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ORIGINAL PAPER

How do universities' organizational characteristics, management strategies, and culture influence academic research collaboration? A literature review and research agenda

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Abstract
In the contemporary science and higher education system, national and supranational governments fund and foster universities to collaborate through specific funding lines and competition in World University Rankings, making it indispensable for universities to demonstrate collaboration at the organizational level. Thus, universities strive to encourage their scientific members to collaborate – and to different degrees – facilitate forms of collaboration. Questions on how universities as organizations influence academic research collaboration arise. To go beyond the existing literature, this study firstly develops an analytical two-dimensional framework organizing the literature on four levels of investigation (meta, macro, meso, micro). Based on this framework, the paper presents a literature review of the current state of the art in academic research collaboration. Secondly, the paper establishes a research agenda by synthesizing organizational influences found as organizational characteristics, management strategies, and organizational culture and presents three research avenues for future research. The paper concludes that we have only just begun to study the organizational influences of universities (especially the organizational culture) on academic research collaboration and how these organizational categories are interrelated.

Keywords Governance · Competition · Organization studies · Science studies · Two-dimensional framework

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Introduction

Profound changes in science and higher education systems worldwide have strengthened the need for universities to collaborate and have made it indispensable for universities to demonstrate collaboration at the organizational level. First, supranational governments, such as the European Union, and federal programs strongly foster and fund collaboration between scientists and universities at the national and international levels (Marques et al., 2020; Marques, 2018; Cuntz & Peuckert, 2015). Secondly, as World University Rankings have been implemented, (internationally) co-published papers increase the universities' ranking positions because indicators (see e.g., THE University Impact Rankings 2019 by SDG, NTU Ranking, The Webometrics Ranking of World Universities) measure the proportion of publications with international co-authors and the organization's visibility. The latter is related to co-authored papers as they obtain higher impact and therefore reach greater international visibility (e.g., Brankovic, 2018; Fortunato et al., 2018; Hazelkorn, 2016). Thus, to achieve competitive and reputational advantages and to secure funding opportunities, universities strive to have their scholars co-publish as much as possible and at best, with scientists from other (international) elite universities. Consequently, questions on *how universities as organizations influence academic research collaboration* arise.

Undoubtedly, when it boils down, academic research collaboration takes place at the individual level, as it is scientists that enhance their creative research capabilities and turn competencies into novel ideas when sharing knowledge and skills (e.g., Laudel, 2002;Beaver, 2001; Melin, 2000; Katz & Martin, 1997). However, research policies aim at fostering collaboration on different levels of the science system, which is why the literature chooses academics, departments, universities, regions, countries, and scientific disciplines as entities to be observed. To compile our knowledge on 'academic research collaboration,' the term is defined as follows: it narrows collaboration to the science system (University-Industry collaborations are excluded because they observe a different subject matter: collaboration with firms) but within this focus, the term is broadly defined as collaboration among scientists (microlevel), research groups, departments, universities (mesolevel), regions, countries, and disciplines (macrolevel). It thereby includes studies that focus on the interrelation between universities as organizations and their scientific members (micro & meso levels).

This paper explores contributions of science and higher education studies with a focus on organizational influences on academic research collaboration, drawing on a unique dataset of 444 publications from 1966 to 2022.

The contribution of the paper is twofold. *Firstly*, it presents, to my knowledge, the first literature review that focuses on the mesolevel of academic research collaboration. It also provides a new analytical framework that is developed from two angles and organizes the literature on academic research collaboration: It synthesizes the literature on four theoretical levels of investigation (meta, macro, meso, micro) and shows four perspectives of research on collaboration as found in the literature (1. Collaboration Influences; 2. Descriptive Analyses of Collaboration; 3. Impacts of Collaboration; 4. Jointly considering 1.–3.). *Secondly*, the paper offers a research agenda on organizational influences on academic research collaboration and provides three research avenues on the question of how universities influence academic research collaboration of their members. Organizational influences can be categorized as organizational characteristics, management strategies, and organizational culture.

The article is organized as follows: *Section two* develops the theoretical conceptualization by encompassing organizational and science studies, while *section three* presents data and sample strategies. The *fourth section* develops the two-dimensional framework. S*ection five* provides a review of the state-of-the-art on academic research collaboration, while *section six* introduces three research avenues[1] on universities' influences as organizations. *Section seven* closes with the conclusion.

On the conceptualization of the science system

The paper combines perspectives from higher education and science studies[2] as science studies allow us to focus on processes of scientific knowledge production (macro-micro level) among individual actors due to disciplinary differences and science policy. Higher education studies take an organizational perspective (meso-micro level) on universities and public research organizations. The research strands share similarities but the combination of different foci of researchers' main interests in each field allows us to address overarching research questions (e.g., Dusdal, 2018; Kyvik & Aksnes, 2015; Frølich & Stensaker, 2005). To understand the relation between universities and individuals, and specifically, the influence of universities as organizations on scientists and collaborative knowledge production, attention needs to be drawn to the entanglement of different levels of the system of science. A multilayered perspective is required to apprehend the relation of meso- and microlevel altered by certain developments on the macrolevel (Gläser & Serrano Velarde, 2018; Marques, 2018; Gläser & Laudel, 2015).

Changes in policy agendas (re)shape the systems and structures of science and higher education (e.g., competition in 'world-class rankings' and expectations of universities' internationalization) (Musselin, 2018; Jung & Horta, 2015; Teichler, 2008). In the last decades, many countries have also witnessed a decline in public research funding accompanied by changes in how that funding has been allocated and monitored. Funding regimes changed towards competitive project- and performance-based funding why processes of science production shifted towards specific subjects, disciplines, and forms of collaboration (e.g., Kosmützky & Krücken, 2021; Marques, 2018; Whitley et al., 2018).

On the national level, higher education is influenced by political agendas (e.g., the Science and Innovation Investment Framework (UK), or the National Science Foundation (U.S.)). In Germany, for example, extensive project funding lines like that of the German Research Foundation moved towards competitive third-party funding and led to the rise of nationally and internationally funded research projects that foster all kinds of collaborative research (Kosmützky & Krücken, 2021). On the organizational level, joint research centers (so-called Sonderforschungsbereiche, Transregios, or Excellence Clusters) are established to connect researchers across disciplinary and organizational boundaries and are characterized by an increasingly internationally oriented dimension. Likewise, regarding inter-

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[2] In this paper, 'science studies' is used as an overarching term that bundles its differentiation (see Jasanoff et al., 1995).

disciplinary collaboration, the importance of research centers (often initiated with large NSF starting grants) as intra-university organizations spanning across disciplines has been stressed (Hackett & Rothen, 2009; Jacobs & Frickel, 2009; National Academy of Sciences, 2005). Moreover, supranational and national funding instruments like the European Union's Framework Programme are developed to strengthen the European Research Area and also foster collaboration among research institutions across national borders[3] (e.g., Marques, 2018; Kosmützky & Krücken, 2015; Primeri & Reale, 2012). Finally, besides political pressures, there is also a strong societal demand for universities and scientists to engage in interdisciplinary collaborations to solve various problems under the umbrella of global climate challenges.

Both individuals and universities are impacted by political agendas as they enact and respond to them (e.g., Seeber et al., 2016; Ramirez, 2021; Krücken & Meier, 2006). First, scientists aim at obtaining funding from extra-mural sources. Thus, they respond to competitive funding opportunities (and pressures) by re-focussing their specific research topics and adapting their practices of knowledge production. Second, increased competition for resources and reputation among universities triggers a strong degree of strategic behavior and has led university leaders and administrators to particularly fund and promote collaboration (Marques, 2018). The formation of international collaborations involves initiatives from scientists to scientists, but they are increasingly managed from the organizational level. The emphasis is on formal collaborations through engaging in commitments on the level of resources and in strategic partnerships affected by impacts of the organizations' reputation (e.g., Marginson, 2021; Owen-Smith, 2018; Isabelle & La Heslop, 2011).

In the traditional perspective, researchers are mainly oriented toward their disciplinary communities and interact in highly self-organized networks that are outside of organizational control (Weingart, 1997). They build autonomous groups characterized by informal communication patterns and self-coordinated cooperation and are part of highly informal disciplinary networks that span globally (Wagner, 2009; Crane, 1972; de Solla Price & Beaver, 1966). Thus, in the longstanding professional view, they are less interested in the organizational goals of their universities as they may identify themselves with their profession much more than with their research organization (e.g., Frost et al., 2015; Altbach, 1996; Clark, 1983). Nowadays, in many national university systems, managerial capabilities of universities' self-steering and control have been increased and universities gained more influence in managing their staff (Enders et al., 2013): merit-based salaries, contracts by objectives, or advancement rules have been implemented, which increase the influence of universities over decisions regarding the development of academic careers, their level of income and the reward system (Musselin, 2013). As researchers are sensitive to incentives, rewards, and obligations, they feel increasingly pressured to respond to criteria related to receiving tenure or promotion (e.g., Xu, 2019; Schimanski & Alperin, 2018; Hüther & Krücken, 2013). However, project-related contracts which seem characteristic of most contemporary funding schemes overlay the funding arrangements researchers have with their organizations as well as other types of research funding (Gläser and Serrano Velarde 2018). This induces a persistent and imperative tension: While universities aim to stimulate more collaborative output on the organizational level, the organizational influence especially on scientists and their knowledge production is still rather limited (Musselin, 2007; Whitley,

[3] See also National Science Foundation (US), Science and Innovation Investment Framework (UK), Fund for the.Scientific and Technological Research (Argentina), Horizon Europe (EU).

2012). Scientists and their global collaboration networks can be only indirectly governed by formal rules because (in a narrow understanding) unlike in the economy, formal rules and managerial 'crackdown' (Hüther & Krücken, 2018, p. 176) on how researchers have to conduct research (e.g., alone or jointly) are mostly non-existent (e.g., Musselin, 2007; Gläser, 2006; Mintzberg, 1989).

Yet, universities by definition are the contexts (or the local environment conditions) in which researchers work and meet, where they find research opportunities and intellectual stimulation. Therefore, is difficult to imagine the contemporary development of knowledge production without taking the role of universities as organizations into account as they are embedded in and mediate structural changes in policy funding regimes (Gläser & Serrano Velarde, 2018). In short, even though scientists themselves are extrinsically motivated to engage in specific forms of collaboration (e.g., for reputational reasons or to secure funding), university leaders (try to) influence their members toward collaboration even more (e.g., Holm et al., 2019; Cummings & Kiesler, 2007; Wagner & Leydesdorff, 2005). However, it is an ongoing discussion whether, when, and how the implementation of incentives leads to changes in the production of scientific knowledge among scientists (Gläser, 2017; Müller and De Rijcke, 2017).

Data and sample strategies

Instead of using keyword and journal-based searches, this qualitative literature review is problem-driven and explores the contributions of science and higher education studies to academic research collaboration, thereby excluding collaboration with firms and industry. Due to recent technology and innovation policies and entailed concepts of academic entrepreneurship or the third-mission, research on university-industry collaboration is en vogue (Etzkowitz, 2003; Owen-Smith, 2003). There is a substantial body of literature (and recent literature reviews) with a focus on R&D collaboration (e.g., Sjöö & Hellström, 2019; Rybnicek & Königsgruber, 2019; Perkmann et al., 2013; Geuna & Muscio, 2009; D'Este & Perkmann 2011). These studies concentrate on the organizational influences of universities, too, but investigate how universities as organizations can facilitate collaborations with firms[4]. However, little is known about how universities influence collaborations between their scientific members or how they engage in research collaboration with other universities of high reputation to secure funding opportunities or gain competitive advantages. To compile our knowledge on 'academic research collaboration,' the term as defined here contrasts with the concept of collaboration in the R&D literature and narrows collabora-

[4] Universities' influences identified by R&D research are sometimes similar or can apply to influences on academic research collaboration (e.g., university research centers, disciplinary composition, organizational type (comprehensive vs. polytechnic university)). Yet, some influences are distinctive for university-industry collaborations (e.g., R&D literature stresses the positive influence of industry contracts, Knowledge Transfer Offices, and legal frameworks). Sometimes both research strands discuss similar influences but with different foci (e.g., R&D literature mostly discusses the organizational culture(s) in terms of barriers between firms and universities, while the literature on 'academic research collaboration' discusses different university cultures in terms of different facilitating research environments). As the observational units differ from the R&D literature sometimes come to different conclusions, especially in terms of influences of university characteristics. For example, universities' high age leads to a decline in University-Industry collaboration but a rise in 'academic research collaboration' or universities' high reputation leads to a decline in university-industry collaboration vs. a rise in academic research collaboration.

tion to the science system but is broadly defined within. Since research policies aim at fostering collaboration at different levels, the literature considers academics, universities, or countries as the units to be observed (especially because co-publication is the predominant indicator of collaboration that can be aggregated at different levels of investigation). Therefore, the term includes collaboration among scientists (microlevel), research groups, departments, universities (mesolevel), regions, countries, and disciplines (macrolevel) and thereby includes studies that focus on the interrelation between universities as organizations and their scientific members (micro & meso levels). However, since working together is far more than publishing together (Laudel, 2002; Katz & Martin, 1997), the term is not limited to co-publication, which is why quantitative studies use other collaboration measurements (e.g., time spent working together) and qualitative studies are included as well.

This review builds on a database of previously collected publications[5]–with a focus on international research collaboration–that reflects researchers' tacit knowledge and illustrates current developments and discussions on the topic of research collaboration, and provides a valuable source of information (Polonioli, 2020, p. 1272; Gläser & Laudel, 2015). Based on a comprehensive analysis of abstracts, publications were included in the current database if they focused on academic research collaboration but excluded if they concerned university-industry collaborations. I augmented the data by snowballing from references. In addition, several renowned journals (e.g., Research Policy, Social Studies of Science, Scientometrics, Journal of Higher Education, Higher Education, Studies in Higher Education) were scanned from 2018 to 2022. This led to a database of 444 publications, the earliest of which is from 1966 and the latest is from 2022.

The framework: a two-dimensional classification

To organize the literature on academic research collaboration and to assess where further research on organizational influences is necessary, I use a two-dimensional framework. It includes a conceptual distinction between macrolevel (policies, or governance structures), mesolevel (collaboration in organizations or groups), and microlevel (collaboration among scientists) as well as a meta-perspective (theoretical assumptions or methodological reflections). To assign the literature to the different levels, Ragin's (1987) distinction between the observational and explanatory unit is applied. The explanatory unit forms the basis for the decision rules. Nevertheless, if a publication's focus bridges, for example, micro-and macrolevels, the paper is assigned to both levels. Additionally, a structured approach (like Bozeman & Boardman, 2014) relates independent variables (e.g., organizational influences) to dependent variables (e.g., academic research collaboration) to receive some clarity of causal reasoning[6] on organizational influences. In contrast to other literature reviews (Bozeman & Boardman, 2014; Boardman et al. 2013 or Stokols et al., 2008), it focuses on the *perspectives of research on academic research collaboration.* In doing so, four perspectives were identified in the literature that structure the framework horizontally: (1) Collaboration

[5] An initial database of 612 publications was collected for a meta-study (Kosmützky, 2018) and a literature review (Wöhlert, 2020), both with a focus on international collaboration. It includes relevant journals in the fields of higher education, science studies, and social science amongst others.

[6] 'Though not necessarily validity of causal inference, a much more difficult and fragile analytical problem'(Bozeman & Boardman, 2014, p. 9).

Influences; (2) Descriptive Analyses of Collaboration; (3) Impacts of Collaboration; (4) Jointly considering 1.–3.

The first research perspective *'Collaboration Influences'* summarizes studies that investigate influencing factors as independent variables on collaboration (the dependent variable). If publications describe or analyze collaboration without dependent or independent variables (e.g., characterizing global collaboration patterns or considering collaboration dynamics of groups), they fall into the *'Descriptive Analyses of Collaboration'* category. The category '*Impacts of Collaboration'* depicts studies that examine, for example, the effect of collaboration on productivity. If publications consider the three previous research perspectives altogether, they are summarized in the fourth perspective *'Jointly considering 1.-3.'*

What do we know about academic research collaboration?

This section presents the literature review of the current state-of-the-art of research on academic research collaboration based on the two-dimensional framework (Table 1*)*. The included literature of the framework is provided for the metalevel in Table 2, macrolevel (Table 3), mesolevel (Table 4), and the microlevel (Table 5). Overall, the review shows that some research perspectives are investigated more strongly (especially '*Descriptive Analyses of Collaboration'* on all levels) than others *('Jointly considering 1.–3'* on the macro-and mesolevel, '*Collaboration Influences,'* and *'Impacts of Collaboration'* on the mesolevel). The current state-of-the-art of research on collaboration lies in researchers' interest in the system configuration of collaboration, leadership and management issues of collaborative groups, collaborative working practices, and team science. Given that public research sectors are increasingly governed by indicators based on numbers (which are supposed to increase scientific productivity), *'Impacts of Collaboration'* are mainly studied in terms of productivity and performance[7].

How universities influence academic research collaboration

Based on the literature review in the previous section, the following section synthesizes organizational influences found in the literature thereby focussing on '*1. Collaboration Influences' on the mesolevel*. Identified research gaps lead to three research avenues of organizational influences: organizational characteristics management strategies and organizational culture.

Influence factors can be categorized based on the ability of university leaders to exert leverage. *(1) Organizational characteristics* constrain and enhance research collaboration but they are rather difficult to influence by organizational leaders[8]. *(2) Management strategies* set incentives and create collaboration opportunities and are easier to establish and change by administrators compared to organizational characteristics (Sporn, 1996; Tierney, 1988; Dill, 1982). *(3) The organizational culture* shapes research collaboration because

[7] The term 'productivity' captures quantitative scientific output, whilst 'performance' refers to measurements such as impact factors of co-authored papers or scientists' reputations.

[8] Especially, universities' age and geographical location.

Table 1 The Two-Dimensional Framework: Organizing the Literature on Academic Research Collaboration

Metalevel				
Methodologies, Epistemology; Types, Definitions; Methods, Theory, Concepts, Frameworks; Literature Reviews, Handbooks, Special Issue				
	1. Collaboration Influences	**2. Descriptive Analyses of Collaboration**	**3. Impacts of Collaborations**	**4. Jointly considering 1. – 3.**
Macrolevel (global, countries)	Policy, Management, Proximity, Crisis, IT, Internationalization, Development, Size	System Configuration, Dynamics & Disciplines, Country(ies) & Regions	Productivity, Performance, Retraction, Innovation/Transformation	Funding Policy & Collaboration Dynamics / Network & Productivity / Performance
Mesolevel (organizations, groups)	**Size, Status, Governance, Structure/ Design, Environment/ Proximity**	Leadership & Management, Working Practice of scientific groups, Teamscience, Dynamics, Network Configuration	Productivity, Performance	Reputation & Development Collaboration & Performance
Microlevel (individuals)	Ascriptive Characteristics (e.g., Academic Career, Personal Relationship, Gender), Physical Space	Collaborative Working Practices	Productivity, Performance, Retraction, Academic Role & Identity	Reasons for Collaboration /Academic Career / Proximity & Working Practice/ Network & Productivity/ Performance/ Benefits

it includes patterns of (collaborative) working routines but also because shared assumptions and understandings about research collaboration are involved (Sporn, 1996; Schein, 2010). Cultures encompass norms and values that partly lie beneath the conscious level of individuals and also influence management decisions (Sporn, 1996). Therefore, organizational cultures are difficult but not impossible to change by organizational leaders thus the management of organizational cultures is located somewhere between the previous two categories.

Organizational characteristics

Size is one of the key characteristics of universities which impacts most of their activities (e.g. Huisman et al., 2015 Daraio et al., 2011 Pfeffer et al., 2005). Universities are sources of knowledge and skilled people where scientists find research opportunities and intellectual stimulation. Large size (typically measured by the number of students, staff or full-time professors) allows for intellectual breadth to be combined with specialization essential for scientific work (Hagstrom, 1971). Accordingly Katz (2000) shows a positive relationship in various OECD countries between the number of various types of collaboration (e.g. mul-

Table 2 Metalevel (theoretical assumptions or methodological reflections)

Methodologies & Epistemology	Akbaritabar 2021; Caballos et al. 2018; Chinchilla-Rodriguez et al. 2021; Dewaele et al. 2021; Easterby-Smith & Malina 1999; Freeth & Vilsmaier 2020; Frenken et al. 2009; Fuchs et al. 2021; Furukawa et al. 2011; Giudice et al. 2012; Griffin et al. 2021; He et al. 2005; Hoffman et al. 2014; Huang et al. 2021; Katz 1994; Kelly et al. 2020; Kim & Diesner 2019; Kosmützky, 2018; Laudel 2002; Powell 2020; Stokols et al. 2008; Wilholt 2016; Zhang 2018; Zhang 2019; Zhang et al. 2018; Zhou et al. 2018
Types & Definitions	Dytham 2019; Franzoni & Sauermann 2014; Katz & Martin 1997; Laudel 2002; Lewis et al. 2012; Morrison et al. 2003; Subramanyan 1983
Methods	Abbasi et al. 2010; Ahlgren et al. 2013; Alvarez et al. 2015; Aman 2018; Bai et al. 2021; Boyack 2009; Di Caro et al. 2012; Gläser & Laudel 2015; Horta & Santos 2016; Jiang 2008; Koopmann et al. 2021; Kosztyan et al. 2021; Leydesdorff 1989; Potter et al. 2022; Rose Georg 2021; Subramanyan 1983; Tuire & Erno 2001; Xie 2019; Yang et al. 2020
Theory Concepts Frameworks	Corley et al. 2006; Creamer 2003; Dahlander & McFarland 2013; Frenken et al. 2009; Gray & Wood 1991; Grimpe et al. 2020; Kretschmer 1999; Mills & James 2020; Mirnezami et al. 2020; Uddin et al. 2019; Ulnicane 2015; Umur 2013
Literature Reviews	Bozeman & Boardman 2014; Bozeman et al. 2013; Bukova 2010; D'Amour et al. 2005; Frenken et al. 2009; Leahey 2015; Panziera Marques & Franco 2020; Sonnenwald 2007; Stokols et al. 2008; Stokols et al. 2015
Handbooks & Special Issue	Austin & Baldwin 1991; Cooke et al. 2015; Falk-Krzesinski et al. 2011; Frodeman et al. 2010; Sabzalieva et al. 2020

tiple-authored papers domestic international intra-organizational) and the university size (measured by publication output). Findings show for example that smaller organizations collaborate domestically while larger organizations tend to collaborate more internally as well as internationally. In contrast Fernandez et al., (2021) explore amongst others the effects of organizational proximity on scientific collaboration in the Spanish research system. Organizational proximity is understood as the degree of similarity between organizations assuming that university institutions sharing certain characteristics will behave similarly. They find that differences in universities' size are not relevant in explaining research collaboration but ***age*** differences are (probably because younger universities try to seek expertise from older universities while traditional universities gain access to new ideas) even though usually university size is correlated to its age (e.g. Daraio et al., 2011; Huisman 2015). In more detail Frølich & Stensaker (2005) emphasize that the historicity of universities matters because intra-organizational collaboration has been traditionally established and is still present in the research process. Moreover, we find the importance of universities' ***reputation*** (e.g. Curran et al., 2020; Wagner & Leydesdorff, 2005; Katz 1994). Jones et al., (2008) examine (co-) publications of 662 U.S. universities to understand the role that multi-university collaborations play in the production of science. In doing so they consider elite and non-elite universities and differentiate between intra- and inter-university collaboration. University status is measured by the total number of citations received by the papers published at the university. They demonstrate that the rising collaboration in science is increasingly composed of inter-university collaborations and elite universities play a dominant role in this shift. As competition in funding and reputation has increased universities of high reputation are valuable collaboration partners because they enhance the visibility of their partner organization and the chances for raising additional grants and research projects. Besides, the ***disciplinary composition*** of universities affects research collaboration with several studies accentuating that collaboration varies across scientific fields and sub-fields (e.g. Coccia & Wang 2016;

Table 3 Macrolevel (policies or governance structures)

1. Collaboration Influences	
Policy	Adams et al. 2022; Amaro de Matos et al. 2022; Clarysse & Muldur 2001; Colatat 2015; Currie-Alder et al. 2018; Davies et al. 2022; Fernandez et al. 2021; Highman 2019; Jappe 2009; Kosmützky & Wöhlert 2021; Lee & Haupt 2020; Lee & Haupt 2021a; Lee & Haupt 2021b; Marques et al. 2020; Mattsson et al. 2010; Matveeva & Ferligoj 2020; Muriithi et al. 2018; Onoda & Ito 2022; Park et al. 2015; Quayle & Adshead 2018; Roberts 2006; Sabzalieva 2020; Smeby & Trondal 2005; Sokolov et al. 2021; Ubfal & Maffioli 2011; van Deursen & Kummeling 2019; Veiga 2021; Zhao et al. 2021
Management	Brewster et al. 2011
Proximity	Hoekman et al. 2010
Crisis	Cai et al. 2020; Lee & Haupt 2021b; Rotolo & Frickel 2019
IT	Ding et al. 2010; Duque et al. 2005; Duque et al. 2009; Teasley & Wolinsky 2001
Internationalization/ Development	Frølich & Stensaker 2005; Hahn 2015; Jung & Horta 2015; Ousey et al. 2013; Smeby & Trondal 2005; Torres-Olave et al. 2020
Size	Katz 2000; Luukkonen et al. 1992
2. Descriptive Analyses of Collaboration	
System Configuration (globally)	Barnard et al. 2012; Barrios et al. 2019; Belli & Balta 2019; Choi 2012; Eduan & Jian 2019; Gazni et al. 2012; Georghio 1998; Glänzel 2001; Hicks & Katz 1996; Hsiechen et al. 2015; Hsiechen et al. 2018; Hu et al. 2020; Kamalski & Plume 2013; Leydesdorff & Wagner 2008; Leydesdorff et al. 2013; Luukkonen 1992; Ribeiro et al. 2018; Shin et al. 2013; Solla Price & Beaver 1966; Valdivieso et al. 2015; Yuan et al. 2018
Dynamics & Disciplines (Topics)	Aleixandre-Benavent et al. 2015; Armando et al. 2010; Babchuk et al. 1999; Barrios et al. 2019; Bordons et al. 1996; Bu et al. 2018; Cabrera et al. 2020; Chen et al. 2019; Chuang 2011; Coccia & Wang 2016; Cugmas et al. 2016; Dutt et al. 2003; Ferligoj et al. 2015; Fortunato et al. 2018; Frame & Carpenter 1979; Fu et al. 2022; Guilera et al. 2013; Guns et al. 2011; Hackett et al. 2006; Heidler 2011; Henriksen 2016; Henriksen 2017; Hsiechen et al. 2015; Huang 2015; Jansen et al. 2010; Katz & Hicks 1996; Kozma & Calero-Medina 2019; Kumar & Manuel 2018; Laband & Tollinson 2000; Larivire et al. 2006; Luukkonen 1992; Maltseva et al. 2022; Ousey et al. 2013; Powell 2020; Rose Georg 2021; Santana et al. 2021; Steinbach 2010; Tuire & Erno 2001; Urbano & Ardanuy 2020; Vlegels et al. 2021; Wagner 2005; Wagner 2016; Wagner & Leydesdorff 2005; Yuan et al. 2020
Country(ies) & Regions	Celis & Kim 2018; Choi et al. 2021; Daraio et al. 2011; Ferligoj et al. 2015; Finardi 2014; Glänzel et al. 2006; He 2009; Hicks 1996; Isabelle & Heslop 2011; Jung & Horta 2015; Kim & Kim 2020; Kozma & Calero-Medina 2019; Kronegger et al. 2012; Kumar & Manuel 2018; Kuzhabekova 2018; Kwiek 2018; Kwiek 2020; Kwiek 2021; Larivire et al. 2006; Ma & Li 2018; Matveeva et al. 2022; Muriithi et al. 2018; Palacios-Callender et al. 2018; Park & Yoon 2019; Pessoa Junior et al. 2020; Quan et al. 2019; Sahin 2018; Sooryamoorthy 2019; van Holm et al. 2019; Vieira 2022
3. Impacts of Collaboration	
Productivity	Bordons et al. 1996; Duque et al. 2005; Scarazzati & Wang 2019; van Holm et al. 2019
Performance	Aksnes 2003; Asubiaro 2019; Chuang 2011; Glänzel 2000; Glänzel et al. 2006; Glänzel & Schubert 2001; Hsiehchen et al. 2018; Katz & Hicks 1996; Katz & Ronda-Pupo 2019; Kwiek 2018; McManus et al. 2020; Presser 1980; Quan et al. 2019; Rigby & Edler 2005; Shen et al. 2021; Tian et al. 2021; Wagner et al. 2019; Youtie et al. 2013
Retraction	Zhang et al. 2020
Innovation/ Transformation	Adams 2013; Crescenzi et al. 2016; Protogerou et al. 2010; Tadaki & Tremewan 2013
4. Jointly considering 1. – 3.	

Table 3 (continued)

Funding Policy & Collaboration Dynamics/ Network & Productivity/ Performance	Defazio et al. 2009; Liang & Liu 2018; Zhou et al. 2020

Table 4 Mesolevel (organizations, groups)

1. Collaboration Influences	
Size	Haeussler & Sauermann 2020; Katz 2000
Status	Celis & Kim 2018; Jones et al. 2008
Teaching focus	Muriithi et al. 2018
Governance Structures	Akbaritabar 2021; Benson et al. 2016; Celis & Kim 2018; Curran et al. 2020; Jung et al. 2021; Knapke et al. 2021; Makinen et al. 2020; Muriithi et al. 2018; Tsikerdekis & Yu 2018;
Organizational Structure/ Design	Kezar 2003; Kezar 2005; Kezar 2006; Laudel 1999; Muriithi et al. 2018; Sá & Oleksiyenko 2011; Turner et al. 2015
Environment/ Proximity	Akbaritabar 2021; Ceballos et al. 2018; Fernandez et al. 2021; Luo et al. 2018; Katz 1994; Kyvik 1995
2. Descriptive Analyses of Collaboration	
Leadership & Management	Adler et al. 2009; Ajmal 2016; Bammer 2008; Bark et al. 2016; Barrett et al. 2011; Cummings & Kiesler 2005; Easterby-Smith & Malina 1999; Enger & Gulbrandsen 2020; Fiss et al. 2010; Gibson et al. 2019; Hacket 2005; He et al. 2021; Hellström et al. 2018; König et al. 2013; Turner et al. 2015
Working Practice/ Teamscience	Ausloos 2014; Barinaga 2007; Barrett et al. 2011; Bayerlein & McGrath 2018; Bercovitz & Feldman 2011; Bone et al. 2020; Bossio et al. 2013; Budd 2018; Chen et al. 2013; Conrad & Phillips 1995; Cox et al. 1991; Cummings & Haas 2011; Degn et al. 2018; Dusdal & Powell 2021; Earley & Mosakowski 2000; Edwards et al. 2011; Fiss et al. 2010; Fox & Mohapatra 2007; Higgins & Smith 2022; Hillersdal et al. 2020; Hoffman et al. 2014; López-Yáñez & Altopiedi 2015; Morrison et al. 2003; Myers 1991; Ousey & Edward 2014; Parker & Hackett 2012; Pershina et al. 2019; Pflüger 2013; Saari & Miettinen 2001; Turner et al. 2015; Ulnicane 2015; Valdivieso et al. 2015
Dynamics	Chen et al. 2021; Dusdal & Powell 2021; Genuth et al. 2000; Higgins & Smith 2022; Hoffman et al. 2014; Steel et al. 2019; Wang & Hicks 2015
Network Configuration	Di et al. 2021; Gazni & Didegah 2011; Kumar & Manuel 2018; Li et al. 2018; Maltseva et al. 2022
3. Impacts of Collaboration	
Productivity	Fan et al. 2020; Fox & Mohapatra 2007; Gazni & Didegah 2011; Kelly et al. 2020; Li et al. 2018; Morrison et al. 2003; Teirlinck & Spithoven 2015
Performance	Asai 2020; Asai 2021; Barjak & Robinson 2008; Bermeo Andrade et al. 2009; Bossio et al. 2013; Demaine 2022; Fan et al. 2020; Gracio et al. 2020; Li et al. 2018; Morrison et al. 2003
4. Jointly considering 1. – 3.	
Funding Policy & Collaboration Dynamics/ Network & Productivity/ Performance	Chen & Wang 2021; Cummings & Kiesler 2007; Heinze et al. 2009; Jones et al. 2008; Vasileiadoua & Vliegenthart 2007; Zharova et al. 2018

Abramo et al., 2009; Heinze et al., 2009). If universities include disciplines that require the sharing of instruments and material resources such as laboratories they are more likely to collaborate. Therefore, the ***organizational type*** shapes universities' disciplinary composi-

Table 5 Microlevel (collaboration among scientists)

1. Collaboration Influences	
Ascriptive Characteristics (e.g. Academic Career Personal Relationship Gender)/ Research Interest	Abramo et al. 2014; Abramo et al. 2019; Baruffaldi & Landoni 2012; Boud et al. 2021; Brodin & Avery 2020; Ceballos et al. 2018; Costas & Bordons 2011; Creamer 2003; Eduan 2019; Ghiasi et al. 2018; Haupt 2021; Horta et al. 2022; Jha & Welch 2010; Jin et al. 2021; Jonkers & Tijssen 2008; Jung et al. 2021; Kwiek 2018; Kwiek 2020; Leahey & Reikowsky 2008; Lindahl et al. 2021; Müller 2012; O'Brien 2011; Paswan & Singh 2020; Rhoten & Pfirman 2007; Rijnsoever & Hessels 2011; Scellato et al. 2015; Tsikerdekis & Yu 2018; Wang et al. 2019a; Wang et al. 2019b; Whittington 2018; Woolley et al. 2015
Physical Space	Kabo et al. 2014
2. Descriptive Analyses of Collaboration	
Collaborative Working Practices	Bikard et al. 2015; Brew et al. 2013; Fox & Faver 1984; Gottlieb 1995; Henriksen 2017; Lai & Li 2020; Landry & Amara 1998; Shore & Groen 2009; Tavares et al. 2022
3. Impacts of Collaboration	
Productivity	Abramo et al. 2018; Baruffaldi & Landoni 2012; Brambila 2014; Cainelli et al. 2015; Hu et al. 2014; Jonkers & Tijssen 2008; Landry et al. 1996; Lee & Bozeman 2005; Mirnezami et al. 2020; Ynalvez & Shrum 2011
Performance	Abramo et al. 2019b; Amjad & Munir 2021; Asubiaro 2019; Lee et al. 2015
Retraction	Zhang & Hui-Zhen 2022
Academic Role & Identity	Kyvik 2013; Leibowitz et al. 2014
4. Jointly considering 1. – 3.	
Reasons for Collaboration/ Academic Career/ Proximity & Working Practice/Network & Productivity/ Performance/ Reputation/ New Knowledge/ New and Deepened Contacts	Bai et al. 2021; Beaver 2001; Bordons et al. 1996; Davis & Wilson 2001; DeHart 2017; Hoegl & Proserpio 2004; Kabo et al. 2014; Katz & Martin 1997; Liu et al. 2022; Martinez & Sa 2020; Melin 2000; Palacios-Callender et al. 2018; Philpott & Strange 2003; Purwitasari et al. 2020; Stead & Harrington 2000; Yemini 2021

tion (e.g. universities of applied sciences comprehensive universities universities including medicine or polytechnics) but research mostly looks at universities sometimes other higher education institutions. Finally, we find some research on universities' ***proximity*** to other research organizations (e.g. Fernandez et al., 2021; Ceballos et al., 2018; Katz 1994). There has been growing consensus that immediate geographical proximity between researchers is one of the key factors in learning and innovation and an incentive to collaborate (e.g. Hennemann et al., 2012; Boschma, 2005; Luukkonen et al., 1992;). Ceballos et al., (2018) propose a new methodology to investigate formal intra-institutional research groups which can be directly strengthened supported and nurtured by universities. Applying a network perspective they analyze seven factors that can facilitate or constrain research collaboration whereby organizational closeness (proximity) is one of them. Against their expectations organizational closeness does not have a positive influence on group formation: probably because organizational closeness is measured by the colleagues a researcher can relate to at a departmental level and physical closeness seems not to be sufficient to form a group of collaborators. Accordingly Luo et al., (2018) investigate organizational proximity thereby concentrating on the distance between Australian universities and the influence on collaboration practices. Results show a weak correlation between distance and collaboration but intra-university collaboration increases collaboration between universities. Therefore:

Research Avenue 1 *The organizational characteristics of universities (e.g. size disciplinary composition age reputation) shape both the opportunities and constraints for research collaboration.*

Due to different indicators used and countries that have been investigated, it remains unclear to what extent organizational characteristics influence academic research collaboration as findings are sometimes contradictory. It is also ambiguous how characteristics are related to each other and how they affect especially different types of collaboration such as co-authored papers: domestic international intra-organizational intra- and inter-sectoral. Additionally science and higher education systems differ among national contexts at all levels and sectors because of historical idiosyncrasies diverse political conditions and interests and the institutionalized system configurations within the country (Marques et al., 2020; de Rassenfosse & Williams, 2015). Thus, a systematic comparative and historical perspective is needed to elaborate for example on the decisive organizational characteristics that enhance and constrain research collaboration on the organizational level. For example further research could quantitatively investigate on different national levels how universities' characteristics are related to each other when it comes to different types of collaboration (e.g. interdisciplinary high-impact collaboration). Deeper insights could explain why some universities and nations engage more in collaborations while others do less.

Management strategies

Publications analyze and suggest various management measures that university leaders and administrators can establish to stimulate and incentivize collaboration and create opportunities for jointly conducted research. First, we find ***structural measures*** that create connections among intra-organizational units or that create bridges to enable and enhance extramural collaboration (Kezar, 2006). To achieve intra-organizational collaboration universities can rebuild the organizational structure and make it more flexible for example by integrating separate units into interdisciplinary centers (Cooke & Hilton, 2015; Hackett & Rothen 2009). Curran et al., (2020) investigate university strategies with a focus on cluster hiring in the United States. It is a university initiative to facilitate cross-disciplinary collaboration between three and eight scientists. The findings indicate that cluster hiring is associated with significant gains on average in the number of collaborators. However, it is no cure-all for fields that are disadvantaged in the competition for external funding or for non-elite universities that are disadvantaged in the competition for prestige. With a similar focus Mäkinen et al., (2020) conducted a case study to understand how scholars' participation in interdisciplinary collaboration is affected by the interdisciplinary and topic-focused centers they are part of. They show that a center's mission physical architecture and leadership and task structure shape collaborative behavior. Similarly Sa & Oleksiyenko (2011) examine how organized research units (defined as centers institutes and laboratories) facilitate international collaborations in an academic health center in Canada. Findings show that organized research units (especially when they focus on specific interdisciplinary niches) allowed scientists to build international networks of collaborators as they engage in teams across departments as well as institutions in collaborative research. In her doctoral thesis, Laudel (1999) uses a mixed-methods approach to investigate whether Collaborative Research Centres (CRCs - so-called Sonderforschungsbereiche) are funded for twelve to fifteen years by

the German Research Foundation to facilitate intra- and inter-university collaboration. She concludes that these centers enable new collaborative relationships and intensify existing ones. Besides, the implementation of Visiting Scholar Centers and International Offices or Research Centers helps to engage in extramural collaboration (López-Yáñez & Altopiedi, 2015; Roberts, 2006; Frølich & Stensaker, 2005). In addition, technical support within a data center seems to be of crucial importance by providing electronic communication possibilities information and training about relevant programs long-accessible data-servers and -archives for researchers and their collaboration partners including data security (Cooke & Hilton, 2015; Stokols et al., 2008). Finally, partnerships with other universities facilitate student exchange programs and national and international research collaboration (Shore & Groen, 2009). Using the example of Berlin, Akbaritabar (2021) examines the structure of scientific collaborations regarding the Berlin University Alliance (BUA). The strategic coalition of four Berlin-based higher education institutions has been established to support higher rates of scientific collaborations. Considering different fields they show that only in Medical and Health Sciences did the four BUA members collaborate densely.

Second, we find an ***incentive strategy*** in the literature that universities use to motivate researchers to collaborate (Tsikerdekis & Yu, 2018). While incentives can be financial or material benefits for individual researchers (e.g. Knapke et al., 2021; Kim & Bak, 2017; Landry et al., 1996) the literature shows contradictory results or suggestions in terms of collaboration requirements implemented in tenure and promotion procedures (e.g. Beaver 2001; Austin 1991). Moreover, awards are strategically used to provide symbolic incentives for jointly conducted research (Knapke et al., 2021; Roberts, 2006; Landry et al., 1996). However, Celis & Kim (2018) analyze the relationship between faculty hiring networks and research collaboration networks as well as their association with organizational prestige. They discovered that hiring faculty with foreign training is a mechanism for universities to access larger collaboration networks and resources available in other countries (especially when faculty's training took place in advanced and mature higher education systems mostly in prestigious universities in English-speaking countries). Also related to human resources, Knapke et al., (2021) consider the role of appointment reappointment promotion and tenure (ARPT) criteria that aim to facilitate interdisciplinary collaboration within a university. Results indicate that changes in ARPT criteria towards collaboration requirements are not reflected in every discipline as some tend to value individual accomplishments. Therefore, ARPT criteria need to be better defined regarding the metrics used to evaluate scientific engagement in interdisciplinary research. However, Kim & Bak (2017) address the question of whether organizational-performance-based reward systems lead to a rise in jointly conducted research at Korean universities. They suggest that a well-designed collaborative reward system enhances intra- and inter-organizational collaboration because it promotes and sets incentives for collaboration. Tsikerdekis & Yu (2018) develop a survey to understand what factors (relating to environmental past researcher behavior and personal research characteristics) facilitate and constrain intra-university collaboration. Findings reveal that besides human factors environmental obstacles like the lack of a supporting system research environment technologies low priority in the unit unit barriers and lack of collaboration guidelines hinder the engagement in intra-university collaborations. Senior administrators can promote collaboration at events (Kezar, 2003, 2006) but communicating the benefits of collaboration in campus newspapers and newsletters enhances collaboration too (Austin & Baldwin, 1991). Moreover, studies often mention the support of (senior) administrators who

play a significant role in promoting collaboration and connecting people across campus or by organizing boundary-spanning conferences (e.g. Kezar 2006; Kezar, 2003; Landry et al., 1996). Finally, universities can facilitate research collaboration by creating opportunities for inter-and intra-organizational networking, for example, by providing common cafés or lunch areas or by organizing conferences workshops and gatherings (e.g. Delicado et al., 2014; Melin, 2000; Landry et al., 1996).

Third, we see that an organizational ***funding strategy*** is essential to enable and enhance research collaboration. Studies widely agree that collaboration needs enough funding to cover travelling fees students and post-doc exchanges and to organize workshops and conferences (e.g. Cooke & Hilton 2015; Turner et al., 2015; Defazio et al., 2009). Moreover, the literature shows that collaborative research needs effective project management in combination with flexible and effective funding management (Defazio et al., 2009). Therefore:

Research Avenue 2 *Universities aim to influence research collaboration by combining collaboration management strategies (intra- and inter-organizational connecting strategy incentive strategy and funding strategy) and related management measures (e.g. the establishment of boundary-spanning units technical support rewards and awards ties to governmental programs and by providing locations for building networks).*

The literature review has proposed a set of management measures universities use (and attempt to use) to facilitate inter-and intra-organizational collaboration. However, in most of the studies on research collaboration these measurements remain vague. There is a need to illuminate more carefully how measurements can be designed to lead to the desired impact. Critically two articles in the literature review contribute to the ongoing discussion about the 'two-sided medal' of managerial incentive strategies that aim to influence researchers. The Korean case investigated by Kim & Bak (2017) demonstrates that if universities try to force researchers to collaborate by tying financial benefits to co-authored papers researchers might publish co-authored papers without working together; actual co-authored papers were sometimes a trade-off between quantity and quality of performance (Kim & Bak, 2017 p. 195). It is well known that incentive strategies especially monetary hamper researchers' motivation and researchers react against 'audit cultures' (Olmos-Peñuela et al., 2014 p. 503). Thus, the literature review points to a fundamental tension between individuals' intrinsic and extrinsic motivations. It could be valuable, for example, to conduct qualitative research applying case studies (drawing on interviews mission statements reports) to elaborate on how different universities (old/young teaching/research polytechnics/comprehensive high/low reputation) engage in collaboration challenges and how management strategies can or should be designed to create support structures and spaces of opportunities to meet the desired collaboration output at the organizational level.

Organizational culture

By reviewing the literature some indications were found that suggest integrating jointly conducted research in the organizational culture to enhance and enable inter- and intra-organizational collaboration. Kezar conducted two case studies in 2005 and 2006 and accentuates how universities need to be redesigned to enable collaboration in terms of their mission organizational structure processes people and rewards. Her findings suggest that research

collaboration should be implemented from the top of the administration by defining the organization's mission and how it is used as a basis for decisions to create a university structure and culture (new values norms and philosophy) which support collaboration (Kezar, 2006). Specifically, strategic initiatives should include actions and words documents and associations of collaboration altogether signalling that collaboration is valued and supported. The results stress that if collaboration is part of the organizational philosophy it becomes a symbolic strategy and a systematic process as part of all work in which researchers are engaged. She also concludes that universities seem most effective in fostering collaboration when balancing top-down and bottom-up governance strategies. Therefore:

Research Avenue 3 *The organizational culture (working routines missions philosophy) of universities influences the enhancement and constraints of research collaboration.*

This is the largest research gap identified. It refers to the influence of the organizational culture of universities on research collaboration. Organizational cultures are an attempt to influence values norms and habits of universities' scientific members (Kezar, 2005, 2006). Therefore, university leaders and administrators formulate their philosophy mission statements mottos and logos and use internal events to implement a university culture. In general organizational cultures are difficult to measure and therefore, complicated to study (Schein, 2010; Dill, 1982; Clark, 1983). This problem intensifies in the academic context because the scientific community in general and specific scientific communities represented in the university influence the organizational culture of why every department develops its subculture (Schein, 2010). As university cultures are multidimensional and have so far been less studied, a qualitative approach would be adequate to deepen our understanding as to whether and how university leaders can influence organizational cultures to promote collaboration. It would be useful to address different perspectives (e.g. university presidents administrators scientists) to elaborate on how management strategies could be designed to achieve goals of intra – and inter-organizational collaboration. However, management strategies are difficult to design because the reshaping of cultures takes time and their influence remains unclear.

Conclusion

This research agenda focused on the question *'How do universities as organizations influence academic research collaboration?'* which is one of the questions less investigated by science and higher education studies. The review demonstrated that researchers have only just begun to focus on the diversity of organizational influences on research collaboration. Due to studies' different indicators and understandings of collaboration related variables and various countries and scientific fields investigated our knowledge of organizational influences on research collaboration is rather fragmented than a complete picture. Further research requires a more systematic exploration of one of its most important dependent variables. As discrete organizational influences affecting academic research collaboration are not conceptualized causally (rather we find indications of relations) more research on theorization about key relationships and empirical causal relations is needed.

This indicates a great potential for further studies concentrating on the question of how policy changes on the macro level are altered and translated to the organizational level and

influence scientific knowledge production because this has so far not been studied in great detail. Therefore, a revision of methodologies and theories considering the entanglement of different levels of the science system is required. To understand how policy changes affect the meso-micro-level relation national and international comparative and qualitative research is needed to investigate science policies in different higher education systems. Moreover, the review clearly shows that organizational characteristics management strategies and organizational culture are related to each other. Thus, more conceptual and theoretical contributions to the interrelation are needed. For example the organizational culture is shaped by the history of a university (organizational characteristics) or by management strategies that aim to influence not only collaborative research but also the organizational culture to facilitate inter- and intra-organizational collaboration. Finally, more research is needed to understand if and how universities due to their characteristics and embeddedness in a distinct national higher education system and their leaders react to these changes and adjust universities' governance of scientific practices that vary among scientific communities.

Nevertheless research on organizational influences on academic collaboration is also of considerable importance. *First,* to help university leaders understand the conditions limitations and opportunities of influencing research collaboration. Due to their specific organizational characteristics management strategies and organizational culture universities develop different collaboration networks or collaboration portfolios that can be seen as a resource of the organization and a signal to others (Powell, 1998). Portfolios can show research collaboration within the science system and–due to third-mission–beyond as universities are expected to engage in university-industry collaboration and need to manage these as well. The literature in the context of R&D research also questions the influence of the organizational context even though recent work has shown that academic engagement is rather driven by the motivation of scientists to engage with industry partners than by university characteristics (Perkmann et al. 2021 7). Thus, both R&D research and science studies relate to the same tension by looking for university governance and policy implications on the national and international levels. Therefore, the current study has limitations since R&D literature has been excluded from this review. *Second,* research policy requires understanding why specific research organizations and (on a national level) countries are more or less strongly engaging in international collaborations as if these are indicators of quality. *Third,* for higher education policymakers more research is needed on the organizational national and supranational levels and the interaction between them to provide a better understanding of whether and how federal funding programs aiming at the collaboration of universities across national borders affect organizational research collaboration in different national international and disciplinary settings.

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