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Kwadwo Atta-Owusu

ABSTRACT

Peripheral regions, like others, require a sustained flow of global knowledge to stimulate innovation and economic growth. Unfortunately, the dearth of innovative firms in these regions hampers foreign knowledge attraction. Nevertheless, academics are recognized as potential agents to perform such a role considering their embeddedness in diverse collaboration ties. As feasible as this may seem, prior research has not thoroughly examined this proposition. This paper, therefore, investigates how the collaboration activities of bridging academics facilitate the flow of knowledge to peripheral regions. Employing a case study of academics in a peripheral region in the Netherlands, it also identifies the mechanisms enhancing knowledge flows. The findings indicate academics tend to have more collaborations with partners in academia and industry than other sectors. Additionally, they use various pathways to establish cooperation relations. Lastly, the mobility of researchers and collaborative projects constitute the widely used channels for knowledge transfer. The implications of these findings for universities and policy-makers include the need to devote particular attention to cooperation ties of faculty; and the assessment of the knowledge needs of organizations in a region and connecting them with academics with the right expertise.

ARTICLE HISTORY

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KEYWORDS

knowledge flows; collaboration; global–local linkages; peripheral regions; bridging academics; the Netherlands

INTRODUCTION

In the last couple of decades, knowledge transfer has become topical academic and policy issue owing to its perceived contribution to economic development of regions. In fact, many scholars believe the generation and exploitation of knowledge remains a key driver of regional competitiveness (e.g., Howells, 2005). Whilst knowledge is the 'fuel' driving economic growth, local knowledge alone is not sufficient. For a region to stay at the frontiers of innovation, locally present knowledge needs to be supplemented with those from external sources. Accessing the external knowledge pools, however, requires regional actors to establish connections with extra-regional networks. Consequently, the policy prescription has been to 'encourage domestic firms and research organizations to participate in global knowledge flows in order to underpin national and regional competitiveness' (Organisation for Economic Co-operation and Development (OECD), 2004, p. 11).

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Yet, being part of global knowledge circuits alone does not guarantee automatic access to novel knowledge. Rather, it is the proactive and cooperative behaviour of domestic actors that engenders the channelling of outside knowledge to regions. For instance, the literature documents the role of local firms in knowledge transmission (e.g., Gertler & Levitte, 2005). The competitive and cooperative activities of small and large companies in global arenas have been shown to contribute to renewed investments and the flow of new knowledge to regions (e.g., Aslesen, Hydle, & Wallevik, 2017; Martin, Aslesen, Grillitsch, & Herstad, 2018). Similarly, the activities of universities have been highlighted as conduits for attracting distant knowledge to regions (e.g., Benneworth & Hospers, 2007; Benneworth, Coenen, Moodysson, & Asheim, 2009). Their role becomes essential, particularly, in peripheral regions where there are few or no leading firms to connect the region to distant knowledge sources.

Whilst existing studies have shed some light on the role of these actors in global knowledge flows,[1] they nonetheless suffer from two main shortcomings. First, the empirical focus has largely been on firms in metropolitan regions. Considering the importance that policy-makers attach to the development of peripheral regions, it is surprising that few studies have focused on knowledge flows to peripheral regions (Fitjar & Rodríguez-Pose, 2011; Grillitsch & Nilsson, 2015; and Pinto, Fernandez-Esquinas, & Uyarra, 2015, are some exceptions). Second, the practices of universities as institutional actors have received much attention, whereas the micro-level practices of academic scientists have frequently been overlooked (Miller, Alexander, Cunningham, & Albats, 2018). This is somehow intriguing given the meaningful roles they perform in the knowledge transfer processes. The unique position academics occupy in international knowledge communities, and their closeness to local actors, facilitates knowledge exchange and the brokering of linkages between distant actors (Trippl, 2013). Therefore, investigating the knowledge-exchange practices of individual academics could enhance the understanding of the dynamics of knowledge flows to peripheral regions as well as inform sound policy formulation.

To understand the knowledge flow dynamics, the paper focuses on academics who simultaneously collaborate with their peers and non-academic partners across varied geographical scales. The bridging role of such academics in diverse networks offers the opportunity to acquire new knowledge from external sources and facilitate their transfer to regional partners. Hence, the primary goal of this paper is to examine the potential role that collaboration activities of such academics play in drawing outside knowledge to peripheral regions. Based on in-depth interviews with a sample of bridging academics at the University of Twente (the Netherlands), the study explores how their cooperative linkages with various actors within and outside the region contribute to knowledge transmission. The research questions addressed are as follows:

- How do the collaboration activities of bridging academics facilitate the transfer of extra-local knowledge to peripheral regions?
- What are the promising mechanisms that can promote extra-regional knowledge transfer?

The paper is structured as follows. The next section presents the conceptualization of the knowledge flows arising from the collaboration activities of bridging academics. The third section discusses the methodological approach adopted in this study. The fourth section presents the findings from the analysis. The paper concludes with a discussion and policy implications.

CONCEPTUAL BACKGROUND

The knowledge link model

Trippl (2013) explicates how the mobility of academic scientists from one region to another contributes to knowledge transfer and the socioeconomic growth of these regions. The model makes a distinction between inter- and intraregional knowledge transfers. The interregional knowledge

flows occur when a researcher moves from region A to region B. This initial movement triggers a series of knowledge spillover effects between the regions. This can assume diverse forms. For instance, members of the researcher's former team or promising students may follow them to their new destination. In addition, maintaining existing ties with partners in the previous location can facilitate a backward transfer of knowledge from the current region. This can also result in the exchange of expertise between these two localities. Furthermore, the development of formal and informal collaboration ties (e.g., joint research, contract research, joint publication and staff exchange) with firms can offer opportunities for sustained knowledge flows across the regions.

Intraregional knowledge flows, conversely, result when academics engage in knowledge transfer activities with various actors within their current location. The maintenance of collaboration ties with partners in educational and research organizations can promote the diffusion of advanced knowledge in the academic sector of the new region. In addition, the building of linkages with industry actors and the commercialization of scientific knowledge or inventions represents a key means of knowledge transfer within the region (Trippl, 2013).

The knowledge link model represents a promising framework for elucidating the dynamics of extra- and intra-regional knowledge flows. However, its narrow focus on the mobility of 'star scientists' makes it insufficient to explain the phenomenon adequately. Indisputably, the mobility of highly qualified persons constitutes a vital mechanism for knowledge transfer. Nevertheless, it remains one of numerous channels of knowledge transfer. Besides mobility, publications, the social network of researchers and research collaboration are other important conduits of knowledge flow (Adams, Black, Clemmons, & Stephan, 2005). Furthermore, the model assumes knowledge flows between two regions: the sending and the receiving regions. While this dichotomous conceptualization is understandable on grounds of parsimony, in reality, knowledge is globally dispersed (Dicken, 2007, p. 82; Powell & Grodal, 2005). Finally, academic scientists do not solely build cooperative linkages with regional actors. They are equally part of 'linkages [that] may be tied to different social networks, different regions and nations, or different cultural contexts' (Bathelt & Cohendet, 2014, p. 2). Therefore, the model is extended to encompass all the aspects raised in the foregoing argument.

Towards an extended knowledge link model

The collaboration activities and networks of academics extend across regional, national and international boundaries. Therefore, focusing on knowledge exchange at one scale while ignoring the other scales does not reveal the entire picture (Fromhold-Eisebith & Werker, 2013). Adopting a multi-scalar perspective can help expound fully the dynamics of knowledge flows. The extended model conceptualizes knowledge flows at multiple geographical levels. However, for ease of presentation, only the regional and global levels are captured in Figure 1. Global knowledge refers to knowledge pools that may be located in regions, countries or a combination of such territories outside the region of bridging academics (Bathelt & Cohendet, 2014). Conversely, regional knowledge denotes knowledge stocks within the locality or region of bridging academics.

Another extension relates to the embeddedness of academic scientists within multiple collaboration ties. In this model, the collaboration activities of academics are conceived as 'bridges' linking different sectors and geographical scales. Through collaboration with international partners and engagement with local actors, such academics ensure a sustained supply of novel knowledge to peripheral regions. In addition, they can also connect regional actors to global networks of knowledge (Bramwell & Wolfe, 2008).

The geography of collaboration activities of bridging academics

The need for scientists to contribute to the advancement of knowledge, and help solve grand societal challenges, has necessitated the forging of research cooperation within and across scientific communities (Katz & Martin, 1997; Sonnenwald, 2007). Academic scientists acquire novel

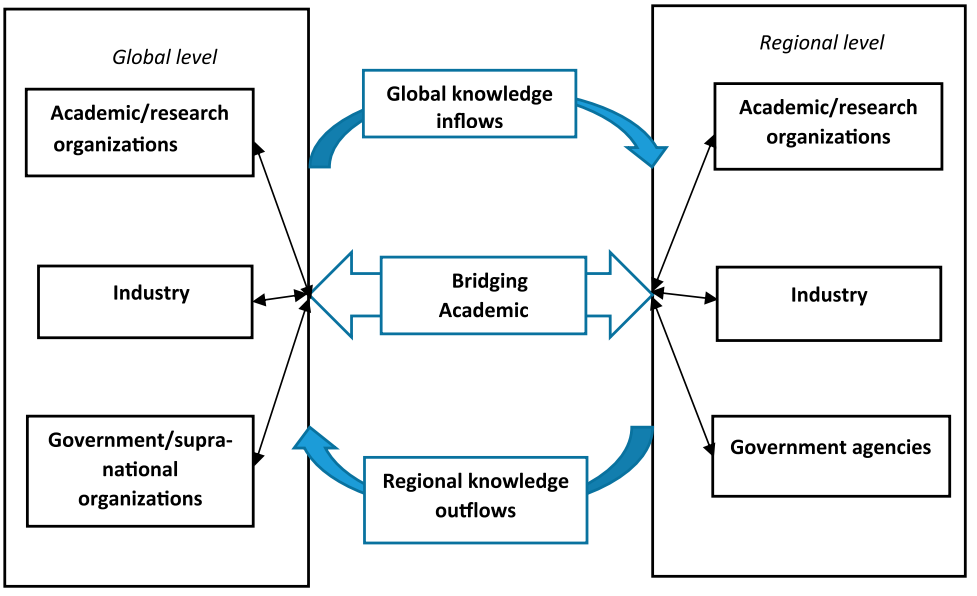

Figure 1. Extended knowledge link model based on Trippl (2013).

knowledge and unique competences through their interaction with reputable researchers outside their regions. This advanced knowledge is subsequently circulated in the region through cooperative linkages with researchers or research institutions (Trippl, 2013).

Another key mode of bridging academics' international collaboration represents their interaction with foreign companies. Bridging academics by virtue of their expertise are involved in research cooperation with both transnational companies (TNCs) and international small and medium-sized enterprises (SMEs; Ponds, 2009). Some researchers have attributed the growth of this phenomenon to academics' need to diversify their external funding sources (e.g., Kauppinen, 2012). However, funding is not the sole resource that academics acquire from these engagements. They also obtain access to new knowledge, equipment and data, and develop new networks that they use in their subsequent research (Jeong, Choi, & Kim, 2014). Similarly, these academics also engage in regional knowledge transfer activities with firms. They forge collaborative ties through various mechanisms such as the placement of students in firms, research and development (R&D) collaborations, and the commercialization of scientific knowledge (Perkmann et al., 2013; Trippl, 2013).

Bridging academics also build and maintain cooperative relationships with external government agencies or supranational organizations. These bodies rely on the scientific research and expert advice in the performance of their functions (Prince, 2012). Put differently, they play the role of advisors or researchers to international policy-makers. An example is the Intergovernmental Panel on Climate Change (IPCC) that provides scientific information for governments to formulate policies on climate change. In much the same way, academic scientists also transfer novel knowledge to regional public agencies through collaboration partnerships. The transmission of such experiences and learning from their international engagements can foster public and social innovation (Abreu & Grinevich, 2013).

The mechanisms and processes of knowledge flows

Novel knowledge from bridging academics' international cooperative activities and networks does not naturally trickle down to regions. However, it is transmitted through diverse channels and the

active interaction with regional actors and organizations. Academics use both formal and informal mechanisms and practices in the knowledge-transmission process (Martin et al., 2018). The choice of a particular mechanism depends largely on the nature of the knowledge being disseminated and the cooperative relationships of the academics.

One of the mechanisms is the mobility of scientists. The mobility of exceptionally skilled individuals constitutes a primary channel of knowledge flows (Faggian, Rajbhandari, & Dotzel, 2017; Trippl, 2013). The movement of these individuals presents an opportunity for new knowledge to spill over into regions, thereby preventing lock-in. Bridging scientists can help attract foreign human capital into peripheral regions through their international networks. By leveraging their connections, such academics can persuade promising researchers to assume positions in the region. Moreover, the temporary mobility of the bridging scientists can also promote the transfer of knowledge to their localities (Jöns, 2015). Embarking on sabbaticals or short research visits overseas equip these scientists with new experiences, knowledge and interpersonal skills. The experiences can result in lasting outcomes such as knowledge production, innovation and social capital. Furthermore, their socialization in different countries provides them with the skills to identify potential transferable or applicable knowledge to their regions (Coey, 2018).

Relatedly, events that bring together academic scientists and professionals of a particular scientific community or technology field also promote knowledge flows (Bathelt & Glückler, 2011, p. 181). Temporary gatherings in the form of international conferences, workshops and seminars facilitate learning and the exchange of tacit knowledge (Maskell, Bathelt, & Malmberg, 2006). Such transient co-location constitutes an opening for face-to-face interaction that helps researchers form personal ties (Orazbayev, 2017). In addition, participation in these events allows bridging scientists to be abreast with advances in knowledge or technology in their field and identify suitable partners for future collaboration.

Another mechanism that facilitates the transfer of foreign knowledge to regions is R&D collaborative projects. Such projects bring together scientists with unique expertise. Therefore, bridging academics' involvement in transnational collaboration may enhance their competences in new areas. In addition, they can also become familiarized with best practices that can be transferred to their region's research organizations (Jeong et al., 2014). Likewise, bridging academics may recommend the inclusion of local research organization or firms in research consortia to undertake international projects (e.g., European Union Framework projects). The regional actors' exposure to international best practices in science can sharpen their research capabilities and help them establish strategic external networks. Harnessing these assets in future research collaborations can ensure sustained knowledge flows into the region (Belderbos, Van Roy, Leten, & Thijs, 2014).

The discussion thus far has focused on extra-knowledge inflows to peripheral regions. However, being a dynamic process, there is the need to account for the backward diffusion of knowledge from regions. While bridging academics' collaborations outside the region contribute in attracting knowledge into the region, their interaction and activities also stimulates knowledge transfer outside. Several mechanisms engender knowledge outflows. The mobility of skilled researchers is one notable avenue. Outstanding students trained by bridging academics may move from the region to assume positions in international research organizations or firms (Saxenian, 2005). Another mode represents the formal collaboration involving bridging academics and external partners. A joint R&D project or a contract research for an international company constitute a conduit of extra-regional knowledge transfer. Furthermore, the commercialization of technological or scientific inventions of scientists also promotes the flow of knowledge. This transfer occurs when scientists sell intellectual property to foreign companies or team up with international partners to establish a spin-off company outside the region.

In sum, the combination of the inward and outward flows triggers transregional circulation of knowledge. This subsequently provides the impetus for innovation and economic development of regions (Trippl, 2013).

METHODOLOGY

The focus of this paper is to explore how the collaboration activities of academics across diverse spatial scales facilitate knowledge transfer in peripheral regions. Because of this empirical focus, a single case study approach is adopted (Eisenhardt, 1989). This approach offers the opportunity to present a nuanced or holistic view of the phenomenon being investigated. An in-depth study of the University of Twente was conducted with faculty members as the unit of analysis. The university was selected as the empirical context because of the following reasons. First, because of its role in the economic development of a peripheral region. The university was created, among other things, to help address the economic and technological decline of the Twente region. Although poorly endowed from the onset, it rose to the challenge to attain 'local economic relevance and international excellence' (Lazzeretti & Tavoletti, 2005, p. 475). Second, its ability to attract high-quality faculty, researchers and students. The attractiveness of the university lies in the scientific excellence it has gained in fields such as nanotechnology, materials science and biomedical technology. This has resulted in numerous research projects involving local and global partners. Such a vibrant research environment provides the ideal context in which to examine the topic under investigation. Lastly, the regional engagement focus of the university. Through several initiatives, it has encouraged the interaction and exchange of knowledge between the university community and regional agents.

Description of the University of Twente case

The University of Twente is a Dutch university located in the city of Enschede, in the eastern province of Overijssel. It was established initially as a polytechnic in 1961 to augment the training of the anticipated demand for technicians and engineers in the engineering fields. It attained university status in 1986 (de Boer & Drukker, 2011). With a technical focus, the university began with four departments: chemical, mechanical, electrical engineering and general science. Enrolment commenced in 1964 following the appointment of professors and the erection of essential infrastructure. Enrolment grew gradually from 250 initially to fewer than 4000 by 1978 (Lazzeretti & Tavoletti, 2005). However, the decline of the textile and machinery industry in the Twente region and financial challenges threatened the collapse of the young university. In fact, student enrolment dropped as low as 200 in 1979, which sparked rumours that the polytechnic would be closed in the beginning of 1980 (Benneworth & Hospers, 2007; Lazzeretti & Tavoletti, 2005).

The fortunes of the embattled technical college turned around following the appointment Harry Van den Kroonberg, a mechanical engineer, as the new Rector Magnificus in 1979. With the support of the new board of governors, the charismatic rector proposed and implemented a radical and distinct entrepreneurial vision for the university (de Boer & Drukker, 2011). He instituted varied institutional reforms and innovative schemes such as the technology transfer office, a business incubator and student entrepreneurship (the TOP programme). This entrepreneurial orientation fostered the engagement of the university with regional actors and the setting up of spin-off companies (Benneworth & Hospers, 2007). While pursuing this regional relevance strategy, it also intensified its teaching and research activities to achieve national and international excellence. Albeit the initial setbacks, the University of Twente has come to be acclaimed as one of the most respected enterprising research universities in the Netherlands. Indeed, it has been consistently adjudged the most entrepreneurial university in the Netherlands

in the past five years.[2] It also won the best technical university award in 2018 in the annual *Keuzegids Universiteiten* study guide.[3]

From the initial four departments, the university presently comprises five faculties with several departments as well as research institutes and centres. One of such institutes is the world-renowned MESA+ Institute for Nanotechnology, which offers cutting-edge research in nanotechnology. The university offers 20 bachelor's and 37 master's programmes in fields ranging from engineering to business administration to more than 10,000 students. It has a staff strength of over 3000, of which faculty constitute 56%. Its vibrant start-up culture has resulted in the establishment of approximately 1000 companies since 1984.[4]

Data collection and analysis

The selection of participants and the fieldwork for data collection commenced in the autumn of 2017. Given that the aim of the study was to gain a comprehensive understanding of a complex phenomenon, a purposive sampling approach was deemed to be more suitable (Eisenhardt & Graebner, 2007). Consequently, the following selection criteria were developed to identify potential participants for the study. First, the academic was an active researcher who has published with international partners or maintains a minimum of five international collaborators in their research network. In addition, she or he has participated in an international or national research (either as the principal investigator or as a partner) in the last three years. Furthermore, he or she was a member of a board of either a national or an international company, a government agency or a non-profit organization.[5] After searching the publication records as well as information on research projects and extra-academic activities, 25 academics were selected. Formal invitations were sent via email to all the identified academics to request for their participation in the study. Of this number, 11 ultimately accepted the invitation and indicated their consent to be interviewed. Table A1 in Appendix A describes the characteristics of these participants.

Data for the study were gathered primarily through interviews. A semi-structured interviewing technique was used to provide flexibility in asking sequence of follow-up questions to encourage comprehensive responses from participants. The intention was to document the detailed perspectives and experiences of academics' collaboration and knowledge exchange practices. Specifically, participants were asked to narrate how their research collaborations evolve and the motives for establishing those relationships. Furthermore, questions related to the key processes of knowledge exchange with collaboration partners and the mechanisms for transfer of knowledge were also probed. The interviews lasted between 30 and 90 min and were audio recorded to obtain accurate account of the dialogues. The data were later transcribed and analyzed thematically (Braun & Clarke, 2006). The transcripts were read to identify interesting recurrent themes from the narratives. These were initially coded, and the codes that were related were later grouped under broad themes. Through an iterative process, the coded data were constantly compared with the entire data to check for patterns of commonalities (Eisenhardt, 1989). The themes that emerged were then examined in relation to the conceptual framework and presented as findings. Selected extracts from the data were added to the selected themes to provide practical illustration to the analysis.

EMPIRICAL FINDINGS

The dynamics of collaboration activities of bridging academics

The collaboration activities of bridging academics follow some sequence of evolution. Academic collaboration, it emerged, typically serves as the precursor to non-academic collaborations. Bridging academics' unique scientific competences, their work in niche research areas, and cooperation with others enhance their visibility in scientific communities. This subsequently put them on the radar of potential partners in industry and government. Their reputation provides them opportunity to also work with other partners at the national and international

level. These relationships, however, do not replace the existing academic partnerships. On the contrary, the non-academic collaboration tends to complement and reinforce the scientific collaboration as it provides new resources for subsequent scientific research. This point is captured by the following quotations:

> [I]t started with research project together with different researchers in America and Asia in my field before it moved to working with companies and government agencies. (PA3)

> I came here [University of Twente] as professor in XXXX … set up a research team and built a certain reputation. We have quite some good inventions that have been very well received which are used in a lot of products. So we became very famous in our field and companies started to approach me and asked if they could sponsor a research in our group. (PA6)

It is instructive to note that other actors do not always initiate collaboration relations. Just as interested partners approach bridging academics to establish research ties, they in turn contact potential partners when the need arises. In effect, relationships can be developed at the instance of any partner, as intimated by this respondent:

> There is no one way of working in that sense. For instance, we just entered into a collaboration with a company looking for a research group that was able to produce some materials for them. … Sometimes I also search for companies that can use our technology. So it goes in two directions. (PA4)

Interestingly, collaborations resulting from unplanned meetings represent a recurrent theme through the narratives of the respondents. Some recount how research cooperation begins through the chance meeting of partners at formal events such as conferences. In essence, the collaborative relationships of bridging academics, sometimes, commence as a result of fortuitous circumstances, as the following quotations illustrate:

> It can be very different. Most at times someone you meet through accident or someone who hears of you through the media or other means and they say 'Oh we're putting in a project proposal or we're going to start a project and we think you could add something interesting.' (PA9)

> At times it [collaboration] just happen by accident. I met people or people saw me give a presentation and collaboration started. For example, I was giving a presentation on a research project and after I finished, the Minister of Education of XXXX [an Eastern European country] asked me to help them develop a research programme. (PA3)

However, there were differing degrees of interaction. While collaboration with academics was widespread, there were variations in interactions with other partners. These differences arise primarily from the research orientation and the motivation of individual academics. Academics working in the science and technology fields expressed their preference for working with firms. For example, one informant explained that firms remained his essential partners because the nature of his research is more relevant to industry than other sectors. Therefore, if the idea is to consider an application for a piece of research, bridging academics naturally seek cooperation with industrial partners. Conversely, if the intent is to build a research consortium or search for funding or other resources, collaboration with other actors is sought:

> We're in science and technology and dealing mainly with external stakeholders that are in the field of science and technology. So in that sense, government is not our direct connecting point. … But companies are very much our natural partners. (PA5)

> I work with a couple of people who work at companies and often very content oriented, it's always the case. And the position that I have right now is more of I seek strategic partnerships. I talk with lots of people in companies and local government to set up strategic alliances. (PA2)

The research orientation regardless, the stage of the research equally determines the relevant partner such academics work with. If the research is at the experimentation phase, the researcher tends to interact more with government agencies (e.g., hospitals) and non-governmental foundations. However, as it moves to the development or commercialization phase, cooperation with companies become critical, as the following quotations exemplify:

> We work with some clinicians [hospitals] and do have some collaborations with companies as well. But then I guess in that case their input is more on the engineering side so something or technology that has been developed here in the lab and they pick that and build some sort of demonstrator or proof of concept. (PA10)

> Well, because we do research on medical applications, it's important to have connections with hospitals. Because if we develop technology but has no connection with the hospital, it means you're just doing something that's never going to be used. Therefore, it's important to have collaboration with doctors. Companies are also important because we're doing research but we don't really have the power to make products on the market. Since at some point you want your work to go to the next stage, you need to collaborate with companies. (PA8)

Another key observation concerns the geographical dimension of collaboration activities. The research linkages of bridging academics are assumed to transcend multiple geographical scales. Nevertheless, there were differences in the level of interactions. Academics did not maintain the same relationships with partners at various scales. While some respondents emphasized their cooperation with all the actors at several locations, others stated they maintain ties with some selected actors at specific geographical locations:

> Yeah, I will say I collaborate with academic partners and the Association of XXXX [a health NGO] in Europe. Most at times, I work with small to medium enterprises because you want an intervention to land in the market. … Sometimes also with large corporations or large government institutions. (PA9)

> We're working together with big companies but also with small and medium enterprises both regionally as well as the national landscape but less abroad. (PA5)

Knowledge flows through mobility and collaborative projects

The actions and behaviours of academics in their collaboration practices contribute directly or indirectly to knowledge flows. Various practices that foster knowledge flows were identified in the narratives of these academics. These mechanisms are broadly classified into two, namely, mobility and collaborative projects. Consistent with the above discussion on mobility, the analysis revealed informants used two types of mobility in their collaborations: permanent mobility and temporary mobility. Through permanent mobility the academics leverage their connections in extra-regional networks to recruit talented students to work in research projects locally. The movement of the students not only promotes the flow of person-embodied knowledge but also helps to formalize informal cooperation, as in the following comment:

> I always seek collaborators who have more knowledge than I do on specific sub-topics. So, I have a long-standing relationship with a group at XXXX [an Eastern European university] and we wanted to make

> this formal between our universities. The arrangement was that they will bring in potential students and then depending on the interest of the students and our mutual interest we define the [research] topic. This is how I expand my collaboration network. (PA2)

It is worthwhile noting that mobility is not typically in one direction. Some bridging academics encourage some of their students to move out to assume positions internationally. While there, the students acquire novel competence and develop new networks. If such students maintain their relationships with the region, they can serve as new conduit of knowledge flows:

> I'm always advising people who do their PhD here and want to stay. I tell them it's very nice but they should first go away, meet new people, get exposed to different environments, different culture, and different way of working, and create their own networks. We will always be interested in bringing them back if they are successful. (PA4)

In addition to the permanent mobility, scientists, their students and regional partners also move out of the region (albeit temporarily) to acquire knowledge. Some interviewees spoke of instances when they have sent students to learn some techniques or new methods from their collaboration partners. This often happens when the local research group has to work on a project but are deficient in certain aspects. This interviewee opined:

> Another thing you can do is if you have a collaborator who has certain knowledge you don't have, you can also send some of your students to learn from the lab of your collaborator. (PA9)

Relatedly, the interviewees spoke about how attendance at international conferences and seminars created opportunities to acquire and exchange knowledge with other partners. Some academics narrated how they got new research cooperation after they had presented their research at such international fora. Another also talked about how he organized visits abroad for some local partners to interact with selected international firms in his network. The rationale was to enable these firms acquaint themselves with international best practices, and to establish linkages with international companies. The following quotations capture these observations:

> sometimes at international conferences and through international networks, when you're there … it gives you the opportunity to give some informal advice or mentorship. On the other hand, you also get the chance to seek advice from someone who is more experienced than you are on some problems. (PA8)

> You really can show them [companies] that they are not unique and that they have to think outside the box. Sometimes I take people from [local] companies and bring them to Germany or Switzerland or Italy to show them why these companies are different and that they too can do it differently. (PA1)

Knowledge also flows from the collaborative projects of academics in the region and beyond. In the international collaborations, the researchers work on varied projects involving different collaborators. In the course of working in interdisciplinary projects, the scientists become familiar with creative methods, technology or innovative approaches to conducting research. Some of the respondents recounted experiences on the collaborative projects with local companies intended to transfer knowledge and help resolve societal problems. An interviewee stated:

> Well as I said, my research is far out but with a local company as one of the collaborators we've developed a robot that is used in diagnosing XXXX [a medical condition]. This robot is now in pre-clinical trials and if it works out that will be something that will help patients. (PA10)

Aside collaborating with regional partners to undertake local projects, academics also team up with them to carry out international projects. One academic recollects his cooperation with a local organization as follows:

> … A good example is a project we just started in XXXX [European country]. 'Alpha' is a testing organization and we've been working together on computer-based testing and have developed a lot of knowledge on how to organize such a large scale assessment. An [European country] organization has to do this huge project so they contacted one of my former PhD students … and she contacted us … we agreed that for the next three years we are going to help them run such a programme and also train them. (PA6)

To sum up, the evolution of collaboration activities of bridging academics follows unique path. It starts with academic partners and develops to include non-academic partners. Moreover, the development of relationship with partners is informed by the nature of research, motivation of the academic, and the stage of the research. Furthermore, they do not maintain cooperation with all at every geographical scale. However, bridging academics maintain ties with relevant actors at distinct locations. Lastly, the practices of these scientists facilitate the flow of knowledge across regions. Notable mechanisms that enable this to happen are mobility and collaborative projects. The following section discusses these findings.

DISCUSSION AND CONCLUSIONS

The regional innovation literature suggests the nature of the innovation system prevailing in a region determines the level of global and local knowledge exchange (Martin et al., 2018). Peripheral regions have been described as suffering from organizational thinness. Hence, they have few or no innovative firms with the international networks to absorb global knowledge (Trippl, Grillitsch, & Isaksen, 2017). In the absence of such firms, academics who maintain links with diverse partners across multiple scales can potentially perform that role. The collaboration activities of these bridging academics remain the promising pipeline through which novel knowledge can flow to peripheral regions. To assess this proposition, the paper drew on the knowledge-link model proposed by Trippl (2013). However, the conceptual model was inadequate to explain how collaboration activities of bridging academics enable the flow of global knowledge to peripheral regions. Consequently, some extensions were proposed. The extended model conceptualized the collaboration ties of bridging academics with diverse actors across multiple geographical scales promote the circulation of knowledge. This subsequently engenders innovation and economic renewal of peripheral regions. The paper empirically analyses this conceptualization using a sample of academics at the University of Twente.

The empirical findings suggest academics maintain relationships with specific actors they find to be relevant for their research and not with all the actors identified in the model. Contrary to the models' assumption, bridging academics appeared not to maintain equal links with academics, industry and government partners at all levels. Most of the participants tended to have more ties with academic and industry partners than with government actors. This does not suggest, however, that the former ties are more important that the latter. As alluded to in the previous section, the research orientation of academics determines – to some extent – the choice of collaboration partners. The disposition of the academics in the study to collaborate more with actors in academia and industry could be attributed to their science and engineering backgrounds. Another study with a representative sampling of academics is required to ascertain if similar or conflicting finding would emerge.

Regarding the geographical dimension of the cooperation ties, there was evidence to suggest differences in the degree of interactions at various scales. Most of the participants engaged intensely with actors in the international arena. This is completely understandable given that the bulk

of knowledge networks exist at the global level. While some researchers enjoy the luxury of engaging with all the actors at various levels, others maintained strategic relations at certain locations. The plausible explanation for these variations may comprise the following. First, the nature of the research. Research remains an invaluable tool for knowledge dissemination but not all knowledge is relevant for every actor. The needs of actors at other scales may not be the same. Therefore, academics may want to collaborate with partners who express a need and would benefit from their research. For example, a researcher working on applied photonics would prefer to interact with companies at the global scale than with regional governmental agencies. Because their research might be more commercially valuable than having policy relevance.

Second, strategic considerations. Establishing and maintaining collaboration relations entail considerable costs. Therefore, it would be uneconomical to maintain cooperation with diverse partners across numerous geographical locations if such ties are unfavourable. Acting rationally, bridging academics establish partnerships with specific partners at locations that offer highest utility in terms of novel knowledge and resources for research.

While the framework is silent on how bridging academics develop their partnerships, the findings reveal distinct pathways through which they establish relations with various partners. These are through active search, passive search and fortuitous encounters. Active search entails the deliberate scouting of prospective partners by academics. Passive search, on the contrary, involves contacting of bridging academics by others partners who want to establish collaboration ties.

Lastly, fortuitous encounters are chance meetings between academics and potential partners that result in subsequent collaboration (Björneborn, 2017). Academics employ various combinations of these channels to build their collaboration networks. However, some may be more significant depending on the career stage, the reputation, and the type of research of the academic. For instance, an academic in the early stage of their career may utilize an active search mode to develop research partnerships. However, they could also obtain solicitations from potential partners if they conduct high quality research. Taken jointly, variations exist among these pathways but there is equally an interplay between them.

In the conceptualization, knowledge is assumed to flow across peripheral regions through various practices of bridging academics such as mobility, collaborative projects and research commercialization. Consistent with this, the paper provides some evidence to suggest that academics' engagement in some of these practices indirectly enhances knowledge transfer to the region. The collaboration activities with international partners promote the permanent mobility of talented researchers into the region. Arguably, the destination of these scientists remains the university and research institutes. Nonetheless, some end up in local firms as industrial doctoral students. These students serve as a conduits of global knowledge flows by maintaining ties with research institutions and scientists in their home country (Bramwell & Wolfe, 2008). Moreover, the temporary mobility practices of bridging academics, their students and regional partners facilitate the transfer of knowledge to the region. Lastly, collaboration projects proved to be a fruitful conduit for regional knowledge transfer. Most of the academics involve their regional partners in some national and international projects. By doing so, they help connect regional firms to global innovation networks (Coe & Bunnell, 2003). These key mechanisms were also instrumental in the backward flow of knowledge from the region. However, there was scant proof to show that the academics used research commercialization for knowledge transfer in their collaborations.

The findings from this study have some implications for universities and policy-makers in peripheral regions. First, university authorities need devoting particular attention to the informal network relationships of their faculty members. As demonstrated in this paper, such linkages abound with opportunities and resources that can be harnessed for the benefit of both the university and the region. While academics enact these relationships at the personal level, department or faculty heads could examine some of the partnerships that hold promise and formalize them at the institutional level. This could promote the mobility of talented researchers to the region.

Next, the universities should also improve the capacity of academics to apply for European-level projects. Involvement of scientists in collaborative projects such as the European Commission's Innovative Training Networks (ITNs) help extend their networks and attract early-stage researchers into regions. Because these projects are competitive, their application is also demanding. As such, universities can establish a unit or hire consultants to assist academics with grant writing. Additionally, they can offer periodic training workshops to help improve the capacity of researchers in project applications.

Lastly, knowledge from global sources is essential for innovativeness of peripheral regions. Nevertheless, not every knowledge may be relevant for the regional actors and organizations. More so, regional actors may not possess the capacity to convert every knowledge into beneficial outputs. Therefore, regional policy-makers need to profile regional organizations to assess their knowledge needs and connect them to regional academics who possess relevant expertise. When certain scientific expertise does not exist at the regional university, local academics can link firms to their external partners with such knowledge. This could prevent under-utilization of knowledge and redundant knowledge flowing into the region.

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NOTES

[1] In this paper global, international, extra-regional and trans-regional knowledge are used interchangeably to refer to knowledge flows from outside a region.

[2] See https://www.utwente.nl/en/news/!/2017/12/312872/the-ut-has-the-highest-impact-in-the-netherlands-and-has-once-again-been-named-the-most-entrepreneurial-university/.

[3] See https://www.utwente.nl/en/news/!/2017/11/601/giant-leap-in-keuzegids-universiteiten/.

[4] See https://www.utwente.nl/en/facts-and-figures/#a-living-smart-campus-where-change-begins/.

[5] A participant had to meet at least two of these criteria to qualify for selection.

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APPENDIX A

Table A1. Characteristics of the respondents ($n = 11$).

Interview code	Faculty	Academic rank	Nationality	Years at university	Years working abroad
PA1	Engineering Technology	Professor	Dutch	40	1
PA2	Electrical Engineering, Mathematics & Computer Science	Professor	Dutch	4	0
PA3	Science & Technology	Professor	Dutch	18	1
PA4	Science & Technology	Professor	Dutch	30	n.a.[a]
PA5	Science & Technology	Professor	Dutch	17	5
PA6	Geo-Information Science & Earth Observation	Professor	Dutch	n.a.	n.a.
PA7	Electrical Engineering, Mathematics & Computer Science	Professor	Dutch	19	0
PA8	Electrical Engineering, Mathematics & Computer Science	Associate professor	French	12	< 1
PA9	Electrical Engineering, Mathematics & Computer Science	Professor	Dutch	6	6
PA10	Engineering Technology	Professor	Canadian	7	7
PA11	Engineering Technology	Professor	Dutch	21	1

Note: [a]n.a., Not available.