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Proximity and multinational enterprise co-location in clusters: a multiple case study of Dutch science parks

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ABSTRACT
This paper explores the role of proximity in strategic asset-seeking multinational enterprises' (MNE) co-location in subnational knowledge/innovation intensive clusters. MNE co-location in three Dutch science parks is examined in terms of the perceived importance of geographic, cognitive, social, organisational and institutional proximity dimensions. While all five proximity dimensions are found to play a role, organisational proximity emerged as the most important factor influencing MNE co-location in the Dutch science parks. This paper argues, in contrast to expectations for a high degree of relatedness and reinforcing effects between the five proximities, that an 'optimal' proximity constellation of low organisational proximity together with high social and cognitive proximity fosters MNE co-location in knowledge intensive clusters, such as science parks.

KEYWORDS
Multinational enterprise; subnational locations; proximity; science parks; The Netherlands

JEL CLASSIFICATIONS
F23; M16; O30

1. Introduction

Around the world, 'science parks' are being established and promoted as 'property developments aimed at supporting research-based commercial activity' (Quintas, Wield, and Massey 1992, 161). Currently, there are over 400 such science parks globally and their number continues to grow (UNESCO 2015). It has been argued that foreign direct investment (FDI) by multinational enterprises (MNEs) has the potential to significantly contribute to subnational locations, such as science parks, in terms of workforce skills, employment, productivity and knowledge transfer (Monaghan 2012).

It is, therefore, unsurprising that policy-makers seek to attract MNEs to such knowledge-intensive clusters in order to boost innovation and enable participation in the global knowledge economy (Bonetti and Masiello 2014). MNEs in turn may benefit from the co-location of knowledge institutes, higher education institutes, science-based knowledge and the highly skilled labour pool present in science parks (Castells and Hall 1994; Ylinenpää

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2001). Indeed, research shows that multinational firms in highly research-intensive, science-based and breakthrough-oriented industries (chemical, pharmaceutical, information technology, telecommunications and consumer electronics industries) seek the benefits of co-location in science parks (Cairncross 2012).

Studies of the science park phenomenon are part of both the International Business (IB) (Porter 1990, 1998; Dunning 1998; Mariotti, Piscitello, and Elia 2010; Monaghan 2012; Monaghan, Gunnigle, and Lavelle 2017; Boschma et al. 2015) and Economic Geography (EG) (Torre and Gilly 2000; Boschma 2005) literatures seeking to look beyond the national level of analysis to subnational locations (e.g. clusters and cities) to study MNE managerial activities and strategies. At the same time, an extensive literature on science parks as a specific type of subnational cluster has also emerged (Quintas, Wield, and Massey 1992; Castells and Hall 1994; Ylinenpää 2001). However, to the best of our knowledge, there is only a limited literature focused on attempting to specifically understand MNE co-location in science parks (Wang and Tu 2006; Zhang 2010).

Science parks seek to facilitate collaborative innovation between businesses, universities, higher education institutes and research organisations to the benefit of all participating organisations (IASP 2002; UKSPA 2016). Steinmo (2015) has argued that adopting the concept of proximity (Boschma 2005) could contribute to understanding the underlying dynamics of academic–industry collaboration in subnational innovation clusters, such as science parks. MNEs are widely recognised to co-locate for such strategic asset-seeking motives (Dunning 1998), due to the benefits of regular interaction, enabled by being located physically closely, for knowledge-intensive activities (Blanc and Sierra 1999; Criscuolo, Narula, and Verspagen 2005). Co-location is understood as the focal firm locating in high physical or geographic proximity to other organisations (Criscuolo, Narula, and Verspagen 2005; Narula and Santangelo 2012) and when taking place on a larger scale is manifested in the phenomena of clustering (Porter 2000) and agglomeration (Mariotti, Piscitello, and Elia 2010). As will be made clear, the concept of proximity is, however, a multidimensional concept that includes, but also goes beyond, the geographic dimension (Blanc and Sierra 1999; Boschma 2005) and the associated interaction benefits for co-location organisations.

In this paper, a proximity and innovation (Balland, Boschma, and Frenken 2015) perspective is adopted to explore the role of five proximity dimensions – geographic (spatial), institutional, social, cognitive and organisational (Boschma 2005; Broekel and Boschma 2012) – in MNE co-location in knowledge-intensive subnational locations, specifically in three science parks in the Netherlands. This study, therefore, aims to answer the following research question:

> How do the different dimensions of proximity explain the co-location of strategic asset seeking MNEs in the subnational knowledge-intensive setting of a science park?

Responding to calls for interdisciplinary work (Cantwell and Brannen 2011) integrating EG and IB scholarship, this paper explores the role of different types of proximity, or distance-related subnational variation (Boschma 2005), on MNE co-location in three Dutch science parks: Amsterdam Science Park, Utrecht Science Park and Leiden Bio Science Park. Our research design consists of a holistic multiple case study featuring a literal replication logic and data triangulation (Yin 2013). The data for the study were collected by interviewing experienced and senior science park managers, managers of MNEs and managers of knowledge institutes active in the focal science parks to ask them about their perceptions of the role of proximity in MNE co-location in the respective science parks.

Our findings suggest that MNE co-location in science parks is best understood as a strategy that seeks to exploit low organisational proximity in an 'optimal' proximity constellation where social and cognitive proximity are high. These findings suggest that the reinforcing nature of proximity put forward in the literature does not apply to all dimensions of proximity in the focal science parks. This contrasts with Knoben and Oerlemans (2006), who suggest that the different types of proximity are closely related, and Boschma's (2005) findings that geographic proximity 'carries with it a reinforcing power which triggers the other types of proximity' (Mattes 2012, 1091). For our respondents, cognitive proximity is not affected by geographic proximity and high social proximity does not depend on geographic proximity. These findings contribute additional insights to the emerging research on the interaction between the different proximities and the conditional boundaries of the positive role they have on co-location in locations seeking to stimulate knowledge generation and transfer (Mattes 2012; Paci, Marrocu, and Usai 2014; Hansen 2015; Fitjar, Huber, and Rodríguez-Pose 2016; Steinmo and Rasmussen 2016), beyond the already recognised negative effects of excessively high proximity (Petruzzelli and Carbonara 2007).

In the next section, we briefly introduce science parks as an international business relevant phenomenon, before proceeding to conceptualise 'proximity' and discuss the interaction of the different proximity dimensions (Section 3). We then describe the study's research design (Section 4), before presenting the within-case findings of our proximity analysis of MNE co-location in Dutch science parks (Section 5). The study concludes with a discussion of these findings in a cross-case analysis, and draws some relevant conclusions and implications.

2. Science parks as subnational R&D locations for MNEs

Innovation processes and associated knowledge spillovers are spatially bounded due to the nature of the tacit knowledge central to such activities (Malmberg, Sölvell, and Zander 1996). Firms are, therefore, inclined to co-locate or agglomerate with other firms, research institutes and other partners, thereby forming 'innovation/knowledge' clusters (Porter 2000). However, this is not always the case; studies show that MNEs' subnational location choices may be influenced by their perception of the likely balance of knowledge inflows and outflows with local firms and other MNEs, depending on the relative competitive position of the focal MNE (Mariotti, Piscitello, and Elia 2010).

The local nature of knowledge flows and the importance of co-location/clustering for knowledge-intensive industries are well established (Henderson, Jaffe, and Trajtenberg 1998; Broekel and Boschma 2012). To better understand the subnational co-location of organisations pursuing innovative activities, it has been argued that research should focus more on one of the key participants in such clusters: MNEs (Dunning 1998, 2009; Beugelsdijk, McCann, and Mudambi 2010; Mudambi and Swift 2012).

Science parks are an eminently suitable geographic location for further research into the co-location of MNEs in knowledge-intensive subnational locations, as they are home to a combination of MNEs, start-ups, knowledge institutes and higher education institutes. Furthermore, the number of science parks is continually growing, due to the recognition by policy-makers of their potential for innovation (Saublens 2008; Tcheng and Huet 2012), making them an interesting and important subnational location to study. The Netherlands currently has eight established science parks and close to 40 parks planned or in the start-up phase (Buck Consultants 2014).

Formally, a science park is an 'organisation managed by specialised professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions' (IASP 2002). It does so by encouraging and supporting 'the start up and incubation of innovation-led, high-growth, knowledge-based businesses' and providing 'an environment where larger and international businesses can develop specific and close […] formal and operational links with centres of knowledge creation such as universities, higher education institutes and research organisations' (UKSPA 2016).

Science parks differ in their degree of specialisation, with science foci ranging from biomedical drug development to subatomic physics. Firms that depend on innovation and technological change will co-locate in a science park that ensures the best possible knowledge externalities and spillovers for their organisation (Porter 2000; Bonetti and Masiello 2014). Firms have the freedom to co-locate in one or multiple science parks to satisfy their need to open new 'technological windows'. Firms may establish a physical presence in a science park in a variety of modes, from small representative offices to larger R&D departments. This freedom to choose locations and determine the extent of their resource commitment, allowing them to (co)locate in different subnational locations within and outside their country of origin, is a defining feature of MNEs (Rugman, Verbeke, and Nguyen 2011). We now proceed to study the extent to which the different dimensions of proximity explain the co-location by MNEs in science parks.

3. Proximity and co-location in knowledge-intensive clusters

The clustering of actors with the goal of facilitating (successful) participation in knowledge exchange and learning (Broekel and Boschma 2012) may be explained by the effect(s) of proximity (Boschma 2005), defined as 'distance-related subnational variation' (Beugelsdijk and Mudambi 2013, 416). This paper focuses on how proximity affects MNE co-location with the diverse actors in science parks. Proximity is a multidimensional concept that can be subdivided into the dimensions of geographic (spatial) proximity and the non-spatial dimensions of institutional, organisational, social and cognitive proximity (Boschma 2005) (see Appendix 1). In the literature, *geographic proximity* is broadly argued to facilitate frequent interaction (Boschma 2005; Cassi and Plunket 2013). *Institutional proximity* provides formal and informal sources of generalised trust (Boschma 2005), while *social proximity* refers to interpersonal sources of trust (Boschma 2005; Balland, Boschma, and Frenken 2015). *Organisational proximity* reflects shared understandings of control and coordination of organisations (Boschma 2005; Balland, Boschma, and Frenken 2015) and, finally, *cognitive proximity* is the degree to which actors have a shared knowledge base that enables effective learning (Nooteboom 2000; Boschma 2005; Balland, Boschma, and Frenken 2015).

Balland, Boschma, and Frenken (2015) review of the proximity literature shows that significant progress has been made in the disentanglement of the proximity dimensions (Boschma 2005; Mattes 2012), understanding the proximity paradox where increasing proximity results in less innovation (Broekel and Boschma 2012), evaluations of the optimal distance for innovation, or the 'Goldilocks principle' (Boschma 2005; Fitjar, Huber, and Rodríguez-Pose 2016), and the phenomenon of temporary proximity (Torre and Rallet 2005; Torre 2008). Studies of proximity have also developed significantly and rapidly from

early, more static approaches (Boschma 2005; Knoben and Oerlemans 2006; see Appendix 1 for a summary of the related assumptions and MNE relevance) to a more recent emphasis on a dynamic theory of proximity and knowledge networks related to innovation (Balland, Boschma, and Frenken 2015). This dynamic approach to proximity not only adds a temporal dimension, but also recognises the potential for the co-evolution of proximity and collaboration (Balland, Boschma, and Frenken 2015) and recognises the existence of complementary and substituting effects between the geographic and non-spatial proximities (Hansen 2015), which can at times be highly related (Knoben and Oerlemans 2006).

The increasingly knowledge-intensive and collaborative nature of international business has been well established (Dunning 1998, 2006). In a knowledge-based view, MNEs that are pursuing a strategic asset-seeking location strategy will co-locate in science parks with the aim of integrating knowledge from external sources to create new competencies (Dunning 1998; Eisenhardt and Santos 2001; Rugman, Verbeke, and Nguyen 2011). A study of MNE co-location with other actors in science parks will seek to understand how proximity is related to the co-location of the local MNE unit in the science park. Importantly, we do not study the collaborative innovation processes with other (local) firms and knowledge institutes (Andersson et al. 2016) that motivate this co-location, but how proximity explains the co-location. Relatedly, Mariotti, Piscitello, and Elia (2010) and Cantwell and Santangelo (2002) have provided evidence that MNEs only tend to co-locate with organisations when doing so offers the potential for positive knowledge spillovers for the MNE, through the inward transfer of external knowledge and technology across the MNE's firm boundary (Eisenhardt and Santos 2001).

Given the significant resources available to MNEs, we argue that the decision to co-locate in a science park will be associated with the desire to source knowledge requiring complex learning – an activity supported by spatial agglomeration (Cassi and Plunket 2013; see Appendix 1). But while geographic proximity has the potential to trigger and reinforce the other proximity dimensions (Boschma 2005; Mattes 2012), researchers argue that it is neither a necessary nor sufficient condition for knowledge exchange or learning to take place (Boschma 2005). Thus, the non-spatial dimensions of proximity are expected to play an important role in explaining MNEs' co-location in science parks, given that MNEs are free to choose a location and are motivated by knowledge integration (Cantwell and Piscitello 2015) and positive knowledge spillovers (Mariotti, Piscitello, and Elia 2010).

Importantly, MNEs have the ability to establish and commit to geographic proximity to varying degrees through their (initial) entry mode (Pan and Tse 2000) and subsequent adaptation of their operational mode (Benito, Petersen, and Welch 2009). The ability to adjust their degree of commitment to a range of subnational geographic proximities over time arguably gives the MNE the opportunity and ability to respond to emerging challenges due to excessive geographic proximity. Entry modes and the adaptation of subsequent operational modes also allow MNEs to respond to formal institutional conditions (Meyer et al. 2009). In fact, MNEs are recognised for their ability to balance the tensions of operating across 'multiple, fragmented, ill-defined and constantly evolving institutional systems' (Westney 2005; Kostova, Roth, and Dacin 2008, 1001). At the same time, the formal organisation of the science park is expected to contribute to establishing and reinforcing norms of behaviour in the park that actively stimulate open innovation and knowledge transfer, thus increasing institutional proximity and making science parks more attractive for MNEs.

Institutional proximity is strongly interconnected with social and organisational proximity, since formal and informal institutions become embodied in norms (social) and routines (organisational) at the micro-level (Boschma 2005). Importantly, MNEs have the potential to transfer new informal institutions to a science park through their internal networks (Kostova 1999), as long as the local units of the MNE are not isolated within the MNE network (Monteiro, Arvidsson, and Birkinshaw 2008). The ability to operate across diverse formal institutional environments and transfer informal institutionalised practices to locations has been recognised as a challenge to local institutional rigidity and an advantage of the MNE compared to local organisations (Kostova, Roth, and Dacin 2008).

Organisational proximity can be studied at the structural and dyadic levels. The former emphasises belonging to the same organisation (Oerlemans and Meeus 2005), while the latter recognises the important effect of the similarity of the organisational contexts in which actors from different organisations work (Wilkof, Brown, and Selsky 1995). Organisational practices are central to the issue of interactive learning (Boschma 2005). When the organisational contexts of interacting parties are similar, the capacity to coordinate the exchange of heterogeneous complementary knowledge held by diverse actors across and within organisations increases knowledge (co-)creation (Knoben and Oerlemans 2006; Mattes 2012). MNEs are also known to use various forms of strategic alliance (Inkpen 1998) to recombine knowledge in host countries, and such alliances create a shared organisational context (Oerlemans and Meeus 2005) that structurally increases organisational proximity. We posit that MNEs will primarily rely on structural organisational proximity when collaborations lead to highly valuable tacit knowledge over which the firm wishes to exercise control (Balland, Boschma, and Frenken 2015). Importantly, MNEs can manage their commitment to this structural organisational proximity through their entry mode (Pan and Tse 2000) and subsequent operational modes (Benito, Petersen, and Welch 2009).

Social proximity is seen as essential for knowledge exchange and refers to the personal relationships between MNE managers and local actors. According to Maskell and Malmberg (1999), greater social proximity is associated with higher degrees of trust, and trust-based social relationships will foster the exchange of tacit knowledge, which is by nature difficult to acquire through the market. Pre-existing relationships between an MNE employee and those of a firm/university/knowledge institute in a science park could therefore explain the propensity of an MNE to co-locate in the science park, to enable participation in innovation processes. Social proximity is thus expected to depend on the (local) networking capabilities of the local MNE unit managers (Luo 2002).

The MNE will achieve cognitive proximity through the employees located in the science park and those that may temporarily join the park. It is important that these individuals share 'a similar educational and/or professional background [to other actors in the science park] and have thereby acquired a similar frame of reference with regard to scientific knowledge' (Moodysson and Jonsson 2007, 120). A minimal level of cognitive proximity is necessary for effective knowledge networking (Nooteboom 2000; Boschma 2005; Nooteboom et al. 2007), as it fosters absorptive capacity and potential for learning (Boschma 2005).

Having established a conceptual foundation for the role of proximity in explaining the co-location of MNEs in knowledge-intensive clusters, specifically science parks, we will now proceed to empirically investigate this phenomenon. The next section explains our data collection method and subsequent approach to the analysis, after which the findings for each of the three focal case science parks are presented individually and then compared.

These findings are then discussed and conclusions are drawn, leading to an initial proximity-based theory of MNE co-location in science parks.

4. Data and method

A qualitative holistic multiple case study research design (Eisenhardt 1989; Eisenhardt and Graebner 2007; Piekkari, Welch, and Paavilainen 2009; Yin 2013) has been adopted for this exploratory study of the proximity concept and MNE co-location in knowledge-intensive science parks. Reflecting IB disciplinary convention (Piekkari, Welch, and Paavilainen 2009), the case study design tends towards a more post-positivist positioning (Guba and Lincoln 2005).

In IB, research varies in the degree of emphasis placed on developing a conceptual foundation for case studies (Eisenhardt 1989; Eisenhardt and Graebner 2007; Piekkari, Welch, and Paavilainen 2009; Yin 2013). This paper's 'deductive bottom-up theorising' approach (Shepherd and Sutcliffe 2011) favours sound a priori conceptualisation of the proximity concept (Gioia and Pitre 1990; Ridder, Hoon, and McCandless Baluch 2014; Yin 2013). This integration of the literature contributes to the study's internal validity by supporting the thematic coding of the data and its external validity, through analytical generalisation (Yin 2013). Drawing on the well-established proximity and innovation literature (Balland, Boschma, and Frenken 2015), while not over-specifying the concept (Eisenhardt 1989), also allowed the potential for incremental theory building (Ridder, Hoon, and McCandless Baluch 2014).

The selection of the three focal science park cases follows a literal replication logic (Yin 2013) and, as far as possible, each holistic case includes interviews with managers at universities, knowledge/research institutes, domestic firms and MNEs. Nonetheless, the three cases differ in size, composition and specialisations (see Table 1), as is typical for case research. Selecting only three cases does not reflect IB research convention (Piekkari, Welch, and Paavilainen 2009); however, the study covers three of the eight established Dutch science parks, including a majority of science parks with a specialisation/focal area(s), and purposively sampled multiple interviewees for each science park. This choice was made to achieve stronger construct validity through data triangulation within and across the cases, given the emphasis on the concept of proximity (see interview sampling below).

Data were collected through semi-structured interviews, ensuring that key topics were covered while remaining flexible and open to unexpected insights, and no predetermined boundaries were set on interview scope (Fylan 2005). The cross-sectional interview-based data collection reflects IB disciplinary convention in case study research (Piekkari, Welch, and Paavilainen 2009). Eighteen interviewees (six for each park) were purposively sampled using a snowballing strategy (Biernacki and Waldorf 1981): university representatives (3), knowledge institute representatives (4), science park managers (5) and MNE managers (6). Unique access to science park managers served as the initial point of referral. To compensate for potential biases with snowball sampling, the referral process was conducted separately for each science park and the interviewees matched by type across the cases, reflecting a theoretical sampling logic for interviewee types (Morse 1995), see Table 1. The interview question protocol is available on request from the authors.

Given the focus on MNE co-location in science parks, detailed information is provided in Table 2 for each MNE where interviews took place, showing the year the MNE presence was established, the entry/operational mode, the year the parent firm entered the Netherlands

Table 1. Overview of science parks and interview respondents.

Overview of science parks					Overview of interviewees		
		Major Research Institutes[a]					
Park	University	University	Other	Number of companies	Interview organisation	Description of organisation	Position of respondent
Amsterdam Science Park	University of Amsterdam Faculty of Science Amsterdam University College	IBED SILS ILLC IvI IOP AIP KdvI HIMS	FOM AMOLF CWI Nikhef ARCNL	120 companies: from start-ups to multinationals	MNE 1	R&D department of a manufacturing firm	Company Secretary
					MNE 2	Data centre and co-location services	Vice-President
					Knowledge institute 1	Building a bridge between research and advanced ICT	Relations manager
					Knowledge institute 2	Fundamental subatomic physics research	Institute manager
					University 1	Science faculty of the University of Amsterdam	Director Market Development
					Science park 1	Central and joint organisation of all partners of the park	Director
Leiden Science Park	University of Leiden	LIC LION LACDR IBL LIACS Leiden MI Leiden Observatory IES LUMC	LIACS LACDR NeCEN	139 companies, of which 33 are active in Biotechnology	MNE 3	Pharmaceutical manufacturing and research	Chief Executive Officer
					MNE 4	Pharmaceutical manufacturing	Director Facilities, Maintenance and Engineering
					Knowledge institute 3	Research and education in Bio-Pharmaceutical Sciences	Institute manager
					Knowledge institute 4	Enables business and government to apply knowledge	Research manager
					University 2	Leiden University Medical Centre	Director of Research
					Science park 2	The foundation responsible for enhancing the network and developing the cluster	Park manager

Utrecht Science Park	University of Utrecht Utrecht University of Applied Sciences	USI WKZ UMC	ARTEMIS CBS-KNAW Climate-KIC Deltares Hubrecht Inst. Immuno Valley IRAS NPC Pontes Medical RIVM SRON TERI TNO ULS 3Rs-Centre ULS	60 companies, of which 30 focus on Life Sciences	MNE 5	Veterinary pharmaceutical company	R&D Officer
					MNE 6	R&D department of a food company	Site Director
					Knowledge institute 5	Research focused on developmental and stem cell biology	Managing Director
					University 3	University of Utrecht	Policy officer for knowledge/technology transfer
					Science park 3	Organisation responsible for the development of the park	Director
					Science park 4		Business Development Manager

[a]Full details on abbreviations available from the corresponding author on request.

Table 2. Overview of the MNE presence in the science parks.

	Focal MNE	Year presence established in science park	Mode of establishment in science park	Year MNE parent/subsidiary established presence in the Netherlands (outside science park)	Year parent MNE established (as a whole)
Amsterdam	MNE 1	2015	Representative office	1918	1868
	MNE 2	2008	Greenfield infrastructure investment	2008	1998
Leiden	MNE 3	2009	Headquarters	1959	1959
	MNE 4	1984	Production and R&D	1984	1886
Utrecht	MNE 5	2012	Representative office	1969	1969
	MNE 6	2012	Greenfield R&D investment	1967	1967

Note: To ensure anonymity of the interviewees, sources are not provided.

and the year the parent firm was established. The age of the MNE, entry into the Netherlands and the length of time the MNE has been present in the science park did not emerge as significant explanatory factors in this study. As can be seen in Tables 1 and 2, the study includes interviewees from a diverse range of organisations, contributing to the credibility of the findings, given the consistency of our results across interviewees.

All interviews were recorded (with permission), transcribed and subsequently thematically analysed using NVivo (Ryan and Bernard 2003; Payne 2004; Saldana 2012). Interviews were conducted in Dutch by a native speaker and any translations for the purposes of this publication have been done in a spirit of active reflexive deliberation to limit any impact on the reliability of the study (Piekkari and Welch 2006). Leveraging the strengths of a deductive bottom-up case study design (Shepherd and Sutcliffe 2011), initial thematic codes for the analysis were derived from the conceptualisation of proximity, while others emerged from the data (Bourque 2004). The individual cases were first analysed separately and then a cross-case analysis was performed with a view to analytical generalisation (Eisenhardt 1989; Eisenhardt and Graebner 2007), thereby increasing external validity (Yin 2013).

5. Proximity and MNE presence in Dutch science parks

In this section, we present the findings from each focal Dutch science park in turn, followed by a cross-case analysis (Eisenhardt 1989; Yin 2013) in which we discuss the implications of the comparison of case specific insights on MNE co-location in science parks in light of the existing proximity literature.

5.1. Amsterdam Science Park

Multinational managers recognise the Amsterdam Science Park as an attractive knowledge-intensive subnational location, and provide evidence that the clustering of knowledge increases the perceived location-specific advantages of the science park (see Table 3). As Amsterdam Science Park has no clear technological or scientific focus, its membership is more heterogeneous than the other two parks. The park is associated with a strong awareness of geographic and organisational proximity and to a lesser degree social and cognitive proximity, with limited emphasis on institutional proximity.

Table 3. Analytical table for case 1 – Amsterdam Science Park.

Conceptual dimension	Main findings	Illustrative quotes
MNEs' FDI motive	• MNEs have strategic asset-seeking motives in the science park • Specifically a knowledge-seeking motive	'The science park is highly attractive for [MNE 1] because it bundles a lot of different scientific [knowledge' (MNE 1 manager)
Geographic proximity	• Difference of opinion on the importance of clustering knowledge-intensive firms and knowledge institutes • Difference between codified and tacit knowledge seems to underlie these contrasting views	'It remains to be seen what the added value of the local knowledge is [for location choice decisions]. Proximity has lost its importance now people are able to communicate in so many ways' (university manager 1) 'If you don't locate here, but try to work from your own factory or research department, you will miss the context, the feeling' and: 'you need to work together in the park in order to better articulate your questions and work towards an operational result' (science park manager 1)
Institutional proximity	• Institutional proximity is not high for the same type of organisations. • Institutional proximity is less useful than other categories for predicting the success of knowledge transfers	'The university did not really look at their problem … while one start-up did immerse itself in their problem, went over to their headquarters and asked good questions because they too are from the entrepreneurial world' (science park manager 1) 'Shell's research also came from the university once; they have never seen another way … … This is the model they have all been raised with' (science park manager 1)
Organisational proximity	• Despite high organisational proximity, MNEs do not co-locate/collaborate with each other • Despite low organisational proximity, MNEs do co-locate/collaborate with knowledge institutes/start-ups • There are no strong networks in the science park. This makes it harder to create local synergies, limiting the park's location specific advantages (LSA)	'[MNEs are] not moving here because ASML [large MNE] has a research department here' (University manager 1) 'The academic world and the business world can profit from each other' (manager MNE 2)
Social proximity	• (High) social proximity between actors is needed for effective knowledge sourcing	'The basis of local [collaboration] lies with the person and the trust he/she has in the park, the faculty and the students' (science park manager 1)
Cognitive proximity	• Cognitive proximity is needed to find and keep partners to work with • Different epistemic communities hinder knowledge-sourcing activities	'No matter whether they had a modern or classical education, work at an MNE or university, engineers will always want to talk with each other about all interesting things' (manager MNE 1) 'Attract new businesses that enter into serious research partnerships with the university and the institutes' (Science park manager 1)

Respondents were ambivalent about the significance of geographic proximity for co-locating in the science park. For them, information and communications technologies (ICT), the high mobility of individuals and temporary proximity (Torre 2008) decreased the importance of long-term co-location for knowledge-intensive firms. This is reflected by the fact that only about 10% of all firms that collaborate with other firms, institutes or the university in the science park are physically present themselves. At the same time, respondents consistently believe that spatial proximity contributes to collaboration, by improving communication and strengthening relationships. These findings echo earlier studies on geographic proximity as an enabler for other proximities (Boschma 2005) and highlight the effects of different types of knowledge transfer, e.g. the transfer of tacit knowledge may need greater spatial proximity than codified knowledge (Autant-Bernard 2001; Desrouchers 2001), though this need may be short-lived (Torre 2008). The decision of an

MNE to establish a limited presence through a representative office – a common strategy for accessing the science park – suggests that a more nuanced conceptualisation of long-term high geographic proximity for MNEs might be needed to account for the degree of commitment to the science park.

Some of the clearest patterns of relevance concern organisational proximity. Some researchers claim that MNEs prefer co-location and/or collaboration with other MNEs, as negative knowledge spillovers are believed less likely than with small local competitors (Mariotti, Piscitello, and Elia 2010). Further, MNEs usually enjoy high (structural) organisational proximity with each other, making knowledge transfer and co-creation easier (Knoben and Oerlemans 2006). However, in our study, no MNE in the Amsterdam Science Park was perceived by interviewees to have a meaningful collaborative relationship with another MNE. The situation is different with start-ups, however. Science parks are breeding grounds for start-ups and spin-offs (Felsenstein 1994), and the low-organisational proximity between MNEs and start-ups seems to spark collaboration between them and encourage MNEs to co-locate in the science park.

According to Andersson, Forsgren, and Holm (2002), (high) social proximity is needed for firms to successfully embed themselves in a science park and ensure effective knowledge sourcing. Our interviewees strongly emphasised social proximity through the consistent importance they ascribed to relationships at the individual level, especially for the establishment of interpersonal trust. There was little support, however, for the idea that the science park alone fosters social proximity between individual scientists and MNE R&D managers; scientific congresses and workshops were also seen as contributing to social proximity, suggesting another way in which temporary proximity (Torre 2008) outside of the park is significant.

Cognitive proximity (possessing the same knowledge base, being part of the same epistemic community) is also an important factor in finding and keeping partners. The Amsterdam Science Park management team actively manages the park's membership, thereby supporting the emergence of high cognitive proximity between organisations and institutions. However, at the same time, the intentional disciplinary heterogeneity within Amsterdam Science Park leads to lower cognitive proximity between different 'epistemic communities'. Interviewees thought this prevented large networks from growing (since most of the people one meets are working in a different research field), hindering successful knowledge-sourcing activities.

Institutional proximity was found to be less relevant to understanding MNE co-location at the subnational level, and interviewees tended to emphasise informal aspects. The interviews revealed differences in the norms and behaviours of actors in the park, which to some degree reflect the nature of the knowledge an organisation is producing and seeking. Differences in informal institutions were perceived as having the potential to affect the successful collaboration of an MNE with another organisation in the science park. There was, however, no clear signal as to how and why different degrees of (informal) institutional proximity would affect collaborative innovation. Some interviewees saw greater informal institutional proximity between small (start-up) firms and MNEs, when compared with informal institutional proximity between these firms and knowledge institutes. At the same time, interviewees stated that most of the MNE managers engaging with the science park had a university degree and were familiar with the way universities work. The degree to which this dimension is relevant in collaborative activity is dependent on the nature of the MNE's knowledge seeking.

5.2. Leiden Bio Science Park

Interviewees recognised the Leiden Bio Science Park as an attractive knowledge-intensive subnational location for strategic asset seeking by MNEs. Respondents in the Leiden Bio Science Park provided insights that suggest a nuanced pattern of understandings of the relevance of the five proximity dimensions (see Table 4). The strong biotechnology/biomedical life sciences focus creates a degree of homogeneity in the park's membership, with the large number of pharmaceutical firms in the park being an indication of sectoral specificity in this case.

Discussions of geographic proximity again revealed contradictory views of its importance. Although interviewees stated that co-location was not needed for cooperation, as cooperation was perceived to be 'content-based' and it was possible to work at a distance, the advantages of high spatial proximity in cooperation was nevertheless repeatedly confirmed. This paradox is arguably explained by the difference between the transfer and absorption of codified and tacit knowledge, in that this proximity dimension facilitates the latter. The associated sense of a continual search to satisfy immediate knowledge needs could also arguably point to an active search within and beyond the science park, if current knowledge needs are not sufficiently addressed within the park.

Table 4. Analytical table for case 2 – Leiden Bio Science Park.

Conceptual dimension	Main findings	Illustrative quotes
MNEs' FDI motive	• MNEs have strategic asset-seeking motives in the science park • Specifically a knowledge-seeking motive	'We knew we had to do more with R&D, thus we needed to attract more people for R&D and we also knew that would be easier in Leiden' (Manager MNE 3)
Geographic proximity	• Geographic proximity is simultaneously important and unimportant • Difference between codified and tacit knowledge underlies this paradox	'I would say that as we are located together, we strengthen each other' (manager knowledge institute 3) 'We are not specifically focussed on the Bio Science Park. We are always searching for those people that fit our needs best at that particular moment' (manager knowledge institute 3)
Institutional proximity	• Formal institutional proximity is low in Leiden, because of strict regulations and a poor tax climate • Strict laws cause a convergence in people's behaviour (high informal institutional proximity)	'I believe the decision of a multinational to locate here [or not] depends mainly on the tax climate' (manager knowledge institute 3) '[They] are part of the same industry, a very regulated industry, everyone understands each other's business a bit' (Manager MNE 4)
Organisational proximity	• Low organisational proximity influences MNEs (and knowledge institutes) when looking for collaboration partners • MNEs do not collaborate with each other within the science park cluster, despite high organisational proximity • Low 'network' organisational proximity since contacts are between individuals and are not shared organisational arrangements	'You can do a lot more with the start-ups than with the big corporations' (manager MNE 3) 'Everyone has their own field, their own expertise … It is not like we will call for help' (manager MNE 3) 'They [a large MNE] are completely autarkic' (manager MNE 3) 'The buildings here are filled with potential relevant [partners] and I experience a real buzzing network culture. Everyone knows everyone' (manager knowledge institute 4)
Social proximity	• Social proximity helps managers with *sourcing* knowledge	'First people will come from your own environment, because these people know you, they know the people who work here or they are former employees' (manager MNE 3)
Cognitive proximity	• Clear focus on research fields ensures high cognitive proximity. • High cognitive proximity ensures informal network of former employees. This increases the LSA of the park	'It does not really matter what you do, the building blocks are always the same' (manager MNE 3)

Organisational proximity plays a significant role in explaining MNE co-location in Leiden Bio Science Park. The science park managers consider it difficult to attract MNEs (see institutional proximity below) and have, therefore, focused on bottom-up growth through start-ups and spin-offs. The resulting ecosystem is attractive to MNEs, with the low (structural) organisational proximity increasing the attractiveness of co-locating in the science park. The smaller and relatively younger organisations are seen as more dynamic, with organisational practices that are different and attractive to MNEs. MNEs, however, are seen as relatively more bureaucratic and less flexible, which is reflected in a perceived absence of systematic inter-MNE collaboration, despite the expectation in the literature that those firms would have higher organisational proximity, setting the stage for successful transfer and co-creation of knowledge (Knoben and Oerlemans 2006).

At Leiden, shared organisational arrangements are perceived to reflect a higher (dyadic) organisational proximity through larger networks. But these arrangements involve larger organisations that rarely have a complete overview of the scope of their inter-organisational relationships in the park. There is some evidence to suggest that smaller organisations experience this network culture more strongly than the larger MNEs. The larger organisations gain more from the acquired informal networks of their employees (a 'talent' network) than from official networks within the park.

The above individual-level 'network culture' and perceived 'network of talent', however, cannot be classified as shared organisational arrangements, and it must therefore be concluded that organisational proximity on the dyadic level is low. These informal networks are, however, strongly related to social proximity (focussing on social- and trust-based relations), and were identified as important on a number of occasions by interviewees. Such social proximity helps with sourcing knowledge, by identifying and gaining access to relevant local knowledge that is being created.

The Leiden case provides support for the idea that the opportunity to join an 'epistemic community', offering cognitive proximity, will affect the decision of an MNE to relocate within the Netherlands to co-locate in this focused park. The 'epistemic community' in the city of Leiden covers almost the whole Bio Science Park, since all research conducted in the park involves DNA. Individuals are able to job-hop in Leiden across organisations and this dynamic contributes to the informal network structure of former employees that is so attractive to MNEs. Leiden Bio Science Park's management will not allow firms that do not fit the profile of the science park to co-locate there, which enhances the cognitive proximity between actors.

Interviewees perceived differences in informal institutions among academic and corporate actors, but at the same time observed that these actors were increasingly similar and that there were pressures for greater convergence. Boschma (2005) argues that such high informal institutional proximity can be expected to positively affect knowledge transfer. Sectoral specificity emerged concerning the role of formal institutions and MNE co-location in this biotechnology focused park: more local rules on operating licenses and zoning and more national tax rules identified as important to (biotechnology) MNEs. Equally, national regulation of drug development and testing were identified as significant; these would apply nationally and be less relevant at the subnational level. Arguably, the strict formal institutional environment for the park's focal sector creates greater informal institutional proximity among the different actors.

5.3. Utrecht Science Park

The Utrecht Science Park was recognised by participants as an attractive knowledge-intensive subnational location for knowledge seeking by MNEs. Respondents in the Utrecht Science Park, which has a strong life sciences focus, provided insights that suggest a pattern of nuanced understandings for all five proximity dimensions, see Table 5. The park features a more homogenous membership profile as a significant number of organisations are focused on life sciences and have a strong sustainability focus.

Interviewees' perceptions of the significance of geographic proximity to other knowledge-intensive organisations were mixed. Potential scientific collaborators were seen in an international light and sought out based on 'current' needs, with distance not perceived to prevent effective collaboration. In fact, the majority of collaborations were 'at a distance'. At the same time, clear benefits were associated with spatial proximity, in particular more opportunities to discuss research face-to-face. This difference in importance accorded to geographic proximity may again be related to whether respondents were more concerned with codified or tacit knowledge. There was a belief that high geographic proximity attracts more organisations in a positive feedback loop, as co-location improves the transfer of (tacit) knowledge, which attracts more organisations and reinforces the clustering of these organisations in the park. This corroborates the facilitating role argued by some authors (Boschma 2005).

Table 5. Analytical table for case 3 – Utrecht Science Park.

Conceptual dimension	Main findings	Illustrative quotes
MNEs' FDI motive	• MNEs have strategic asset-seeking motives in the science park • Specifically a knowledge-seeking motive	'Here, right in our backyard, there are a couple of really important players for us' (Manager MNE 6) 'I am able to use the expertise and know-how of different people, all located in the park' (Manager MNE 5)
Geographic proximity	• Geographic proximity is simultaneously important and unimportant • Difference between codified and tacit knowledge underlies this paradox	'We always choose partners based on our current needs … Science is international' (manager knowledge institute 5) 'Collaborations with parties that are very close are of a higher quality' (manager MNE 6) 'The more organisations locate here, the greater the energy we transmit to the outside world. Attracting even more organisations' (manager MNE 6)
Institutional proximity	• Data shows low institutional proximity • This is not seen as an insurmountable obstacle	'It is easier for some scientific disciplines to use their scientific knowledge than it is for others' (science park manager 3) 'The academic world has changed considerably … the university will increasingly seek collaborations with businesses' (manager MNE 6)
Organisational proximity	• Despite low organisational proximity, some MNEs are interested in working with small firms/start-ups • Despite high organisational proximity, MNEs do not have relations with other MNEs in the science park • There are strong organisational arrangements between organisations	'Large and small firms can really learn a lot from each other' (Science park manager 3) 'Honestly, I am fine the way things are. At the moment there is no possibility of competitors roaming around in my lab' (manager MNE 5) '[We]place a relatively large number of orders with the university, the university of applied sciences [and/or others] and thus increase the reach of their research network' (science park manager 4)
Social proximity	• Social contacts and trust in others have been one of many reasons for both MNE 5 and MNE 6 to move to the Utrecht Science Park	'Social contacts are a prerequisite for all successful partnerships' (manager knowledge institute 5)
Cognitive proximity	• High cognitive proximity attracts firms to the science park	'[We] had more affinity with the life sciences we found here' (manager MNE 5)

Responses about organisational proximity revealed a pattern where the larger (corporate) organisations showed a strong preference for co-locating to collaborate with the smaller organisations in the science park. According to interviewees, this relates to concerns about competitors (other large firms) gaining access to laboratories and also the perceived opportunity to learn from smaller firms and institutes that are not as close in terms of structural organisational proximity. This was generally perceived to be the case despite the number of large firms (or departments of large firms) in the park having sharply risen. By way of example, an MNE in the park is developing a new building in which the entire ground floor is reserved for small firms and start-ups. Thus, some MNEs in the park are quite interested in working with small firms/start-ups, despite low structural organisational proximity. In addition, notwithstanding their high (structural) organisational proximity, MNEs do not seek to develop relationships with other MNEs.

According to respondents, social proximity in the park is based on the networks of individual employees. Interviewees at both MNEs emphasised that social contacts and trust in others had been one of the (many) reasons for co-locating in the Utrecht Science Park. These included high trust relationships with existing partners, knowledge organisations in the park, park management and local government. The creation of trust-based social relationships is bolstered by the interaction of people from the scientific community and the R&D community who often meet each other at congresses and conferences. These relationships are not only based on social and trust factors, but also on shared academic and/or professional backgrounds and interests. These actors experience high cognitive proximity and this seems to attract firms to the science park. Indeed, this was given as the most important reason for many firms to relocate and was a significant driver for one MNE to move its whole R&D department to the Utrecht Science Park. The cognitive proximity of actors at Utrecht Science Park is 'safeguarded' by the park's management, which seeks to attract companies in its focal area(s) that share the same *academic* level. It should be noted that all respondents from the Utrecht Science Park work in the same focus area and do not have links with actors from other focus areas.

Informal institutions emerged as a significant focus for interviewees in explaining co-location, as the informal dimensions of organisational life often resulted in different understandings of common language being used. A difference in mindset was perceived between employees of firms and employees of knowledge institutes, specifically in the degree to which work was tied to identities and in the temporal dimensions of thinking and doing work, which can lead to differences in behavioural norms. Differences in the practices and working methods of the particular discipline were said to affect the ability to collaborate with corporate entities such as MNEs. Medical collaborations seemed to have some success in knowledge transfer activities. Interviewees perceived a certain informal institutional convergence, which increased institutional proximity and resulted in more effective knowledge transfer and thereby increased the attractiveness of the location.

5.4. Patterns of proximity in Dutch science parks

The findings from all three cases lead us to focus on geographic, organisational, social and cognitive proximities in this section. Institutional proximity has been found to be less relevant to understanding MNE co-location in science parks in all three cases. This is arguably explained by the ability of MNEs to operate across diverse and fragmented institutional

environments (Westney 2005; Kostova, Roth, and Dacin 2008) and transfer needed organisational practices via the internal MNE network (Kostova 1999).

Findings for all three science parks suggest an ambivalent understanding of the importance of being geographically proximate to knowledge 'hubs', arguably reflecting the perception that geographic proximity is neither necessary nor sufficient to enable knowledge-based collaborations (Boschma 2005; Mattes 2012). Most respondents shared the view that in an increasingly digitalised and globalised world, geographic proximity has lost its importance for successful external knowledge transfer, and instead they emphasise the importance of global search (Rosenkopf and Almeida 2003). However, respondents (often the same ones) also acknowledge that high spatial proximity to partners and other knowledge-intensive organisations facilitates the successful transfer of knowledge through practical application. These seemingly paradoxical findings may be explained by the difference between codified and tacit knowledge. Information (easily codified knowledge) may be sourced from all over the world, while the 'valorisation' of knowledge (the utilisation of scientific knowledge in practice) tends to involve tacit knowledge, which is hard to receive from a distance. This is also consistent with Porter's (2000) theory on the benefits of clustering and with the theory on the importance of geographic proximity for tacit knowledge to successfully facilitate learning and innovation (Autant-Bernard 2001; Desrouchers 2001). Our findings regarding the important role of MNE representative offices suggest that a more nuanced conceptualisation of high geographic proximity might provide a useful avenue for further integrating IB and EG research to advance our understanding of proximity and innovation. The ability of MNEs to maintain low commitment high-spatial proximity, via a representative office mode (Pan and Tse 2000; Benito, Petersen, and Welch 2009), suggests a mechanism for achieving non-spatial proximities through local MNE employees.

Our findings on the perceived influence of organisational proximity on the propensity of organisations to co-locate to initiate knowledge-based collaborations differ from those normally found in the literature (Boschma 2005; Knoben and Oerlemans 2006; Mattes 2012). According to the literature, it is easier to share knowledge when the organisational proximity of interacting parties is high (Knoben and Oerlemans 2006), and connections between organisations are mainly sustained through organisational proximity (Petruzzelli and Carbonara 2007). However, interviewees from MNEs and other organisations in the three science parks consistently articulated a view whereby MNEs do not have intensive ties with other MNEs. This suggests that the influence of organisational proximity on MNE co-location in science parks is affected by the degree of competition with potential partners, and that MNEs view smaller firms and knowledge institutes as a better choice for positive knowledge flows (Cantwell and Santangelo 2002; Mariotti, Piscitello, and Elia 2010). MNEs co-locate in all three science parks to pursue relationships with small domestic firms (start-ups and/or spin-offs), as they are perceived to have a disruptive, energetic and quicker way of thinking/working than MNEs are able to achieve (Prashantham and Birkinshaw 2008). MNEs seek access to these competences to be able to respond more effectively to new developments. Reciprocally, partnerships with MNEs (or local MNE subsidiaries) are an effective way for small firms to globalise successfully (Prashantham and Birkinshaw 2008). Significantly, low (structural) organisational proximity seems to drive collaborations rather than prevent successful knowledge-based collaboration, thereby promoting co-location, see Figure 1.

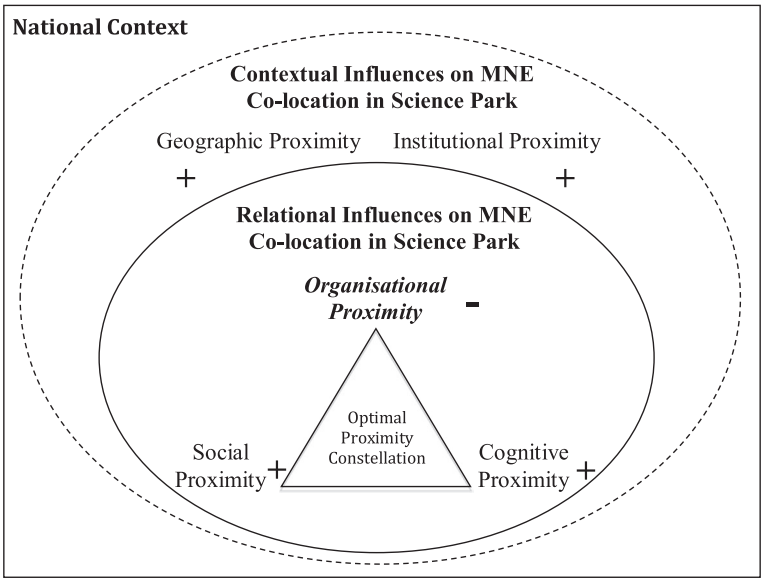

Figure 1. Model of the role of proximity in MNE co-location in science parks.

Regarding organisational proximity through shared organisational arrangements, the inter-organisational relationships (networks, dyadic level of organisational proximity) between MNEs and members of all three science parks seem to be uncoordinated and affected by bounded rationality (Simon 1991), leaving MNEs with an incomplete overview of the scope of their inter-organisational relationships in a park. The absence of a strong network structure reduces the chances for successfully sourcing knowledge.

The importance of social relationships based on trust for successful knowledge transfer and knowledge-sourcing activities has been underlined in all the cases and the findings suggest low (or medium) social proximity does not lead to (lasting) knowledge-intensive collaborations, making co-location less likely, see Figure 1. High cognitive proximity seems to be a given in the setting of a science park, see Figure 1, reflecting the fact that the management teams at all three science parks actively select new entrants, assessing the profile of the organisation, its knowledge base and relationships with other organisations in the park. However, it should be noted that only the Leiden Bio Science Park has a somewhat clear focus on one theme. The Utrecht Science Park focuses on two broad themes (sustainability and life sciences/health) and the Amsterdam Science Park has organisations in the fields of IT, life sciences, advanced technology and sustainability. Having different focus areas prevents large networks from growing, thus hindering successful knowledge-sourcing activities.

Our findings respond to the need to develop more dynamic understandings of social and cognitive proximity (Balland, Boschma, and Frenken 2015) by revealing the importance of temporary proximity (Torre 2008) outside the science parks in strengthening these dimensions of proximity. These findings arguably reveal an interesting mechanism for decoupling social relationships from organisations in the science parks and reinforcing cognitive proximity via a larger temporary spatial aggregation of epistemic communities beyond the science parks, for example through conferences.

6. Concluding remarks and implications

This study set out to gain a better understanding of the role of proximity in MNEs' co-location in knowledge-intensive subnational spatial clusters. Our research builds on the literature concerning clusters (Porter 2000), (subnational) knowledge transfer (Mariotti, Piscitello, and Elia 2010) and, crucially, the concept of proximity (Boschma 2005; Balland, Boschma, and Frenken 2015). Importantly, our findings show almost no variation in emphasis on the nature and effects of the proximity dimensions across the three major Dutch science parks.

Our findings suggest that MNE co-location in science parks is best understood as a strategy that seeks to exploit low organisational proximity with smaller firms and knowledge institutes to achieve positive knowledge flows from collaboration and/or knowledge sharing. Small firms/start-ups are seen as offering a different, more energetic and disruptive way of thinking, reflecting the importance of heterogeneity for innovation (Mattes 2012). This low organisational proximity emerges in an 'optimal' proximity constellation with high social and cognitive proximity, see Figure 1, allowing MNEs to exploit the low organisational proximity. MNEs seem to manage the ambiguous role of geographic proximity via the low commitment entry/operating mode of a representative office. Representative offices create a long-term spatially proximate presence that can accumulate the necessary social and cognitive proximity, which can be exploited as and when it is needed to access codified and tacit knowledge (Autant-Bernard 2001; Desrouchers 2001). This is a possible variation of the facilitating role of geographic proximity (Boschma 2005). Finally, institutional proximity did not play a significant role in explaining MNE co-location in the science parks.

6.1. Opportunities for future research

We identify two MNE specific foci for future research about co-location in knowledge/innovation intensive subnational locations, specifically science parks. Firstly, there is a need to better understand the relationship between the degrees of commitment to subnational locations when MNEs co-locate, our study suggests that low levels of commitment are sufficient, as evidenced in the extensive use of representative offices. Secondly, there is evidence that MNEs are able to collaborate with organisations without being present in the science parks and that this is explained by the suggested optimal proximity constellation. How this specifically works and the effectiveness of such collaboration was not covered in our study and future research should compare this to co-location strategies.

6.2. Research limitations

One limitation of the study is the different backgrounds of the MNE managers interviewed. While all the MNEs are knowledge-intensive firms, they operate in a wide variety of markets, focus on different parts of the production process and have relocated within the Netherlands or have moved to the Netherlands. These differences may influence the importance accorded to the dimensions of proximity. Additionally, the relatively small number of interviewees for each type of organisation (knowledge institutes, MNEs, university and science park management) limits our study to theoretical generalisation. The theoretical generalisation of the study's findings is further limited by the unique nature of the focal country, the

Netherlands, which is widely recognised as a small open economy, featuring a highly educated and multilingual workforce. Finally, this paper only looks at MNEs that have already co-located in a science park; MNEs outside knowledge clusters may well perceive proximity to be less important than the MNEs that are part of this study.

6.3. Scientific relevance and managerial implications

There is clear evidence to support the EG concept of proximity as relevant to International Business (IB) scholarship, and this study provides one initial response to calls for more interdisciplinary work (Cantwell and Brannen 2011). Proximity may prove a useful complement/alternative to the established concept of distance in IB research (Ghemawat 2001; Hutzschenreuter, Kleindienst, and Lange 2015). Investigating the conditions under which these concepts might prove most useful would allow scholars to explore not only how differences at the national but also the subnational level of analysis matter to MNEs.

Our findings are also relevant to policy-makers and managers concerned with knowledge-intensive clusters and/or boosting the knowledge-intensive economy. There is a need to invest in, support and promote start-ups and small firms in order to attract MNEs to knowledge-intensive clusters, like science parks, with a view to creating synergies. It is important for managers and policy-makers to understand the effects of the degree of focus of science parks (or other knowledge-intensive clusters), as the focus on a limited number of research fields increases cognitive proximity, which supports knowledge transfer processes and the creation of synergies – adding to the attractiveness of the location.

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Appendix 1. The proximity concept and its MNE relevance

Table A1. Proximity dimensions' definitions, strengths and weaknesses and MNE relevance.

	Definitions and key dimensions	Adaptation[a] of Steinmo and Rasmussen (2016, Table 1 on p. 1252)		Multinational enterprise (MNE) interpretation/ relevance
		Strengths	Weaknesses	
Geographic	Geographic proximity is the degree to which actors are co-located in geographic space. Geographic proximity is associated with higher innovative performance (Audretsch and Feldman 1996) • Spatial distance (Boschma 2005) • Agglomeration (Balland, Boschma, and Frenken 2015)	• Brings people together and makes knowledge transfer easier (Boschma 2005) • Has a positive impact on the establishment of collaborations because frequent interaction enables firms to allocate resources to more complex learning processes (Cassi and Plunket 2013)	• Proximate partners can be a source of mistrust because they feel threatened in local markets (Ben Letaifa and Rabeau 2013) • Plays a role in the establishment of collaboration, but a minor role in subsequent collaborations (Cassi and Plunket 2013) • Excessive geographic proximity may weaken innovation performance and impede responses to new developments (Boschma 2005)	• MNEs' asset-seeking foreign direct investment seeks access to (new) knowledge-based firm-specific advantages (Dunning 1998, 2009) • MNEs prefer to agglomerate with organisations that will produce positive knowledge externalities (Cantwell and Santangelo 2002; Mariotti, Piscitello, and Elia 2010) • MNE entry modes differ in their degree of initial commitment to geographic proximity (Pan and Tse 2000)
Institutional[a]	Institutional proximity is the macro-level Northian (1991) distinction between informal institutions (taboos, customs, traditions, norms and ethical values and codes of conduct) and formal institutions (laws, property rights, constitutions) (Boschma 2005) • Trust (based on formal and informal institutions) (Boschma 2005) • (de)institutionalisation (Balland, Boschma, and Frenken 2015)	• *An effective predictable (stable) legal system (ownership and property rights) provides a formal source of trust enabling economic coordination and interactive learning* (Boschma 2005) • *A shared (informal) culture of trust supports learning and innovation* (Boschma 2005) • *Institutional openness (new entrants) and flexibility (experimentation with new institutions) contributes to knowledge sharing and innovation* (Boschma 2005)	• *Institutional interdependencies may lead to inertia that prevents learning and innovation* (Boschma 2005) • *Inward-looking (formal and informal) institutional constellations may prevent new entrants* (Boschma 2005) • *Institutional rigidity (excessive stability) prevents experimentation with new institutional arrangements that could support innovation* (Boschma 2005)	• MNEs address macro/formal institutional conditions first through the entry mode (Meyer et al. 2009) and later operation modes (Benito, Petersen, and Welch 2009) • MNEs are able to transfer informal institutions (logics/working practices) to local units via the MNE network (Kostova 1999) • Unless MNE subunits become isolated (Monteiro, Arvidsson, and Birkinshaw 2008), the intra MNE network serves as a counterbalance to excessive institutional proximity (Kostova and Roth 2002)
Organisational	Organisational proximity is 'the extent to which relations are shared in an organisational arrangement, either within or between organisations' (Boschma 2005, 65) • Control (Boschma 2005) • Integration (Balland, Boschma, and Frenken 2015)	• Closer connections between firms foster collaboration and knowledge spill-over (Balland 2012) • Firms' knowledge bases are more readily available to collaborative partners (Balland 2012) • Has a positive effect on establishing collaborations (Cassi and Plunket 2013)	• Excessive organisational proximity may undermine learning and innovation because of a lack of flexibility (Boschma 2005) • Poses a risk of being closed to specific relationships, which may hinder access to other sources of useful information (Boschma 2005) • Interactive learning is rare in bureaucratic systems (Boschma 2005)	• MNE entry modes differ in their degree of control in initial organisational proximity (Pan and Tse 2000) • Adjusting their mode of operation over time (Benito, Petersen, and Welch 2009) allows MNEs to manage subunit organisational proximity • Unless MNE subunits become isolated (Monteiro, Arvidsson, and Birkinshaw 2008), the intra MNE network serves as a counterbalance to excessive organisational proximity

(*Continued*)

Table A1. (*Continued*).

	Definitions and key dimensions	Adaptation[a] of Steinmo and Rasmussen (2016, Table 1 on p. 1252)		Multinational enterprise (MNE) interpretation/ relevance
		Strengths	Weaknesses	
Social	Social proximity captures the degree of trust (based on experience, friendship and/or kinship) based on the relationships between individual members (actors) of different organisations (Boschma 2005; Balland, Boschma, and Frenken 2015) • Trust (based on social relations) (Boschma 2005) • Decoupling (Balland, Boschma, and Frenken 2015)	• The social embeddedness of firms fosters interactive learning and innovation (Boschma 2005) • Facilitates the trust needed for effective collaboration (Boschma and Frenken 2009) • Social proximity makes communication and collaboration easier, as trust and mutual commitment are built when people know each other (Ben Letaifa and Rabeau 2013)	• *Excessive social proximity may lead to deception in social relationships because of the risk for opportunism in closed communities of people* (Ben Letaifa and Rabeau 2013) • Risk of opportunistic behaviour: overly close social relationships may produce negative results for calculating actors (Boschma 2005) • Close social networks may lock out other people with new ideas (Boschma 2005)	• Local MNE managers will vary in their networking capabilities (Luo 2002) • Unless MNE subunits become isolated (Monteiro, Arvidsson, and Birkinshaw 2008), the intra MNE network serves as a counterbalance to excessive social proximity (Kostova and Roth 2002)
Cognitive	Cognitive proximity refers to the extent to which actors share an absorptive capacity and potential for learning as a result of having the same knowledge base (Boschma 2005; Balland, Boschma, and Frenken 2015) • Knowledge gap(s) (Boschma 2005) • Learning (Balland, Boschma, and Frenken 2015)	• Facilitates effective communication (Boschma 2005) • People with a shared knowledge base may learn effectively from each other. (Nooteboom 2000) • Similar technical language is important for innovation (Huber 2011)	• Excessive cognitive proximity may weaken learning and innovation, as interactive learning requires complementary knowledge (Boschma 2005) • A high level of cognitive proximity may hinder firms' ability to exploit new knowledge, as they are often in the same paradigm (Nooteboom 2000)	• To foster innovation, firms need to widen cognitively by also establishing networks outside the region (Boschma and Iammarino 2009) • Unless MNE subunits become isolated (Monteiro, Arvidsson, and Birkinshaw 2008), the intra MNE network serves as a counterbalance to excessive cognitive proximity (Kostova and Roth 2002)

[a]This table has been adapted from Steinmo and Rasmussen (2016), by adding a succinct definition of the proximity dimensions in column 2, largely adopting and adapting (in italics for significant changes) the strengths and weaknesses summarised by Steinmo and Rasmussen (2016), and adding a multinational enterprise interpretation in the final column. The institutional proximity strengths and weaknesses (*in italics*) have been added to the original content of Steinmo and Rasmussen (2016).