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New inter-organizational knowledge tie formation after firm relocation: Investigating the impact of spatial, relational, and temporal context[☆]

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ABSTRACT

To what extent does the relocation of a firm affect the formation of new knowledge ties with new partners in a subsequent period? This study aims at answering this question. It assesses empirically to what extent the spatial and temporal context of relocation and the relational context of a focal firm affect new knowledge tie formation with new partners in the post-relocation phase. Based on a sample of 83 relocated firms operating in the sector of architecture and engineering consultancy in the Netherlands, the results show that both the number of continued knowledge ties of firms and the time passed after relocation hamper the formation of new knowledge ties. These findings point out that firms are well aware of their knowledge deficits and consequently act quickly to compensate for it after relocation. Therefore, policy makers should target to facilitate knowledge sharing practices particularly for small firms in the post-relocation period.

1. Introduction

External knowledge sources are crucial assets for firms as they help complementing their internal knowledge base (Liao & Marsillac, 2015), and facilitate their innovativeness (Laursen, Masciarelli, & Prencipe, 2012). Literature shows that organizations are more likely to utilize knowledge sources in their technological and geographical vicinity when searching for external knowledge (Coombs, Deeds, & Ireland, 2009; Rosenkopf & Almeida, 2003; Wagner, Hoisl, & Thoma, 2014). This so-called ‘local search’ or ‘search bias’ is generally seen as a product of the geographical and technological boundedness of firms. As firms cannot evaluate all potential options available to them in a perfectly rational way, their search for new knowledge, which is influenced by their own past experiences, previous knowledge, and existing routines (Coombs et al., 2009), is often restricted to familiar and proximate technological and geographical areas (Rosenkopf & Almeida, 2003). Rosenkopf and Almeida (2003), for example, empirically showed that it gets easier to draw from the knowledge stock of each other when two parties are geographically close, which reduces search costs and makes the functioning of knowledge relationships smoother.

Once a firm has identified or evaluated a potential knowledge partner, being involved in knowledge exchange with that partner does, however, not take place automatically because well-functioning inter-organizational knowledge relationships are not formed overnight. Like organizational know-how or reputation, they are intangible assets of high strategic importance that are established, developed, and invested in by partners over longer periods. For this reason, “they are difficult to replicate, cannot be traded or acquired, and have inimitable properties unique to the specific partners” (Schertzer, Schertzer, & Dwyer, 2013, p. 607). Such relationships tend to ‘bind’ firms to their location especially when they operate at local scales. In their empirical study, Knoblen and Oerlemans (2008), for instance, provided evidence that being involved in a high number of localized inter-organizational relationships constrains the spatial mobility of firms.

Yet, every year thousands of firms in various sectors change their geographical location (see Kronenberg, 2013, p. 699 for related figures). Moving to a different location means a change in geographical distance to existing knowledge partners and quite often involves a change not only in the physical, but also in the socio-economic environment for a focal firm especially when the move is far-distance. For an organization,

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relocation is a non-routine and critical event (Isabella, 1990; Knoblen, Oerlemans, & Rutten, 2008) which possibly has two opposing effects: As a negative effect, it might introduce instability in firms' organizational embeddedness (Knoblen, 2011) as particularly far-distance moves appear to be the most disruptive for organizations (Carter, 1999). For the sake of minimizing the effects of this disruption, firms might adopt a strategy of relying more on their existing knowledge partners after relocation to secure and stabilize the flow of external knowledge they need. As a positive effect, firm relocation can be a form of organizational adaptation to (better) survive in an increasingly competitive business environment (Brouwer, Mariotti, & van Ommeren, 2004). Moving to a new location may serve as a way of getting out of a spatial lock-in, which means being too much embedded in existing localized relationships, which, in turn, hinders the adaptation of firms to changing conditions (Knoblen & Oerlemans, 2008). Firms may achieve this by looking for new knowledge partners after moving to their new location to tap into different sources of knowledge externally available. In either of these cases, the event of relocation is likely to challenge firms to reconsider and reconfigure their portfolio of inter-organizational knowledge relationships. This reconfiguration might trigger the addition of new knowledge ties to firms' knowledge tie portfolio as well as the deletion of old ones. While the latter decreases the number of channels for external knowledge acquisition and, by doing so, may provide "freed-up relational capability" (Lechner & Dowling, 2003) to create new ties in the post-relocation phase, the former increases or renews the number of external knowledge sources through which the knowledge base of a focal firm is enlarged or updated.

In this paper, the focus is on the formation of new inter-organizational knowledge relationships after a spatial firm relocation because important changes in external knowledge sourcing in a subsequent period can essentially be brought by having new knowledge partners rather than relying on or removing the old ones. Therefore, the main research question of this study is: To what extent does a firm relocation affect the formation of new inter-organizational knowledge ties with new partners in a subsequent period? We answer this question at the firm level by taking simultaneously the spatial context (that is, relocation distance and relocation direction), the relational context (that is, size and localized characteristics of firms' inter-organizational knowledge tie portfolio), and the temporal context (time passed after relocation) of new knowledge tie formation into account.

Understanding new inter-organizational knowledge tie formation after relocation is important because relocation can be another strategic mechanism for accessing new and/or distant sources of knowledge that may be conducive to firms' outcomes. Relocated firms may also act as conduits for knowledge exchange between their previous and present location by spanning a "geographic hole" (Bell & Zaheer, 2007). Previous research has produced an extensive body of literature examining the role of alliances (Rosenkopf & Almeida, 2003), the role of knowledge worker mobility (Agrawal, Cockburn, & McHale, 2006; Park, Howard, & Gomulya, 2018) or the role of intermediary organizations (Wagner et al., 2014) for the acquisition of external knowledge. Surprisingly, firm relocation has been given hardly any attention as another possible mechanism for drawing from formerly distant knowledge sources by getting closer to them. To the best of our knowledge, no study is available in the literature examining the effect of firm relocation on the formation of new inter-organizational knowledge relationships in a subsequent period.

By using a primary data set consisting of a sample of 83 architecture and engineering consultancy (AEC) firms which relocated within the Netherlands, we found that firms establish new inter-organizational knowledge relationships after relocation depending on the size of their core inter-organizational knowledge tie portfolio, that is, the number of continued knowledge relationships after relocation. The findings also show empirically the effect of time in forming new knowledge relationships after relocation that establishing new ties and acquiring new external knowledge through them rather quickly is as important as

setting-up the business routines in the post-relocation period. The study enriches the literature on tie formation by testing simultaneously the effects of change in a spatial, relational, and temporal context imposed by relocation. It also contributes to the literature on professional service firms by providing insight into the knowledge network management of AEC firms in particular when they relocate.

The remainder of the paper is structured as follows. Section 2 presents the theoretical background and the hypotheses of the study. Section 3 describes the research setting, sampling, data collection, and variables employed in the analyses. Section 4 reports the results of the empirical analyses. The paper ends with discussion and conclusions in Section 5.

2. Theoretical background and hypotheses

This study pays particular attention to the formation of new knowledge ties with new (that is, formerly unknown) partners when firms move to another location because new relationships are considered to have greater potential for providing new and different information than existing relationships (Beckman, Haunschild, & Phillips, 2004), and thereby bringing important changes in knowledge sourcing. New partners in a firm's inter-organizational network potentially "broaden the scope of the firm, increasing the likelihood of obtaining new information and of adding to the diversity of information to which a firm is exposed. Considering a firm's network as a knowledge base to be tapped, firms expand that knowledge base by forming new relationships with new partners" (Beckman et al., 2004, p. 261). Besides, formation of new knowledge relationships with new partners might also help incumbent firms avoid network inertia (Kim, Hongseok, & Swaminathan, 2006).

Three categories of factors influence firms' decision to relocate, namely firm internal factors (i.e. firm growth), firm external factors (i.e. market relationships) and location factors (i.e. site and region) (Brouwer et al., 2004; Lloyd & Dicken, 1977; Pellenburg, van Wissen, & van Dijk, 2002). These factors influence not only the relocation decision, but may also play a role in establishing new knowledge relationships after relocation. As knowledge resides within members of various organizations and each member is located in a certain geographical place, sharing and working on knowledge tasks are associated with profound geographical dimensions (Howells, 2012), which manifest in varying degrees because "different types of service have different requirements for close proximity and hence there are different types of distance relationships" (Bennett & Smith, 2002, p. 253). The present study focuses on architecture and engineering consultancy firms, which are among industries with a synthetic knowledge base, which essentially combine existing knowledge in new ways to develop solutions to concrete practical problems (Martin & Moodysson, 2013). "Although knowledge required for these activities is partially codified, the dominant form of knowledge is tacit, owing to the fact that new knowledge often results from experience gained through learning by doing, using and interacting" (Martin & Moodysson, 2013, pp. 173–174). Therefore, knowledge exchange in these industries is relatively more sensitive to geographical proximity between the actors involved (Moodysson, Coenen, & Asheim, 2008).

Because an inter-organizational knowledge relationship is also a social relationship, it is not independent of the spatial and relational context in which it is embedded (Habinek, Martin, & Zablocki, 2015). In the literature on inter-organizational relationships these two interdependent contexts have been acknowledged as being influential in the acquisition of external knowledge (Christensen & Drejer, 2005; Knoblen, 2011). The spatial context is related both to the geographical location of an organization (a firm in our case), and to regional endowments associated with that location. The relational context is comprised of the relationships of a focal firm with other firms and organizations. As building inter-organizational relationships takes time and they acquire meaning in a specific time and space, it is necessary to add the temporal context, which refers to the (clock) time passed after the relocation, to

these two. Each of these three contexts is likely to change when a firm moves to another location and to influence formation of new knowledge relationships with new partners. Therefore, the remainder of this section deals with these three questions:

- (1) To what extent does change in the spatial context facilitate new knowledge tie formation after relocation?
- (2) To what extent does the relational context of a focal firm affect forming new knowledge ties after relocation?
- (3) What role does the temporal context play in establishing new knowledge ties after relocation?

2.1. Spatial context of forming new knowledge ties after relocation

It is generally agreed that where an organization is located will influence the opportunities in developing its knowledge capacity through learning and collaborating with others (Howells, 2012). In such a context, spatial proximity plays an important role in the portfolio of organizations with which a firm interacts for obtaining the relevant knowledge, that is, which organizations are a part of a firm's knowledge ego-network. Moving to another location may dictate a complete or partial change in the spatial portfolio of a firm's knowledge relationships. Two spatial dimensions are important from a relocation point of view: relocation distance and relocation direction.

2.1.1. Relocation distance

Inter-organizational knowledge relationships function over spatial distances depending on where knowledge partners are geographically located. The knowledge ego-network of a focal firm consists of an array of inter-organizational partners located at various geographical distances. For the sake of simplicity, we will distinguish between local and non-local inter-organizational ties, the former of which is defined in this study as being located in the same city or municipality. These ties are likely to be shaped or maintained through a strategically calculated trade-off between the cost of knowledge interaction, which is a function of the distance between knowledge partners, and the benefits accrued from that interaction (Rutten, Westlund, & Boekema, 2010). Moving to another location might be disruptive for this trade-off depending on the distance of relocation. Near-distance moves tend to be less costly and create less organizational problems (Pellenberg et al., 2002). They also bring the comfort of staying near to the previous location and make maintaining the business routines much easier for firms. Most firms relocate over near distances. For example, 75% of firm relocations in the Netherlands take place within the municipality where the firm was previously located (van Oort et al., 2007). This is probably for the reason that near-distance relocations are less likely to be disruptive for established routines and interactions of firms including those with knowledge partners. Relocation is strongly associated with locational uncertainty as “an existing location offers a degree of security in that its attributes are known, whereas those of other locations are not, except indirectly through the reported or observed experiences of others” (Lloyd & Dicken, 1977, p. 331). In this respect, locational uncertainty involved in a far-distance move is higher than that of a near-distance move as the unfamiliarity of a new location is expected to increase with the distance from the previous location. This unfamiliarity mainly emerges from the changing market area of a relocated firm. This can even be more the case for business services firms when it is considered that the frequency of direct, face-to-face interaction with the client is crucial for the production of a service (Malhotra & Morris, 2009) and a far-distance move may hinder the intense relationships with clients in (or near to) the previous location. van Dinteren (1987) showed that business service firms in the Netherlands generate between 33% and 82% of their turnover within 30 km of their office location. More recently, Arnarson and Gullstrand (2017) found in a Swedish case that the effect of manufacturing exports on the sales of business service firms disappears after 20 km distance

between them confirming that business service firms predominantly supply locally. In line with these findings, relocation over far distances has the potential of creating more disruptive effects for organizations (Carter, 1999) due to a substantial change in their geographical market. As connecting to strangers as new partners is associated with higher levels of risk and uncertainty (Dahlander & McFarland, 2013) in terms of expected benefits, firms may follow a strategy of sticking to their extant knowledge partners after relocation especially when far-distance moves are in question. Because “if the net revenues of a social relation are positive, this relation may be maintained over long distance” (Rutten et al., 2010, p. 869).

In sum, establishing a new knowledge tie with a new partner after relocation - especially when firms relocate across far distances - requires dealing with two types of uncertainty, namely locational uncertainty (Lloyd & Dicken, 1977), which results from unknown attributes of a new location, and social uncertainty, which results from the intentions of exchange partners, including the possibility of opportunism (Lazzarini, Miller, & Zenger, 2008). Whereas firms may attempt to relocate within a possible nearest distance to minimize the former uncertainty, they may reduce the latter uncertainty through maintaining the existing knowledge relationships rather than forming new ones with new partners. For this reason, we hypothesize that:

Hypothesis 1: The farther the relocation distance is, the less likely a firm establishes new knowledge ties after relocation.

2.1.2. Relocation direction

Neither resources nor economic activities are evenly distributed in space, which leads to high variation of, for example, wealth and welfare, across regions within a country. Also, the availability of knowledge sources varies by location (Roper, Love, & Bonner, 2017). In other words, every location offers a distinct set of opportunities and constraints for firms in terms of access to knowledge sources. Therefore, moving to another location means a change in the set of locational opportunities and constraints available to firms. For example, a firm moving to a region with a highly developed infrastructure can enjoy an increase in its accessibility whereas a firm moving to a highly congested region can experience some constraints such as high land prices, lack of space, etc.

When a firm relocates, the characteristics of the destination region will likely be different from the region where it was previously located. Knoblen (2011) showed empirically that firms indeed take the differences in regional characteristics into account when they search for a new location. The presence or absence of local knowledge sources impels firms to develop corresponding spatial strategies for the acquisition of external knowledge. For example, Davenport (2005) presented the case of both manufacturing and service SMEs in New Zealand that firms adopt a non-localizing approach as the preferred mode of external knowledge acquisition due to the absence of co-located organizations in the same sector. Similarly, Drejer and Vinding (2007) showed in the case of Denmark that firms located in the relatively sparsely populated region are more likely to collaborate with firms located outside the region. However, the question of to what extent differences in regional endowments affect the behaviour of forming new knowledge ties after relocation has not been answered yet.

An inter-organizational knowledge relationship is worth forming when a knowledge partner offers resources that are needed but not possessed or controlled by the focal firm (Pfeffer & Salancik, 1978). Firms operating in the same sector are more likely to have a higher degree of similarity in their knowledge bases, which possibly give access to redundant knowledge. Therefore, regions characterized by localization economies (i.e. economies arising from the co-location of firms in the same industry) generally offer less diversity in knowledge sources than those regions characterized by urbanization economies (i.e. economies occur through co-location of firms operating in different industries). Supporting this view, Knoblen (2011) found that firms do not favour regions with higher levels of localization as a new environment to

operate in when they search for a new location. When firms produce their services in interaction with customers, suppliers, research institutions and regulatory bodies, and use diverse sources of knowledge in this process, relocating to a region with a greater opportunity set in terms of access to diverse and complementary knowledge sources (in comparison to the previous region) is likely to facilitate the formation of new knowledge ties after relocation. However, firms relocating to a region characterized by localization economies might find it more difficult to develop new relationships with new knowledge partners. A more intense local competition due to the relatively greater dominance of firms in the same sector, and the difficulty of connecting to extant knowledge networks in the new location may hinder accessing external knowledge sources for a newcomer firm. Therefore, it is less likely for firms, which relocated to a region characterized by localization economies, to form new ties with new knowledge partners. Based on these arguments, we propose the following set of hypotheses:

Hypothesis 2a: A firm relocating to a more diverse region in terms of knowledge sources is more likely to establish new knowledge ties in this region after the relocation event.

Hypothesis 2b: A firm relocating to a more similar region in terms of knowledge sources is less likely to establish new knowledge ties in this region after the relocation event.

2.2. Relational context of forming new knowledge ties after relocation

Relational context refers to the set of direct inter-organizational relationships which a focal firm has with other organizations (Kim et al., 2006; Nohria, 1992). Although this is essentially an a-spatial construct, moving to another location may facilitate some changes in it through the addition and/or deletion of some ties. In such a case, the presence of continued relationships in the knowledge ego-network of firms and their geographical component might influence forming new knowledge ties in the post-relocation phase.

2.2.1. Core knowledge tie portfolio

There is a general consensus that firms depend on a core of stable inter-organizational relationships to perform successfully (Lechner & Dowling, 2003; Venkataraman & Van de Ven, 1998). Stable relationships are long-term, committed relationships between organizations that are created through repeated exchanges, which, in turn, lay the foundation for the development of trust, creation of shared social norms and values, and social attachment (Lazzarini et al., 2008), forge relationship-specific routines (Jones, Hesterly, Fladmoe-Lindquist, & Borgatti, 1998), and enable the standardization of knowledge creation (Li, Veliyath, & Tan, 2013). These characteristics facilitate the comprehension and transmission of knowledge among firms.

As mentioned before, relocation presents a possibility for firms to reconfigure their inter-organizational knowledge ego-network, which may lead to the deletion of some ties while maintaining others. We term the set of knowledge relationships maintained after relocation as the core knowledge tie portfolio. Although maintaining these relationships entails costs in terms of the resources to be invested in (Bae & Gargiulo, 2003), they are very important in providing a steady flow of external knowledge resources to the focal firm. As knowledge has always a tacit element to some degree (Lorentzen, 2008), its transfer or exchange is facilitated by stable inter-organizational relationships (Ahuja, 2000). Firms offering complex products and services necessitate the effective usage of knowledge gained from external sources, which is only possible through a high level of understanding between knowledge partners (Howells, 2012). Once such a relationship is established and works effectively, it cannot be substituted easily. Due to jointly established trust, norms and values, and informed expectations reciprocally built through a long duration, such relationships may function without much difficulty through stretched spatial distances between partners and therefore persist easily even when the partners are located at a further distance to each other.

Having a greater number of knowledge sources increases the probability of obtaining valuable external knowledge (Leiponen & Helfat, 2010). However, “there is always a limit to a firm’s capacity to relate with other firms” (Glückler, 2007, p. 623). Exceeding this limit leads not only to higher managerial and organizational costs due to increased complexity of managing a wider variety of knowledge sources (Leiponen & Helfat, 2010), but also increases the probability of redundant knowledge in the firm’s inter-organizational network and a lack of internal knowledge processing capability. Therefore, firms with a relatively larger core knowledge tie portfolio (thus having a high number of continued knowledge partners after relocation) may prefer maintaining their extant knowledge linkages after relocation rather than forming a new knowledge tie with a new partner. Moreover, the history of collaboration, familiarity, and trust with an existing knowledge partner might reduce the perceived benefit from a new partner, which, in turn, reduces the need to change the existing knowledge network (Demirkan, Deeds, & Demirkan, 2013). Conversely, having a low number of continued knowledge partners after relocation may function as a constraint on accessing the required knowledge. Such firms may deliberately adopt a strategy of seeking new partners after relocation through which they potentially increase or diversify their set of external knowledge sources as well as reduce their reliance on any single partner (Beckman et al., 2004). This logic leads us to the following hypothesis:

Hypothesis 3: The larger the size of the core knowledge tie portfolio of a firm before relocation is, the less likely it establishes new knowledge ties after relocation.

2.2.2. Geographical component of the core knowledge tie portfolio

Not only may the size of the core tie portfolio but also its geographical component play an important role in the formation of new knowledge ties after relocation. Geographical distance to some knowledge partners may increase because of relocation whereas the distance to some others may decrease. Subsequently, some partners might gain a localized character in case the focal firm moves to the city or municipality where they are located whereas some others may no more be classified as local since the focal firm is not located in the same city or municipality with them anymore.

The role of localized ties has been extensively investigated in the literature on external knowledge acquisition and economic geography. Localized ties facilitate (tacit) knowledge sharing between a firm and its partners through frequent and long-term interaction (Christensen & Drejer, 2005). They also promote fine-grained information transfer, joint problem-solving arrangements and trust, and thereby, help perceive locational opportunities (Uzzi, 1996). For relocated firms, it is very important to be involved in localized social interaction in their new location. This so-called ‘localized connectivity effect’ “enhances the ability of firms to recognize and evaluate local external knowledge, providing better access to and understanding of specialized information, language, know-how, and the operations of other actors and allowing more efficient communication” (Laursen et al., 2012, p. 180). Tacit and localized information is also relevant in identifying and evaluating attractive partners for R&D collaborations (Reuer & Lahiri, 2014).

Therefore, if a relocated firm has already some localized ties (among its continued knowledge ties) in its new spatial setting, it might be deterred from forming new knowledge ties because the existing localized ties may already serve as a conduit for having access to locally available knowledge sources and help increase local connectedness of the focal firm. Thus, we hypothesize that:

Hypothesis 4: The higher the share of localized ties (in the new location) in the core knowledge tie portfolio of a firm is, the less likely it establishes new knowledge ties after relocation.

2.3. Temporal context of forming new knowledge ties after relocation

Perhaps one of the most pronounced statements in the literature on inter-organizational relationships is that strong relationships develop

over time (Ring & Van de Ven, 1994). New tie formation with a new partner is a process that brings strangers into a relation (Dahlander & McFarland, 2013). Getting to know a new partner and eventually establishing a knowledge relationship requires considerable time and effort because key characteristics of successful relationships such as trust, credibility, commitment, having a set of common norms and values as well as reciprocity, emerge as a function of time. For example, Spekman, Isabella, MacAvoy, and Forbes (1996) describe three formative stages of an alliance: anticipation, which starts with searching for a potential partner; engagement, which is related to the identification of a partner; and valuation, which is necessary to determine the worth of the relationship. Thus, forging working relationships may take years for the exchange parties due to the difference in organizational cultures, the mobility of the personnel, and the development of joint plans in changing environments (Spekman et al., 1996).

In this context, the time passed after the event of relocation is expected to affect the likelihood of forming new knowledge ties in a subsequent period. Here, the interest is in the length of time needed for forming a new knowledge relationship after relocation. Putting aside all the requirements and complexities of developing a business relationship with a new partner, identifying a new knowledge partner and initiating a new relationship with it might simply not be among the priorities of a firm right after relocation. More time and effort can be allocated for networking once the focal firm is settled in the new environment. Besides, “external knowledge acquisition generally requires longer and extensive interpersonal relationship building before trust can be established” (Kong, 2015, p. 464). For this reason, it is plausible to hypothesize that:

Hypothesis 5: The longer the time passed after relocation is, the more likely a firm establishes new knowledge ties.

3. Empirical design

3.1. Research setting

The setting of the empirical study is the sector of architecture and engineering consultancy (AEC). In the literature, this sector has been classified as a category of professional service firms (PSFs) (Löwendahl, 2005; Malhotra & Morris, 2009; von Nordenflycht, 2010). It is a sub-sector of knowledge-intensive business services (KIBS) (Tether, Li, & Mina, 2012), and also an example of project-based organizations (PBOs) (Gann & Salter, 2000; Kloosterman, 2008). The underlying feature of this sector is that firms “have only the expertise of their staff as assets with which to trade” (Winch & Schneider, 1993, p. 923). In other words, they strongly depend on the knowledge and skills of their employees who are typically highly educated professionals (Wagner et al., 2014). Their work “includes designing, maintaining and adapting the built environment, involving many organizations from a range of industrial sectors, temporarily working together on project-specific tasks” (Gann & Salter, 2000, p. 959). Projects in this sector are dependent on teamwork, and typically location-bounded unlike projects in, for instance, the software sector. As projects are managed within networks of numerous bodies such as suppliers, customers and regulatory bodies, “knowledge is differentiated and distributed throughout these networks” (Gann & Salter, 2000, p. 961). AEC firms have a synthetic knowledge base, which relies on the use and new combinations of existing knowledge in developing solutions to concrete problems (Martin & Moodysson, 2013) that are context-specific and tied to particular settings, both of which prioritize the exchange of tacit knowledge and interactive learning. In such industries, “relatively little collaboration takes place across greater geographical distance, while knowledge networks are primarily nationally or regionally configured” (Martin, 2013, p. 1432).

Other distinctive features of this sector are the customization of the product and/or service and the close, also from a geographical perspective, interactions between the service provider and the client

(Schertzer et al., 2013; Wagner et al., 2014). Fulfilling the specific requirements of the client requires substantial interaction between the client and the service provider (Löwendahl, 2005). Due to the highly customized nature of the product and/or service, operations “consist of a very large percentage of exceptions rather than routine replications of earlier procedures” (Löwendahl, 2005, p. 58). As changes in the economy and society accompanied by more complex standards and regulations create demands for new types of buildings and structures, AEC firms have to respond to changes in engineering, information and materials technologies, rising costs (Gann & Salter, 2000) as well as change in markets (Winch & Schneider, 1993) to stay competitive. Therefore, they are among “PSFs that rarely develop new knowledge but are continuously exposed to new knowledge, accumulate this knowledge and make it available to their clients” (Wagner et al., 2014). For example, learning a soundproof plaster system from a drywall contractor, or new techniques for smoke evacuation from a fire department can help an AEC firm to accomplish its projects in a better way. All these features underline the importance of getting access to new knowledge and practices in this sector, which makes it interesting to study in the context of establishing new knowledge ties.

Another reason for choosing the AEC sector is related to the spatial mobility of commercial (business) services being by far the most mobile sector in geographical space, both in absolute numbers and by migration rate in the Netherlands (Kronenberg, 2013; Pellenberg et al., 2002). Furthermore, a high number of small-sized enterprises in the Netherlands dominate the sector: More than 75% of the firms in the AEC sector are one-person and two-person businesses. Small firms are more likely to be dependent on external knowledge sources as being small often means having a smaller repository of internal knowledge. Additionally, being small in size is generally associated with a higher tendency to relocate as the costs of moving and organizational problems are expected to be much less for small firms (Pellenberg et al., 2002). Furthermore, given these characteristics, many firms operate on spatially bounded markets.

As industries show great variation regarding the nature of the knowledge they use and the configuration of their knowledge access network (Salavisa, Sousa, & Fontes, 2012), and there is heterogeneity even across professional service firms in terms of their organization and management (Malhotra & Morris, 2009), focusing on a single category of PSFs allows us to exclude both inter- and intra-sectoral variation.

3.2. Sampling and data

The research population in this study is the firms in the sector of architectural and engineering consultancy (NACE Rev.2, 71.1), which relocated within the Netherlands between 2002 and 2006. The list of these firms was obtained from the LISA database. We sorted the firms in the list in ascending order based on their relocation distance. The distribution of the firms in the research population in terms of relocation distance shows a high positive skewness: 75.1% of the moves were within the distance of 10 km. As farther relocation distance is expected to impose larger effects on a firm’s knowledge relationships, we decided to apply a two-stage disproportionate stratified sampling to avoid the dominance of near-distance moves in the sample.

The sampling frame of the study comprised 2,810 firms. In Stage 1, we adopted a systematic random sampling for the firms that moved within 40 km (2,652 firms) by selecting every 5th element on the list. In Stage 2, we incorporated all the firms, which moved more than 40 km (158 firms). Through this sampling procedure, 688 firms were chosen to be contacted for participation in the research project. The primary data was collected in December 2007 and January 2008 via a telephone survey. The fact that the study was conducted some time ago has both an advantage and a disadvantage. The advantage is that depicting the situation in 2007 / 2008 has the potential of serving as a kind of benchmark for future studies in a similar line of research. The disadvantage is that it obviously does not reflect the present situation, in particular, with

respect to the use of digital communication technologies.

Each firm on the list was given three calls at different times if it was not reached at the first call. In the end, 107 firms answered the questionnaire. However, we dropped 16 firms as they reported having no external knowledge linkages, and removed an additional 8 firms as they did not complete the questionnaire. Finally, the sample ended up consisting of 83 firms with a net response rate of 12.1%. Despite this low response rate, running a chi-square goodness-of-fit test revealed that the firm size distribution of the sample fits that of the research population. Therefore, a significant sample bias regarding firm size distribution can be excluded. Here, we should note that the sample is not representative of the population concerning relocation distance as relocations farther than 10 km distance are overrepresented in the sample. In this aspect, we traded the representativeness of the sample (in terms of relocation distance) for the relevance. The results of both tests can be provided upon request.

Collecting data at multiple points in time from the same firms (i.e. a panel study) would be an ideal way of assessing change in the inter-organizational knowledge ego-network of firms after relocation. However, it is not possible to know beforehand which firms will relocate within a specified upcoming period. A great majority of firms is unlikely to move to another location within a short timeframe: Previous research showed that only 3.4% of the firms in knowledge-intensive market services in the Netherlands (comprising the sector of architectural and engineering consultancy) relocated between 2003 and 2004 (Kronenberg, 2013, p. 699). Making face-to-face interviews in two waves would also be too costly as firms operating in the chosen sector are located all over the Netherlands. Therefore, carrying out an ‘ideal’ panel study poses serious problems for collecting the data for this research. To avoid these problems, we conducted the survey among the firms, which relocated between 2002 and 2006. As some part of the data on knowledge ties were to be obtained through retrospective questions, it was very important to minimize recall error. The potential for recall error generally depends on the salience of the events to individuals and the length of the recall period (Steele, 2005). The use of milestone events as a reference point is among the techniques adopted to minimize recall error (Steele, 2005). In this study, we took relocation as a milestone event for firms. Focusing on the last five years before the research (for generating the sampling frame) was for shortening the length of the recall period. Although a possible recall error cannot be fully excluded, collecting relational data through roster methods relying on respondents’ recall is found to be generally reliable (Marsden, 1990). Therefore, we implemented all the analyses under the assumption that the recall error is negligible.

The data were collected through a telephone survey. Each respondent firm had to fulfil three criteria for the interview: (i) having been relocated within the last five years before the research (between 2002 and 2006), (ii) has not experienced a merger, acquisition or takeover in the last five years, and (iii) being a single-site firm. Moreover, it was indispensable to obtain the relevant data from the manager who supposedly knows about the firm’s knowledge relationships. Gathering the data by a telephone survey allowed us to contact the firm manager for replying to the questionnaire as well as to directly target the firms meeting the criteria which would not be possible in case of a postal survey.

The questionnaire had three parts. The first part included general information on the firm (the founding year of the firm, its present and previous address, the reason for relocation, firm size before and after relocation, firm innovativeness). The questions on the present knowledge ties of the firm were asked in the second part, and the third part contained questions on the knowledge ties, which were terminated after the relocation. In this study, we were interested in “up-to-date knowledge on products, processes, services and markets” that the relocated AEC firms acquire externally, and asked two successive questions to the respondent firms about their business partners providing such knowledge:

Q1: With how many organizations (firms, universities, etc.) does your firm interact for its business activities?

Q2: Among these organizations, some might be particularly useful in providing up-to-date knowledge on products, production methods, services, and markets. How many organizations do you consider providing such knowledge for your firm?

A name-generator technique was used to collect detailed information on knowledge relationships: Each respondent firm was asked to name these organizations, which resulted in a roster of contacts. When the respondent firm was hesitant about giving the names of its knowledge partners, it was asked to provide only initials of the names or give the letters of A, B, C, and so on for each partner in a successive manner to ensure the full anonymity. We chose not to limit the number of contacts to be reported with the aim of obtaining information on the entire inter-organizational knowledge ego-network of firms. As AEC firms deal with complex tasks and are subject to diverse knowledge from various fields, we decided to use a broad definition of knowledge rather than differentiating among types of knowledge (such as technical advice, market, innovation-related knowledge, and product) available to the firm through its partners.

A series of questions were asked to the respondent (firm manager) describing the details of each cited contact such as the name, the location, the type of the organization, the duration of the knowledge relationship, and the similarity of the knowledge bases. The telephone survey lasted 15 to 40 min for each respondent firm depending on the number of reported knowledge linkages. We classified each reported knowledge relationship indirectly as continued, new, or dissolved after relocation. For example, if a firm was 6 years old during the interview and relocated 2 years ago, its age during relocation was 4 years. Similarly, if the duration of a knowledge relationship of this firm was 5 years during the interview, it is clear that it was 3 years during the relocation. We termed ties, which were formed after relocation (i.e. those whose duration was shorter than the time passed after relocation) as new knowledge ties, and those terminated after relocation as dissolved knowledge ties. In this way, we constructed the entire data set for two periods as ‘before relocation’ and ‘after relocation’. In this respect, the data are quasi-longitudinal in nature. This is similar to the method suggested by Anderson (1995): Collecting data on business relationships at a single point in time, classifying them by their phase, and using this data for quasi-longitudinal analysis.

3.3. Measures

3.3.1. Dependent variable

New tie formation. Inter-organizational tie formation at the firm level is the binary dependent variable which takes the value of 1 for the focal firm, which established at least one new inter-organizational knowledge tie with a new partner after relocation, and the value of 0 for having not formed any new knowledge tie in the new location.

3.3.2. Independent variables

Relocation distance. Relocation distance was measured as the nearest driving distance in kilometers between the present and previous address of the focal firm by using the route description tool in Google maps. It was log-transformed due to a marked positive skewness of its distribution.

Relocation direction. To test the Hypotheses 2a and 2b separately, two different measures are used. To assess whether the focal firm moved to a region with a higher level of urbanization or vice versa (H2a), the population density figures at the municipal level provided by Statistics Netherlands were used. The reader is reminded that the region in this study refers to a municipality. Population density is often employed as a proxy indicator of urbanization economies (Knoben, 2011; Kronenberg, 2013) as larger cities are associated with a higher diversity of economic activity which is seen as crucial for the development of new products, services, and markets (McCann & Folta, 2008; Jacobs, Koster, & van

Oort, 2014). For each relocated firm the population density of the region where it was formerly located was subtracted from that of the destination region. A positive result in this arithmetic shows that the focal firm moved to an environment with greater population density in comparison to its previous location.

To construct the independent variable for testing Hypothesis 2b, we used the employment figures in the commercial services for municipalities as Statistics Netherlands did not have the employment figures for the sector of architectural and engineering activities at the municipal level. Then the level of localization economies was measured by computing the location quotient for the commercial services at the municipal level. Similar to the previous construct, the location quotient for the commercial services in the originating municipality was subtracted from that of the destination municipality. A positive score in this calculation shows that the direction of relocation for the focal firm was towards a more specialized region in terms of commercial services.

Size of the core knowledge tie portfolio. This construct was measured as the total number of continued inter-organizational ties in a focal firm’s knowledge ego-network after relocation at the time of the survey. Focusing on the continued ties also made us save on a degree of freedom in the statistical analyses, as it was no more necessary to include a dummy variable of whether a firm terminated a knowledge tie or not after relocation as a control. This is useful especially when the sample size of the study is small.

Geographical component of the core knowledge tie portfolio. The percentage of localized ties (local according to the new location) of the focal firm in the core knowledge tie portfolio was taken as the geographical component of the core tie portfolio. The operationalization of the local dimension differs greatly in previous research depending on the country where the research was carried out. For the Netherlands, in some studies being within reach of a 20-km radius from the focal firm is considered as local (Knoben, 2011; Knoben & Oerlemans, 2008) whereas some others define a 50-km range as spatially proximate (Stam, 2003). As the mean and median relocation distance for the sample is 48 km and 25 km respectively, taking a 20-km or 50-km radius from the focal firm as local would result in classifying the majority of the relocations as local. While constructing the variables for relocation direction, relocation between two municipalities was regarded as a change in regional endowments. However, considering a knowledge partner, which is located in another municipality within, for example, 20 km from the focal firm, as local (this means in a way that there is no change in regional endowment) would produce inconsistency across these independent variables. Therefore, this study adopts a rather narrow definition of local: the knowledge partners, which are located within the same town or city with the focal firm after relocation (that is, located in the same municipality), are considered as localized.

Time passed after relocation until the formation of the first new knowledge tie. This was measured at the time of the survey as years passed between the relocation and the formation of the first new knowledge tie at the new location for each focal firm. The sample consists of the firms, which were relocated at different time points within the last five years before the survey. For example, a firm, which relocated 4 years ago at the time of the survey but formed its first new knowledge tie 2 years after relocation, was given the value of 2 for this variable. Yet, a proportion of the sample reported not having established any knowledge tie in the post-relocation period. Therefore, this variable is right-censored. A firm, which relocated 3 years ago at the time of the survey and did not form any new knowledge tie, was given the value of 3.

3.3.3. Control variables

We included two firm-specific control variables, namely firm age and firm size, as they might affect knowledge tie formation of firms after relocation. Networks are critical especially for young and small firms operating in knowledge-intensive sectors which experience difficulties in accessing the range of resources for innovation due to liabilities of smallness and newness (Salavisa et al., 2012). Besides, small firms

benefit more from adding more or new sources of knowledge to their tie portfolio than large firms (Roper et al., 2017). Therefore, young and small firms might be more inclined to establish new knowledge ties compared to big and/or incumbent firms. *Firm age* was computed as the years passed after the establishment of the firm at the time of relocation and log-transformed because of being positively skewed. *Firm size* was measured as the number of full-time employees in the firm at the time of relocation. The operational definitions of all variables used in the analysis are given in Table 1.

3.4. Method

To test the hypotheses, we performed a binomial logistic regression analysis with the logit link function. We constructed the models hierarchically to compare change in model fit and coefficients as each independent variable was added to the equation. Yet, the nonlinearity of logit models does not allow a straightforward interpretation of coefficients such as reporting merely the significance and sign of coefficients as in linear regression models (Hoetker, 2007; Zelter, 2009). Wiersema and Bowen (2009) suggest that testing the nature of the relationship between an independent variable and the dependent variable in a logit model requires a supplementary analysis that examines the value and significance of the independent variable’s marginal effect, and it is necessary to compute the marginal effect of each variable for each observation along with the z-statistic values. In our case, the sample consists of 83 observations, so there are 83 values of the marginal effect and the corresponding z-statistic for each independent variable. Taking the average of these 83 values gave us the average marginal effect of the related variable.

4. Results

Before reporting the results of the analysis, it is useful to give an overview of some characteristics of new knowledge ties of AEC firms in the sample. 36 Out of 83 firms (43%) reported having formed 60 new knowledge ties within the five years after relocation. 48 Ties (80%) are at the inter-city level whereas 8 ties (13%), 3 ties (5%) and 1 tie (2%)

Table 1
Variables used in the analysis.

	Operational definition
Dependent variable	
New knowledge tie formation	Coded as 1 if the focal firm formed at least one new knowledge tie with a new partner after relocation, as 0 if it did not
Independent variables	
Relocation distance	Nearest driving distance (km) between the previous and the present location of the focal firm, obtained using the route function in Google maps (log-transformed)
Relocation direction – towards a more diverse region	Calculated by subtracting the population density of the originating municipality from that of the destination municipality
Relocation direction – towards a more similar region	Calculated by subtracting the location quotient for the commercial services in the originating municipality from that of the destination municipality
Size of the core knowledge tie portfolio	Total number of continued knowledge ties of the focal firm after relocation
Geographical component of the core knowledge tie portfolio	Percentage of localized continued knowledge ties of the focal firm at the new location
Time	Number of years passed between the relocation and the time the firm formed its first new knowledge tie
Control variables	
Firm age	Number of years passed after the establishment of the focal firm at the time of relocation (log-transformed)
Firm size	Number of employees (in FTEs) in the focal firm at the time of relocation

have been established at intra-city, European and overseas levels respectively. The average distance to new knowledge partners-excluding new partners in Europe and overseas (4 ties in total) due to their outlier effect- is 67 km. If these new ties had been formed at the previous location, then their average distance to the focal firm would have been approximately 90 km. They are forged within closer proximity to the present address of the focal firm than its previous location.

The descriptive statistics for the variables included in the analysis are presented in Table 2. The average relocation distance of firms is 48 km with a standard deviation of 55.8. While the average size of the core inter-organizational knowledge tie portfolio is 2.30 ties with a standard deviation of 1.39, the average geographical component of this portfolio is 0.11 ties with a standard deviation of 0.26. The average firm age is approximately 7 years (with a standard deviation of 6.79) and the average firm size is 3.2 FTE (with a standard deviation of 4.95). On average, we surveyed the firms 2.7 years after their relocation and those firms having new knowledge ties established those ties 1.3 years after relocation. The variance inflation factors (VIFs) reported in Table 2 range from 1.06 to 1.12 which is far below the commonly accepted threshold of 10 (Cohen, Cohen, West, & Aiken, 2003). The correlation matrix in Table 3 shows that there is no pair of variables, which correlate highly with each other (the highest correlation is -0.51). These figures rule out the existence of multicollinearity for the data.

Table 4 displays the results of the binomial logistic regression employed in the analyses. The baseline model includes only the control variables. Models 1–5 are estimated by adding independent variables successively to the baseline model. Decreasing value of the log-likelihood across the models, as well as an increase in Nagelkerke’s pseudo R-squared from 14.3% to 44.0%, reflects the improvement in model fit. All models are statistically significant indicated by the p-value of the likelihood ratio chi-square statistic, which tests each model against the intercept-only model as suggested by Wiersema and Bowen (2009).

Model 1 introduces the term of relocation distance into the estimation to test Hypothesis 1. As expected, relocation distance is negatively related to new knowledge tie formation after relocation in all models (Model 1–5). Based on the full model, all values of the marginal effect for the relocation distance are also negative. However, they are not statistically significant in any model. Consequently, Hypothesis 1 is rejected.

Model 2a and 2b test the impact of change in regional characteristics on new knowledge tie formation. Contrary to the prediction, moving to a more diversified region in terms of the knowledge base is negatively associated with forming new knowledge ties after relocation. Moving to a more specialized region in terms of knowledge base turns out, as expected, to hurt the formation of new knowledge ties with new partners as well. Yet, none of these variables capturing the different aspects of the regional environment are statistically significant throughout the

estimated models. In sum, there is no support for Hypothesis 2a and 2b.

Model 3 adds the size of the core inter-organizational knowledge tie portfolio to the equation. As predicted, the coefficients for this variable are negative and statistically significant in all models ($p < 0.01$ in Model 3 and 4, $p < 0.10$ in Model 5). However, the size and significance of the effect can vary at different values of the variable due to the nonlinear nature of the relationship between the dependent and independent variables in logit models (Wiersema & Bowen, 2009). All values of the marginal effects for the core knowledge tie portfolio, computed by using the full model, are negative. Additionally, we calculated the predicted probabilities for the size of the core knowledge tie portfolio based on the full model (Model 5) by keeping all other variables at their mean. Here, it is also important to report the confidence intervals, which provide a range of likely values for the true population parameter, not just a point estimate (Wooldridge, 2009). In a logit model, the response scale is within the range of 0 and 1. That means the confidence intervals for the true population parameter have to be within this range as well. In other words, confidence intervals should not take any negative values, as there cannot be a negative probability. For this reason, the 95% confidence intervals are computed on the scale of the link function, which results in being asymmetric on the response scale. The predicted probabilities for the size of the core knowledge tie portfolio and the related confidence intervals are presented graphically in Fig. 1. It shows that whereas the probability of forming new knowledge ties after relocation is 68% when the focal firm does not have any continued knowledge linkages; it drops to 8% if it has eight continued knowledge ties (ceteris paribus). All these provide support for Hypothesis 3.

Model 4 includes the geographical component of the core knowledge tie portfolio in the analysis. The sign of the regression coefficient of this variable is inconsistent as it is negative in Model 4 and positive in the full model whereas the univariate regression reveals a negative relationship between the geographical component of the core knowledge tie portfolio and the new knowledge tie formation after relocation. The average marginal effect of this variable calculated using the estimates from Model 4 and the full model give the same results. As none of these analyses produces statistically significant results for this variable, Hypothesis 4 is rejected.

Model 5 (the full model) adds the temporal aspect of new knowledge tie formation after relocation. Contrary to the prediction, the coefficient for the time variable is negative and highly statistically significant in the model ($p < 0.000$). Yet, as mentioned above, a straightforward interpretation of this coefficient is not possible as different values of this variable can be associated with different size and significance effects along the logistic curve. The marginal effect of time on the formation of new knowledge ties after relocation is negative and highly significant through all possible values of this variable in the sample. Additionally, it is necessary to plot the predicted probabilities of forming a new knowledge tie after relocation against the relevant values of the time while holding all other variables at their mean. The 95% confidence intervals are computed on the scale of the link function. Fig. 2 shows that while the probability of forming a new knowledge tie after relocation within the first year after relocation is 73%, it decreases to 3% within the fifth year after relocation (ceteris paribus). This finding shows the opposite effect of what is maintained in Hypothesis 5. Firms form new knowledge ties rather quickly after relocation to compensate for their knowledge deficits.

As for control variables, both firm size and firm age are negatively related to new knowledge tie formation after relocation but only marginally statistically significant ($p < 0.10$) in all models except for the full model.

4.1. Robustness checks

We performed two different checks to assess the robustness of the results of the analyses. When the sample is rather small, maximum likelihood method employed by the traditional logit models may

Table 2
Descriptive statistics of the variables (N = 83).

	Min	Max	Mean	SD	VIF
New tie formation	0	1	0.43	0.50	n.a.
Relocation distance (km)	0.20	237.00	48.06	55.84	1.12
Relocation direction – towards a more diverse region	-5283	4144	-518	1706	1.07
Relocation direction – towards a more similar region	-1.09	0.38	-0.03	0.22	1.09
Size of the core knowledge tie portfolio	0	8	2.30	1.39	1.06
Geographical component of the core knowledge tie portfolio	0	3	0.11	0.26	1.12
Time (years)	1	5	2.02	1.19	1.10
Firm age (years)	1	35	6.98	6.79	1.11
Firm size (FTE)	1	30	3.19	4.95	1.08

Note: All variance inflation factors (VIFs) were calculated based on Model 5 in Table 4.
n.a.: not applicable.

Table 3
The correlation matrix.

	1	2	3	4	5	6	7	8
1 New tie formation	–							
2 Firm age (log)	–0.20	–						
3 Firm size	–0.24**	0.06*	–					
4 Relocation distance (log)	–0.03	–0.14	–0.21*	–				
5 Relocation direction towards a more diverse region	–0.07	–0.01	–0.05	–0.21*	–			
6 Relocation direction towards a more similar region	–0.05	0.02	0.03	–0.17	0.29***	–		
7 Size of the core knowledge tie portfolio	–0.33***	0.10	0.13	–0.09	0.18	0.10	–	
8 Geographical component of the core knowledge tie portfolio (%)	–0.03	–0.09	–0.01	–0.02	0.16	0.16	–0.04	–
9 Time	–0.51***	0.29***	0.23**	–0.01	0.01	0.08	0.33***	0.16

*p < 0.10, **p < 0.05, ***p < 0.01.

Table 4
Logistic regression estimations of the likelihood of forming new knowledge tie after relocation (N = 83).

	Baseline model	Model 1	Model 2a	Model 2b	Model 3	Model 4	Model 5 Full model	Average marginal effects ¹
Constant	0.976* (0.565)	1.568** (0.794)	1.627** (0.804)	1.585** (0.794)	3.042*** (1.028)	3.163*** (1.060)	3.613*** (1.112)	–
<i>Control variables</i>								
Firm age (log)	–0.510* (0.308)	–0.552* (0.310)	–0.569* (0.313)	–0.551* (0.310)	–0.512 (0.313)	–0.528* (0.316)	–0.166 (0.357)	–0.008 (0.017)
Firm size	–0.167* (0.093)	–0.191* (0.101)	–0.191* (0.101)	–0.191* (0.100)	–0.188* (0.103)	–0.187* (0.101)	–0.134 (0.093)	–0.021 (0.014)
<i>Spatial context</i>								
Relocation distance (log)		–0.161 (0.148)	–0.195 (0.153)	–0.173 (0.149)	–0.227 (0.163)	–0.231 (0.164)	–0.157 (0.172)	–0.006 (0.007)
Relocation direction towards a more diverse ² region			–0.129 (0.142)	–	–	–	–	–0.027 (0.030)
Relocation direction towards a more similar region				–0.574 (1.095)	–0.369 (1.181)	–0.267 (1.197)	–0.438 (1.387)	–0.070 (0.222)
<i>Relational context</i>								
Size of the core knowledge tie portfolio					–0.620*** (0.227)	–0.631*** (0.230)	–0.400* (0.242)	–0.065* (0.036)
Geographical component of the core knowledge tie portfolio (%)						–0.515 (0.920)	0.235 (1.266)	0.038 (0.203)
<i>Temporal context</i>								
Time							–1.088*** (0.359)	–0.175*** (0.045)
Nagelkerke's pseudo R-squared	14.3	16.1	17.3	16.5	28.6	28.9	44.0	–
Log likelihood	–52.109	–51.500	–51.083	–51.360	–46.860	–46.702	–40.281	–
Model significance	0.009	0.014	0.022	0.027	0.001	0.002	0.000	–

*p < 0.10, **p < 0.05, ***p < 0.01; standard errors are in parentheses.

¹Average marginal effects (AME) of the variables are calculated using the estimates from Model 5. The AME for the variable *Relocation direction towards a more diverse region* is computed based on Model 2a.

²The coefficients and standard errors of this variable are multiplied by 1000 due to representative purposes.

produce estimates that are skewed away from the true parameter values even if no other bias is present (Greenland, Schwartzbaum, & Finkle, 2000). Therefore, we first changed the functional form of the estimation to overcome this so-called small sample bias. The bias-reduction method, which is an improvement over traditional maximum likelihood, was used because it has a smaller variance than the maximum likelihood estimator and the resultant estimates and their corresponding standard errors are always finite while the maximum likelihood estimates can be infinite (Kosmidis, 2007). The results of Model 4 estimated with the bias-reduction method were consistent for the explanatory variables in terms of sign and significance of the coefficients. The re-estimation of the full model revealed only the time variable to be highly significant (p < 0.01).

Second, we assessed whether the obtained results are consistent across a set of subsamples of the data. We created 20 subsets of the original data set by taking 80% of the observations (66 firms) randomly without replacement. Both Model 4 and the full model were re-estimated 10 times by using a different subset each time. The coefficients for the variable of the core tie portfolio size had negative signs and were significant in the re-estimations based on Model 4, therefore, consistent with the results. As for the time variable, the coefficients were all

negative and highly significant throughout the re-estimations based on the full model. All the relevant calculations can be provided upon request.

5. Discussion and conclusions

The study attempts to answer the question, to what extent a firm relocation affects the formation of new knowledge ties with new partners in the subsequent period. The findings reveal that whereas the relational and the temporal context, both being a-spatial constructs, do indeed affect the formation of new knowledge ties after relocation, the spatial context itself exerts no impact on this behaviour.

The most interesting finding of the study is related to the role of time in the formation of new knowledge relationships after relocation. The underlying idea for this has been that in the post-relocation phase firms are likely to prioritize setting up their business routines in the new location over establishing new knowledge linkages as the latter functions based on trust, which demands considerable time and effort to be built. However, contrary to the prediction, the analysis revealed a highly statistically significant negative relationship between the time passed after relocation and the formation of new knowledge ties. This shows

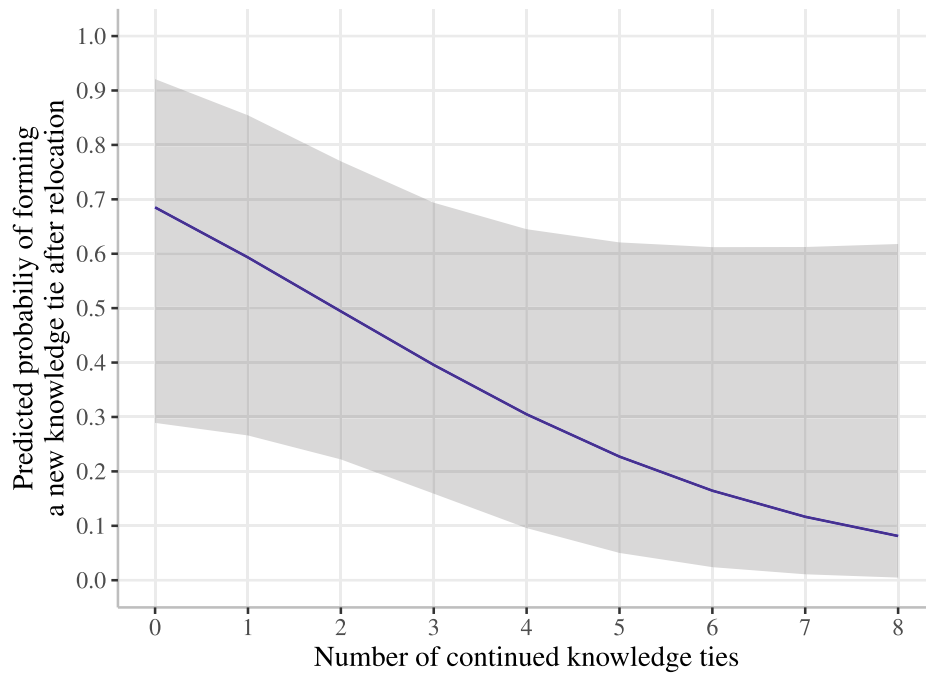


Fig. 1. Effect of an increase in the number of continued ties on the likelihood of forming new knowledge ties after relocation. Shaded areas represent 95% confidence intervals.

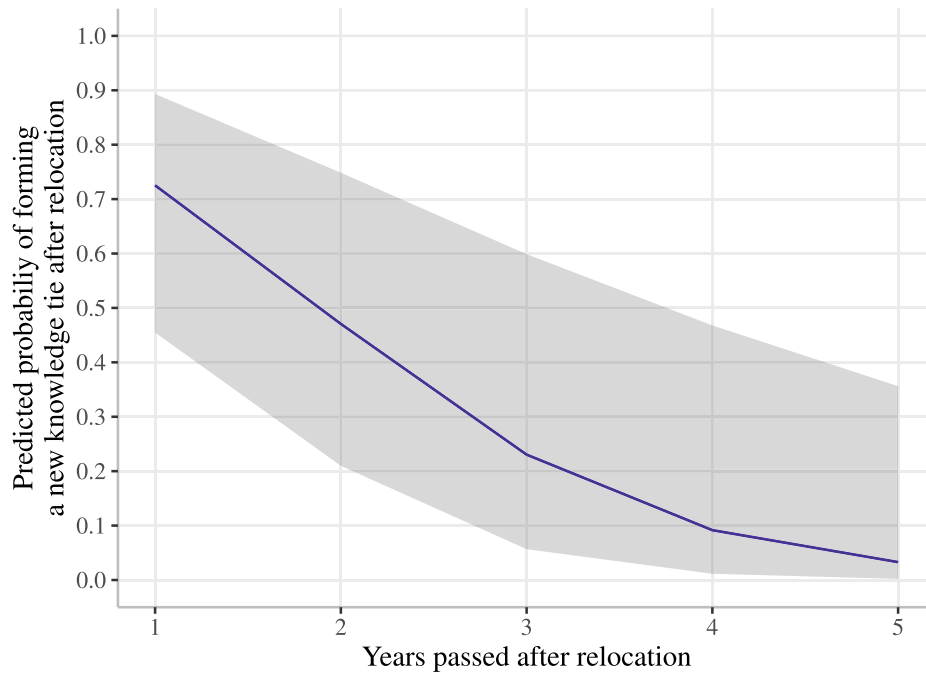


Fig. 2. Effect of time on the likelihood of forming new knowledge ties after relocation. Shaded areas represent 95% confidence intervals.

that accessing external knowledge through new knowledge partners relatively quickly is as important as setting up the business routines after relocation. Being involved in a new knowledge relationship generally emerges from a deficiency in the internal knowledge base. Knowledge is the most important resource for competitiveness. When firms lack competitive resources, they are more inclined to form inter-firm linkages (Ahuja, 2000). For this reason, firms seem to deal with this deficiency by forming new knowledge ties rather soon after relocation: The probability of forming a new knowledge tie drops below 50% after roughly 1.8 years passed after relocation.

Another important finding of the study is related to the role of the size of the core tie portfolio in the formation of new knowledge linkages after relocation. The likelihood of forming new knowledge relationships with new partners after relocation decreases substantially with the number of continued knowledge linkages of a focal firm. The presence of limited relational capability (Lechner & Dowling, 2003) may explain this finding. It suggests that for firms there is a limit for the ability to establish, maintain and develop relationships (Ahuja, 2000; Glückler, 2007). Firms cannot continuously expand their knowledge ego-networks for two main reasons. First, an increasing number of partners eventually

leads to diminishing returns (McFadyen & Cannella, 2004) as the added value of each new tie decreases with the higher likelihood of the shared knowledge being redundant. Second, building and maintaining of these relationships entail substantial costs as well (Bae & Gargiulo, 2003). This is consistent with the findings in earlier research on network management which demonstrates the inverse relationship between network size and network growth (Demirkan et al., 2013). This suggests that firms are well aware of the costs and limits involved in managing their network: As the size of their network increases, they tend to slow the growth of their network down (Maurer & Ebers, 2006) and maybe even stop expanding it. Therefore, firms, which have already a high number of knowledge partners, shun from establishing new knowledge relationships after relocation. In other words, when the size of firms' core knowledge tie portfolio is relatively large, firms opt for relying on their existing partners rather than trying to build new relationships with new partners after relocation. In this way, they can secure a reliable and steady flow of external knowledge from familiar sources in the post-relocation period. On the other hand, firms with a lower number of continued ties in their core portfolio are more likely to form new knowledge ties with new partners after relocation to increase or diversify the external sources. However, having a local component in the core knowledge tie portfolio (that is, a local and continued knowledge partner in the new location) does not play a role in the formation of new knowledge ties after relocation. This means having an existing knowledge partner in the new location neither impedes nor facilitates the formation of new knowledge relationships after relocation.

Relocation distance does not play a significant role in the formation of new knowledge ties with new partners in the post-relocation period. Firms seem to be insensitive to the change of their location when they need to have access to new knowledge sources. Yet, this non-significant finding should be interpreted with caution, considering that the mean distance of relocation in this study appears to be only 48 km, which is accepted as “local” or “geographically proximate” in some studies (e.g. Stam, 2003). Moving to another location within such a limited range might not exert the expected negative effect on the formation of new knowledge ties because relocating within a near distance does not bring a high enough locational uncertainty, which means keeping the business as it is. Moreover, it should also be emphasized that what is considered as near distance may be influenced by national boundaries. A three-hour drive might be considered as near in a very large country whereas that may be felt as equivalent to a one-hour drive in a small country. Thus, it should be kept in mind that the investigated effect of relocation distance might differ depending on the size of a country.

As for relocation direction, moving neither towards a more diverse nor towards a more similar region in terms of the knowledge base has an impact on the formation of new knowledge ties in the subsequent period. When it is about forming a new knowledge relationship with a partner formerly unknown to the focal firm, factors such as specific resources or capabilities of the prospective knowledge partner are likely to be more important than the change in generic regional endowments after relocation.

The findings of this study contribute to three different bodies of literature. First, it makes an empirical contribution to the literature on time in organizational research. In the last two decades, there have been various calls for incorporating a temporal lens in organizational research (Ancona, Okhuysen, & Perlow, 2001; Berends & Antonacopoulou, 2014; Mitchell & James, 2001; Zaheer, Albert, & Zaheer, 1999). It has been often emphasized that researchers should investigate not only a causal relationship between an X and a Y, but also examine and specify “when things happen”, that is, “when the variables involved in the relationship occur” (Mitchell & James, 2001, p. 530). By including a temporal context, the study answers the question of **when** firms are likely to form new inter-organizational knowledge ties after relocation. Second, it informs the literature on external knowledge sourcing in the context of relocation. By examining simultaneously the change in a spatial and temporal context associated with relocation as well as the relational

context of a focal firm, it identifies which context plays an influential role in the sourcing of external knowledge through new inter-organizational relationships in the post-relocation period. Third, it enriches the literature on professional service firms, which is critiqued as being “simply as a literature of law and accounting firms” (von Nordenflycht, 2010, p. 155), by providing insight on new knowledge tie formation behaviour of AEC firms in particular.

This study has several limitations. First, as we do not have a control group of firms that did not relocate in the specified period and, thus, no information about their tie formation behaviour, we are unable to say to what extent relocation triggers the need for forming new knowledge relationships in a subsequent period. Second, the results of the study only concern the knowledge relationships of relocated firms in the AEC sector in the Netherlands. Generalization of the results requires further empirical work at least in other categories in professional service firms and other sectors. As for the generalizability to other countries and regions of the world, we contend that the findings are likely to be valid in comparable situations, that is, in the context of small countries where cultural and institutional homogeneity prevails.

Future research may focus on the role of strength, frequency and/or importance of existing ties as well as the role of the whole network the firm is embedded in on the tie formation behaviour in the post-relocation phase: What is the role of the strength, frequency and/or importance of extant ties on the formation of new ties after relocation? To what extent does knowledge seeking behaviour of relocated firms affect establishing new ties in the subsequent period? What roles do indirect ties (i.e. focal firm and a potential knowledge partner having common partners) play in identifying and developing new relationships with new partners after relocation? Overall, new knowledge tie formation appears as an interesting topic offering a wide variety of research directions to gain more detailed insights on the process of external knowledge acquisition over time.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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