fargues, 2006; Özden, 2006).

The approach used in Chapter 2 tracks changes in author affiliation at the country level, but all changes do not necessarily indicate a break in ties with the researcher's original country, especially for travelers with multiple affiliations. The continued development and advancement of scientometric mobility studies will yield substantial benefits for

[1] **Chapter 2 is based on:** El-Ouahi, J., Robinson-García, N., & Costas, R. (2021b). Analyzing scientific mobility and collaboration in the Middle East and North Africa. *Quantitative Science Studies*, *2 (3)*, 1023–1047. https://doi.org/10.1162/qss_a_00149

policymakers and science policy analysts because these studies offer insights into linkages between sending and receiving entities. These studies will play a pivotal role in identifying programs and strategies that facilitate international collaborations and mobility, including initiatives such as the China Scholarship Council and the Marie Sklodowska-Curie fellowship. Future research can employ different methodologies, including regional, city, and institutional levels of analysis, and consider additional typologies of mobility flows. For instance, future research may seek to use the approach presented by Sugimoto et al. (2016) to represent and estimate the mobility at the regional, city and institutional levels in MENA. Also, the return of mobile researchers and the more transient type of mobility relationships (i.e. researchers with just an occasional affiliation relationship with a country, cf. Moed and Halevi (2014)) could be considered in more granular analyses. By incorporating local and dynamic perspectives, we can better understand the phenomenon of scientific mobility. Furthermore, there is a possibility to combine the mobility indicators with other scientometric information such as citation metrics as proxy measures of impacts, and research areas or topics to compare trends across various fields. These advanced scientometric mobility studies will benefit decision-makers and science policy analysts seeking to promote international collaborations and mobility.

### 7.2.2 Women participation in science in MENA and temporality of gender policies



**RQ2.** *What is the proportion of women scientific authors in MENA by country and field? What is the relationship between gender and productivity and lead authorship in this specific region? And how has the participation and performance of women in science changed recently?*

Chapter 3[1] answers RQ2 by analyzing a total set of 1.7 million WoS papers published between 2008 and 2020 by 1.1 million authors affiliated to institutions in MENA. Based on

[1] **Chapter 3 is based on:** El-Ouahi, J., & Larivière, V. (2023). On the lack of women researchers in the Middle East and North Africa. *Scientometrics*, *128*(8), 4321-4348. https://doi.org/10.1007/s11192-023-04768-5

the first names of the authors of these publications and their suspected country of origin, chapter 3 infers algorithmically a gender to the authors.

This chapter also defines three cohorts of researchers who started their research career in three different years (2008, 2012 and 2016) by using the year of first publication as the start of their research career. To gain a comprehensive picture, the shares of women authors are computed at the country and field of research level. The number of published papers by authors between 2008 and 2020, as a measure of publishing productivity, is also examined for each cohort. Combining the gender information with the bibliometric information of scientific papers, and more specifically the authorship position used as a proxy measure of leadership and seniority, chapter 3 compares the probabilities of being first or last author for each cohort. Overall, findings of this chapter provide evidence of the gender disparities in science in MENA in terms of women participation and performance.

Chapter 3 provides a quantitative analysis of gender disparities in scientific authorship in the MENA region, including representation, research productivity, and seniority. The results indicate that men dominate in terms of the number and productivity of scientific authors. These disparities are present in every country of the region, although some countries, such as Tunisia, Lebanon, Turkey, Egypt, Iran, Morocco, and Algeria, show relatively smaller gender gaps. Comparing data from 2008 and 2016, there has been a 7% increase in the proportion of women authors, with Tunisia, Qatar, Jordan, and Iran showing the greatest improvements. However, there are significant differences between countries, with some experiencing declines or minimal progress.



In terms of productivity, there is no significant difference between men and women in their first year of their publishing career. However, in subsequent years, men's output is higher than women's by 11% to 51%, and this gap has increased over time. Men also have a higher probability of being the last author, indicating greater seniority.

Various reasons have been proposed to explain why men publish more than women, including differences in family responsibilities, academic rank, and career absence. Personal motivations and societal division of labor have also been cited as factors contributing to women's attrition in science. Additionally, chapter 3 highlights a trend where the percentage of women in science initially increases with per capita wealth but then declines. The representation of women in the scientific workforce is higher in developing countries of

North Africa compared to higher-income countries in the Gulf Cooperation Council (GCC). To address these disparities, policymakers in the MENA region are urged to adopt policies that support women in managing family burdens and fostering a more balanced research ecosystem. However, focusing solely on educational attainment may not be sufficient for promoting women's empowerment in the region. Overcoming societal, structural, institutional, and legal obstacles simultaneously is crucial. Chapter 3 emphasizes the need for context-specific policies, preceded by small-scale trials, to determine the most effective strategies. Although the MENA region is making progress in gender policies, it still lags behind other regions globally. Countries such as Turkey, the UAE, Saudi Arabia, Morocco, and Tunisia have taken steps to promote gender equality, but further improvements are necessary. Recent developments in the UAE and Saudi Arabia have enhanced legal equality for women, while North African countries already show higher levels of women's participation in science compared to GCC countries.

Karam and Afiouni (2014) emphasized the need for policymakers across the MENA region to adopt policies that support women in managing family responsibilities, thus facilitating their scientific careers and fostering a more balanced research ecosystem. Such policies are crucial for achieving inclusive development. However, it is important to note that focusing solely on educational attainment may not be sufficient to effectively promote women's empowerment at all levels within the region (Shalaby, 2014). In fact, the World Bank (2013) referred to the rising educational attainment of women coupled with low economic participation as the "MENA paradox". Assaad et al. (2020) argue that the MENA paradox primarily stems from changes in the opportunity structures faced by educated women in the 2000s, rather than the supply-side factors commonly discussed in the literature. Achieving genuine gender parity in the MENA region necessitates addressing multiple obstacles on societal, structural, institutional, and legal levels simultaneously (Momani, 2016). Tasci (2021) has also provided several recommendations to empower women scientists within the international research landscape. Ultimately, the effectiveness of policies depends heavily on the context of each country. Therefore, it is preferable to conduct carefully designed small-scale trials of proposed initiatives before scaling them up to a national or regional level, rather than relying solely on past experiences.

From a scientific development perspective, the contribution of women in science plays an important role. In some fields, authorship positions serve as proxies of leadership and

seniority in scientific research projects (González-Alcaide et al., 2017; Henriksen, 2019; Larivière et al., 2016). However, without specific descriptions of the role of each author, it remains difficult to precisely assess authors contributions. For more informative analyses of the contribution of women in science, future research may seek to use descriptions of authors contributions as promoted in the Contributor Roles Taxonomy (CRediT) initiative[1]. Also, major bibliographic databases tend to index mainly scientific papers published in English. Since national languages are often mainly used in fields such as in Social Sciences and Humanities, where applications are nationally oriented, future research projects may also include regional databases covering more regional content, such as the Arabic Citation Index. The analysis of regional content may provide more comprehensive analysis and understanding of the representation of women in specific regions. Furthermore, other approaches are also needed to better understand the contribution of women in science. For instance, Ceci et al. (2023) analyzed the empirical evidence for gender bias in seven important contexts in the tenure-track academy: tenure-track hiring, grant funding, teaching ratings, journal acceptances, salaries, recommendation letters and, lastly, journal productivity, which can moderate bias in the six other contexts. No evidence of bias between women and men was found in grant funding, journal acceptances, and recommendation letters. Ceci et al. (2023) also found that women were advantaged in the hiring domain. However, bias was found against women in the teacher ratings and the salaries contexts. Considering the significant resources dedicated towards gender bias in academic science, these authors suggest that it becomes important to gain a precise understanding of the situations and locations where research efforts are justified.



Also, chapter 3 raises important questions about the temporality of policies and the timing of our bibliometric analysis. It is challenging to assess how recent policies have potentially influenced the changes observed in Chapter 3. We speculate that these changes, both in terms of policy development and bibliometric trends, are the result of underlying societal transformations. To a significant extent, societal and cultural shifts play a crucial role. At present, it is still too early to observe substantial changes in the science systems of MENA but the recent progress is promising. Countries like Turkey, Morocco, Algeria, Egypt, UAE, Qatar, Jordan, and Iran have the potential to narrow the gender representation gap in science within the next decade. Overall, the MENA region is catching up in terms of policy

[1] https://credit.niso.org/

engagement and women's representation in science, signaling positive developments for the future.

### 7.2.3 Research funding in MENA and policy formulation

**RQ3.** *To what extent has the funding structure in MENA evolved over recent years? What are the characteristics of the major funders in MENA, in terms of type and location?*

Chapter 4 answers this research question with an extensive analysis of funding acknowledgements found in 2.4 million scientific papers published between 2008 and 2021 by authors affiliated to institutions located in Middle Eastern and North African countries and indexed in the Web of Science.

Chapter 4 focuses on funding activities in the region by identifying the major funders and evaluating their contributions to national scientific publications. A major step consists of applying a data unification process to variant names of funders. Chapter 4 also classifies the funders following the typology of funders found in InCites. The location of the funder is also considered to determine the source of funding granted to researchers. Findings of chapter 4 shed light on the structure of the research funding in MENA. The results of this chapter also confirm the complex nature of funding in research, especially when co-authorship and co-funding are involved.

It is crucial to differentiate between domestic publications and those with international co-authors. The study found that the increasing trend of international co-authorship in scientific publications played a significant role in explaining why certain countries in MENA exhibit a relatively high level of contribution from foreign funders. It is likely that these foreign funders provided financial support to researchers who collaborated with their MENA counterparts on relevant scientific publications. Moreover, chapter 4 reveals the involvement of both major domestic funders and select foreign funders in funding domestic research endeavors.

Chapter 4 highlights significant disparities in the proportions of publications with funding acknowledgments across MENA countries. Overall, MENA countries displayed lower proportions of publications with funding acknowledgments compared to the world average.

However, Saudi Arabia and Qatar emerge with approximately half of their publications containing funding acknowledgments. While this observation may suggest a high level of available funding at the country level, it is important to consider cultural factors that might influence what authors choose to acknowledge in their publications across the MENA region.

Overall, an upward trend in the share of funded publications with funding acknowledgments can be observed across all MENA countries, except those that have experienced conflicts or unrest in recent years. Such uptrends may possibly indicate an increase in the funding available at the country level. Since science and technology are essential for economic and societal progress, MENA may be well-positioned to benefit from these trends in the years to come. Furthermore, chapter 4 reveals a diverse funding landscape. Iran, Turkey, Saudi Arabia, and Egypt emerged as countries with the largest number of domestic funding organizations in the MENA region. The variation in the number of funders can be attributed to the respective country's size and the different national funding structures in place as well as the level of international collaboration.

Based on chapter 4, three distinct groups of countries in MENA could be identified based on the number of funders. Some countries, including Qatar, Palestine, and Morocco, featured several dozen funders that contributed to at least 1% of the total number of national publications when considering all publications. On the other hand, countries such as Saudi Arabia, the UAE, Kuwait, and Pakistan primarily relied on a few funders. Finally, countries like Turkey or Iran were dominated by one or two major funders. However, when analyzing only domestic publications, most countries in MENA had only a few major domestic funders.



The findings of chapter 4 also shed light on the contributions of both domestic and foreign funders to the scientific output of each country. Certain countries, including Turkey, Iran, Oman, Kuwait, Jordan, and Saudi Arabia, exhibited a relatively high level of contribution from domestic major funders mentioned in their scientific papers. In contrast, other countries in MENA seem to rely more heavily on foreign funding sources. These countries often displayed a high rate of international co-authorship, which explain the prominent presence of foreign funders in their research endeavors.

Government and academic organizations emerged as the main funders identified in scientific publications in MENA, which is not surprising considering that a majority of scientific research in the region is conducted by public universities funded by the governments.

Specifically, funding is often provided through entities such as the Ministry of Higher Education and Research or equivalent national institutions. However, the study also revealed the contributions of other sectors and types of funding sources, including nonprofit institutions, research councils, and national academies.

It is important to acknowledge that the analysis of funding acknowledgments has its limitations, potentially leading to an underestimation of the role played by institutional funding, which researchers may not always explicitly mention. For instance, the recent increase of international co-authorship in scientific publications partly explains why some countries show a relatively high level of contribution of foreign funders. For example, researchers who are employed by public universities and receive research funding from their employer, which essentially originates from the government, may not explicitly acknowledge this as external funding in their publications. In such cases, the researcher's affiliation may better reflect the support provided by their research institution as a funder.

Despite these limitations, Chapter 4 provides insights into the structure of scientific funding in the MENA region, including funding sources, types and trends. These insights can inform policymakers in monitoring and designing research funding programs. For instance, policymakers can assess whether researchers who receive funding from specific countries have produced scientific publications (Albrecht et al., 2009) or explore the funding trends in specific research areas Dorsey (Dorsey et al., 2006). Previous works analyzing funding acknowledgments have involved mapping funders to specific fields (Lewison & Dawson, 1998; Lewison et al., 2001) or specific funding programs (Boyack & Börner, 2003). Rangnekar (2005) also conducted an analysis of the mention of the Multiple Sclerosis Society as a funder in multiple sclerosis-related publications to analyze its visibility, research focus, and impact.



From a scientific development perspective, such analyses are particularly useful to formulate research policies which concerns various stakeholders: governments, public and private funding institutions, universities, research managers and researchers. A simplistic input-output model of funders and scientific publications does not accurately reflects the reality (Rigby, 2011). Researchers present their research findings in various ways or forms serving different purposes. Based on the investigation of funding acknowledgments found in scientific publications, it is possible to gain an understanding of the nature of funding granted

to researchers. Although, funding acknowledgments are not always structured consistently, their analyses provide evidence on how funding plays an important role in science in terms of scientific development. Analyzing funding acknowledgments contribute to better approach the variety of funding available from different types of funding agencies focusing on different types of research topics and projects. It may also help to examine the impact that funders have and the role they play in specific contexts. For instance, the Economic and Social Research Council of the UK Research and Innovation defines economic and societal impact in particular as the "demonstrable contribution that excellent social and economic research has on society and the economy, and its benefits to individuals, organizations or nations"[1]. It is still unclear how such impact can be measured or demonstrated. It is crucial to distinguish the scientific impact from the societal impact.

From a scientometric perspective, one can still consider citation-based indicators as proxy measures of scientific impact or influence (Waltman, 2016). Within policy contexts, the meaning of the term 'impact' is mainly refering to the societal impact. Recent scientometric developments have classified scientific publications at the paper level (Waltman & Van Eck, 2012) and mapped them to the United Nations Sustainable Development Goals (Armitage et al., 2020; Nakamura et al., 2019; Rafols et al., 2021). While showcasing the contribution of research stakeholders and funders remains difficult, these mappings provide basic building blocks for assessing such contributions. However, more funding does not necessarily imply more scientific publications nor predict scientific development or societal impact. Therefore, it is crucial to have more in-depth analyses of funding contexts especially in relation to international collaboration and institutional partnerships or national programs. For future research, using quantitative and qualitative methods to analyze scientific publications with funding acknowledgments may contribute to determine such contributions and their contexts. Additionally, analyzing the co-funding networks by country, institution at the paper topic levels would also provide some useful insights into the structures of funding mechanisms with regards to international collaboration and research fields.

[1] https://www.ukri.org/councils/esrc/impact-toolkit-for-economic-and-social-sciences/defining-impact (Accessed June 2023)

### 7.2.4 Research management and standards of quality

**RQ4.** *How do research managers in MENA adopt global scientometric standards in local contexts? In which local processes are scientometric data and indicators used and what specific functions do they serve?*

Chapter 5 explores the usage of scientometric data and indicators by research managers in the Middle East and North Africa in different science systems. Chapter 5 answers RQ4 through a qualitative study of transcripts of semi-structured interviews with research managers. The research managers are affiliated with 12 distinct research institutions spanning across 9 different countries in MENA.

Chapter 5 proposes that the implementation of scientometric-based rules plays a crucial role in driving the transformation of science systems. Firstly, this chapter highlights how research managers adopt scientometrics as 'global standards'. Additionally, it demonstrates the adoption of various scientometric data and indicators through a 'glocalization' process. Lastly, the study illustrates how research managers leverage this data to inform decision-making and policymaking. By exploring the research management and evaluation based on publication activities in specific contexts, Chapter 5 contributes to a better understanding of the usage of scientometric data by research managers. Moreover, it explores how such data facilitates the adaptation and transformation of local science systems to align with global standards. By contributing to ongoing debates on research funding, conduct, and assessment, chapter 5 emphasizes the increasing importance of organizational management within academic institutions due to the rise of science system assessments.



Chapter 5 reveals that research managers in MENA adopt scientometric indicators as 'global standards' (Paradeise, 2016; Paradeise & Thoenig, 2013). These indicators encompass various metrics such as citation counts, journal impact factors, and quartiles, which have become more accessible with technological advancements. The adoption of scientometric indicators occurs at different levels within research institutions, often communicated to researchers through workshops and applied in contexts such as publication venue selection and promotion. However, research managers may face challenges and resistance from researchers who have their own perspectives and opinions. This negotiation process follows a *glocalization* approach, where research managers communicate the value of scientometrics

in their own unique ways (Robertson, 2012). Hence, while scientometric indicators are adopted as standards, they are also adapted locally by different research stakeholders.

The integration of scientometric data and indicators into decision-making processes contributes to the *glocalization* process, where global standards are tailored to local contexts, resulting in the creation of *glocal* standards that reflect local needs and priorities. This includes the establishment of scientometric-based rules and organizational goals, which directly implement scientometrics in local science systems. For instance, research managers may set guidelines or rules for publishing in high-impact journals and offer financial incentives to researchers who meet these targets. Promotion and tenure decisions for faculty may also be determined using scientometric indicators. This process occurs partly through the development of new decision-making processes by research managers who draw on scientometric data as judgment devices for decision-making purposes. For instance, hiring, promoting and allocating budget are done by using judgment devices, as research managers have to recommend someone or a group from a range of entities with unique multidimensional qualities or 'singularities' (Karpik, 2010). These rules influence science systems, by following those used in countries like the United States and the United Kingdom. Consequently, researchers adapt to these new scientometric rules, leading to the emergence of new science systems.

The findings of chapter 5 underscore the growing reliance of several MENA research institutions on externally established standards that are subsequently adapted internally to define and evaluate academic quality (Paradeise, 2016; Paradeise & Thoenig, 2013). This phenomenon occurs within the context of internationalization, which is related to a university's position in global rankings, as elucidated by Hazelkorn (2015, 2018). Research-oriented metrics employed in such rankings exert influence over a university's standing and impact national science systems in various aspects. Research governance is on the rise, with research evaluation assuming a prominent role in driving these changes (Whitley & Gläser, 2007). Notably, the findings of chapter 5 reveal that research evaluation encompasses multiple spheres of influence, control, and governance, including faculty recruitment, promotion, research funding, publishing, collaboration, decision-making, and policy formulation.

In this context, the *More Than Our Rank* initiative has emerged as a response to the adverse effects associated with global university rankings. Its objective is to shed light on the diverse ways in which universities contribute to the world, which often go unnoticed in rankings. Several initiatives, such as the *San Francisco Declaration on Research Assessment (DORA)*, *The Leiden Manifesto for research metrics*, and the *Coalition for Advancing Research Assessment (CoARA)*, have all provided critical insights into the role of metrics in evaluation frameworks. These initiatives have the potential to reshape the utilization of scientometrics in specific countries worldwide. Many governmental bodies and research institutions have already devised and implemented more comprehensive frameworks for assessing research. This suggests that 'global standards' themselves are evolving due to these initiatives. Consequently, this implies that MENA countries may be adopting scientometrics as 'global standards' based on past practices rather than embracing the potential new 'global standards' that may emerge from these recent initiatives.

Future research may aim at examining how such initiatives are implemented and the implications they have on research policies. Future research might also seek to study the dynamic nature of 'global standards' in research assessment. For example, Janavi et al. (2020) assessed the Iranian publications based on the Iranian *National Master Plan for Science Education* proposed by the Iranian Supreme Council of Science, Research and Technology. To do so, eight scientometric indicators were used and the authors concluded that the plan was not suitable. They also suggest that it was necessary to review and modify the indicators used by the national monitoring system of scientific research.



### 7.2.5 Regional scientific literature as a complement to 'global standards'

**RQ5.** *What are the predominant research domains and topics represented in the literature indexed in the Arabic citation index (ARCI)? How can the usage of this bibliometric database contribute to a more comprehensive and inclusive assessment of research activity in the MENA region?*

Chapter 6 answers RQ5 on the basis of bibliometric analyses of ARCI. This chapter provides a comprehensive overview of the scientific literature indexed in ARCI and explores its potential applications in research evaluation.

About 140 thousand scientific papers published between 2015 and 2020 are analyzed by using their available metadata. Besides, chapter 6 presents the distribution of such literature at various levels such as research domains, countries, languages but also open access availability. In addition, unsupervised machine learning techniques and text mining algorithms are employed to reveal the main topics of ARCI. Findings of this chapter show how ARCI can complement so called 'global standards' in the context of more inclusive research assessment processes. Finally, this chapter also discusses the study findings and open up to several research opportunities suggested for further exploration.

Chapter 6 aims to examine the structure and implications of ARCI, which currently includes 613 Arabic journals as of June 2021. The indexation of these journals brings numerous benefits to the scientific community, primarily enhancing their visibility and accessibility. By meeting selection criteria and providing essential publication metadata, ARCI ensures the inclusion of high-quality journals. This database is expected to greatly improve scholarly literature search, helping researchers identify influential research published in Arabic.

The analysis of ARCI reveals that it mainly comprises journals in the Arts & Humanities and Social Sciences categories. Egypt, Algeria, Iraq, and Saudi Arabia contribute significantly to the research published in these journals. ARCI covers content from 19 out of the 22 Arab League countries, with Egypt and Algeria accounting for over 60% of indexed journals. The establishment of national journal platforms and workshops for journal editors has been instrumental in improving the visibility of local journals. It is important to note that ARCI indexes journals based on the country of publication rather than the language used. Therefore, it does not include journals published in Arabic outside the Arab League countries. Nevertheless, ARCI shows contributions from countries such as Iran, Malaysia, the United States of America, France, Turkey, and the United Kingdom, indicating its potential as an international platform.

The majority of the content in ARCI consists of articles, predominantly published in Arabic. However, English and French also have a significant presence in the database, suggesting research addressing regional issues of interest. The analysis of authorship structure indicates

a preference for single authorship, which is common in the humanities and social sciences. Disciplines such as Cultural Studies, Quranic Studies, Poetry, Hadith, Islamic Creed, and Social Work exhibit a higher proportion of single authorship publications. Conversely, multi-authorship is more prevalent in disciplines like Geography, Special Education, Management, and Economics, indicating a collaborative aspect. Topic analysis and term maps provide insights into the underlying structure of ARCI, offering an overview of the covered topics. The clusters identified in ARCI show a broad coverage, and the availability of the corpus in Arabic contributes to understanding regional topics of relevance. Approximately 31% of the content indexed in ARCI is openly accessible, which is slightly lower than the share of open access publications indexed in WoS. The availability of Open Access information in ARCI is valuable for sharing scientific knowledge and tracking the adoption of local Open Access mandates. This information can aid agencies and academic institutions in strategic planning and funding decisions.

Research evaluation commonly involves bibliometric analysis, which plays a vital role in research policies worldwide. Bibliometric databases are extensively used to assess research at national, institutional, and author levels. Citation-based indicators have become widely employed in academic assessments, facilitating the identification and recognition of excellence in locally relevant research. As a result, ARCI is likely to attract attention from publishers and funders, offering valuable bibliometric data sources for science assessment and research analysis.



The findings of chapter 6 can be used by research funders, academic institutions, and individual researchers for research activities, performance assessment, and decision-making. ARCI complements multidisciplinary databases like the WoS by providing a more inclusive evaluation framework for non-English scientific publications. The potential increase in Arabic scientific content and the language's growing presence on the internet further support the positive effects that ARCI is expected to have on research discovery, management, and evaluation in the Arab region. For instance, the indexation of Arabic scientific literature in ARCI enhances the visibility and accessibility of Arabic journals, making them more easily discoverable. Journals included in ARCI must meet specific selection criteria, ensuring the availability of essential publication metadata. Consequently, this database holds the potential to significantly improve scholarly literature searches and aid researchers in identifying influential research published in Arabic.

The establishment of such a database has several implications for research evaluation, which often involves bibliometric analyses of research output (Wilsdon et al., 2015; Wouters et al., 2015). Bibliometric analysis plays a vital role in research policies across many countries, utilizing bibliometric databases to evaluate research at national, institutional, or author levels. Indicators based on citation indices have become widely employed in academic assessments (Bornmann & Haunschild, 2018; Campbell et al., 2010; Derrick & Pavone, 2013; Hicks & Melkers, 2013). ARCI can serve as a valuable bibliometric data source for research managers involved in science assessment and research analysis. This new database could help to *identify and reward excellence in locally relevant research* (Hicks et al., 2015).

Regional databases commonly aim to enhance the visibility of local journals and research published in languages other than English (Huang et al., 2017; Jin & Wang, 1999; Leydesdorff & Jin, 2005; Moskaleva et al., 2018; Pajic, 2015; Seol & Park, 2008; Vélez Cuartas et al., 2016). As of January 2020, Arabic ranked as the fourth most popular language online, accounting for 5.2% of worldwide internet users, following English (25.9%), Chinese (19.4%), and Spanish (7.9%). Furthermore, Arabic has witnessed significant growth as a language on the internet (Internet World Stats, 2020). Considering these observations, this may imply a potential increase in scientific content published in Arabic. Therefore, ARCI is likely to have positive effects on regional research discovery, research management, and research evaluation in the Arab region. Multidisciplinary databases like Web of Science only provide a partial glimpse into research publishing activities, particularly for non-English scientific publications. While the full impact of ARCI is yet to be realized, it establishes a robust foundation for a more inclusive research evaluation framework in the MENA region, specifically among Arab League nations. In this context, regional citation databases and indices such as the Arabic Citation Index could provide useful bibliometric data sources to research managers for research analysis but also research assessment. Multidisciplinary databases like the Web of Science provide a partial picture of research publishing activities, especially for non-English scientific publications. From a more inclusive research assessment perspective, future research may seek to propose detailed bibliometric analyses of scientific publications at various levels based on the Arabic Citation Index to better understand the contribution of countries, research organizations and researchers which is not captured in major bibliometric databases. This would allow to set strong foundations in defining relevant local standards, especially in Social Sciences and

Humanities where research tends to be more nationally oriented and published in national languages. Moreover, the analyses of open data sources, which generally aim to provide an inclusive coverage of scientific literature (e.g., Crossref and OpenAlex), can further improve and complement the evaluation of research publishing activities.

## 7.3 General reflections

The global science system is a complex and ever-evolving network of research stakeholders, including governments, funders, policy makers, research institutions and researchers. This dissertation raises a crucial question about the integration of the science systems in the MENA region into the global science system. It seems that the MENA region has become significantly integrated in the global scientific community in recent years. This PhD thesis highlights a growing engagement with science in North Africa, in the Middle East. This is reflected by an increased scientific output, growing scientific collaboration and mobility, higher research and development investments, and changes in science policies related to research management and evaluation.

Scientific collaboration and mobility partners include mainly Western countries but also Far-East countries, and more specifically China and Malaysia. China is one of the most significant drivers of changes in the global science system. China's rapid growth in scientific output may indicate its strong will to establish itself as a scientific powerhouse on the global stage. In recent years, China has made significant investments in science and technology with a growing scientific output surpassing the United States as the world's leading publisher of scientific papers in 2020. But this growth in scientific publishing may also reflect the controversial 'publish or perish' character of the Chinese science system and also raises important questions about research integrity, with more frequent scientific misconduct and an increasing volume of retracted publications (Ataie-Ashtiani, 2018; Qiu, 2010).

On the one hand, this fast growth of publications occurs in the context of significant shifts in the global world order, particularly with increasing alliances between Brazil, Russia, India, China and South Africa (BRICS). China's growing prominence in the international arena is reshaping the dynamics of global politics and economies (Ciuriak, 2023). One recent event that reflects China's emphasis on collaboration is the Iran-Saudi and China Trilateral Agreement, which is further contributing to the reshaping of the global world order (Ahmad et al., 2023). As China strengthens its ties with nations in the Middle East and South America,

it confirms its position as a key player in international affairs. Furthermore, during the BRICS' Leaders Meeting in June 2022, Chinese President Xi Jinping advocated for expanding the BRICS group by inviting new members (Gouvea & Gutierrez, 2023). Notably, Argentina, Iran and Saudi Arabia recently formalized their applications to join the BRICS during this meeting, signaling a potential shift in the group's composition and influence. This move may indicate China's intent to enhance its global reach through geostrategic partnerships. It is also possible that science and research collaborations may play a crucial role in this transformation. As a result, the MENA region, currently considered peripheral in the global science system, may see changes due to various factors. Chinese investments in the MENA region as part of the *Belt and Road Initiative* could lead to increased research collaborations and partnerships with China and other emerging countries. This may result into a shift towards greater integration with the emerging Asian science systems.

On the other hand, the evolving nature of the global science system has become an integral part of the transformation of science systems in MENA. The Interacademy Partnership, the International Science Council and the Global Young Academy recently released a discussion paper pointing at the risk of divergence and fragmentation of the global science system with national research systems evolving at different rates (2023). This chapter focuses on national developments and institutional reforms, dominated by initiatives in Europe and North America, to improve research culture, and research assessments. It also highlights that in some parts of the world such actions related to research evaluation reforms are just emerging or still absent. In a recent conference report, the Global Research Council also underscores that research assessment shapes research culture (Global Research Council, 2021). In particular, research evaluation influences how research is conducted and disseminated. The same report recommends that all the stakeholders of the research and innovation ecosystem should collaborate to develop responsible research assessment. Quantitative metrics can form a critical part of research assessment in the transition to a more open, public-facing and accountable research system (Royal Society, 2012) but they are also heavily used in the 'publish or perish' research culture which affects the quality, the integrity and trustworthiness of research worldwide (Haustein & Larivière, 2014). As such, the publishing sector is a stakeholder with huge influence over research dissemination and knowledge production. Journal-based metrics have become powerful incentives in certain national science systems to encourage researchers to publish in specific scientific journals. The report titled *Opening*

*the Record of Science* by the International Science Council (2021) notes that when scientific publishing becomes a means of evaluation rather than scholarly communication, researchers who choose to communicate their research in reports, proceedings, books, monographs or in any other ways than journal documents are disadvantaged. In this context, the open science movement has become increasingly relevant, especially in Europe and Latin America. This movement challenges the way we think about science and the criteria by which we judge high quality research especially in terms of societal engagement. Open science is indeed not only about how research is disseminated in terms of open access scientific publications. The UNESCO acknowledges the empowering aspects of open science, allowing new social actors to engage in scientific processes, including citizen science, to democratize knowledge, combat misinformation, and address inequalities (UNESCO, 2021a). Furthermore, the UNESCO stresses that open science must go beyond sharing among scientific communities by including underrepresented groups to reduce global knowledge disparities but also to use diverse knowledge to solve contemporary and societal issues and to foster transformative change.

Research assessment based on scientific publishing is at the basis of the 'publish or perish' research culture. Many national science systems with a strong 'publish or perish' culture, such as China, have experienced issues related to research integrity (Qiu, 2010; Quan et al., 2017). This is particularly reflected by thousands of retracted publications with an increasing concentration of retracted publications in Asia, especially in China, Iran, and India (Cabanac et al., 2023). The delisting of indexed journals in databases such as the Web of Science is also an element that reflects the growing importance of research integrity (Clarivate, 2023b). Certain countries with strong 'publish or perish' science systems are now affected by these research integrity issues and are confronted by the downsides of the systems they have put in place. For instance, there have been some recent policy changes in China to address issues related to academic publishing and research evaluation by shifting away from the 'papers only' culture (Li, 2020). However, moving away from the 'publish or perish'-based science system to a better science system is not an easy task. Perhaps, the research integrity crisis may be a game changer and a catalyzer facilitating this transition and forcing research stakeholders to assess and value research more responsibly and more fairly but also to engage more with the open science movement.

This dissertation acknowledges the dynamic nature of 'global standards' of quality used by research stakeholders in various science systems. Many countries have adopted Western-influenced global standards in their strategic plans and research assessments. Examples of such an adoption in emerging countries are numerous and include faculty hiring, promotion or financial incentives based on these 'global standards'. This dissertation also notes that many MENA countries have adopted and adapted these standards into their own 'glocal' versions. But these standards are also evolving and adapting to the changing landscape of science and research due to recent reforms and initiatives launched mainly in North America and Europe (e.g. Science Europe, 2022). Therefore, these glocalised standards might be practices of the past rather than new best practices. For instance, Iran, Turkey, Saudi Arabia, Morocco, Tunisia, Pakistan and the UAE, have likely adopted some policies inspired by Western science systems, such as rankings, promotion criteria, financial incentives and usage of scientometric data, but the role of these metrics keeps evolving (Al-Jamimi et al., 2023; Bouabid, 2014; Ibrahim et al., 2022; Janavi et al., 2020; Mukundan & Narayanan, 2019; Uzun, 2006; Wahid et al., 2021).

In conclusion, the dissertation suggests that the global science landscape is witnessing a deep transformation, with on the one hand the Western countries reforming their science systems and on the other hand China reforming its science system and playing a central role in reshaping the world order through alliances, agreements, and scientific collaborations with various countries. MENA's trajectory within these changing paradigms raises important questions about its integration into the global science system and its potential to become a driving force in shaping the future of science. What do all these changes, such as the reforms in research assessment, the growing open science movement, or the increasing importance of research integrity mean for the countries in the MENA region? Understanding and analyzing the MENA's trajectory will be critical in navigating the complex dynamics of the global science system in an ever-changing world.

So, what's next? The rise of China and other emerging economies is having a profound impact on the global science system. The traditional dominance of the United States and Europe is being challenged, and new centers of scientific excellence are emerging rapidly in Asia and other parts of the world. Looking towards the future, with the rise of China and the growth of science systems in Asia, there is a possibility of a new global science system emerging. The MENA region has the potential to play a significant role in the future of global

science, considering that this region has also undergone significant changes in its science system in recent years with increased investment in science and technology. Additionally, the region has a rich scientific tradition and a very young population, but it needs to overcome several challenges, related to research infrastructure, research policy and brain circulation, in order to fully realize its potential in global science. However, the MENA region's role in transformation of the global science system remains uncertain. What do the MENA countries really want or need? Since their current science systems have been influenced by other science systems strongly focused on the 'publish or perish' research culture, MENA countries may be expected to be confronted with similar challenges that some countries, for instance China, have been facing recently (Li, 2020). Do MENA countries really need to go through the same process and try to catch up where the world was a decade ago and go through the same known issues? Or will MENA take a leading role in shaping the new global science landscape, skip the challenges and try to catch up with where one expects the rest of the world to be in five years' time?