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The role of R&D resource commitment in accessing co-location advantages

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ABSTRACT

In a globalized economy, multinational enterprises (MNEs) pursue competitiveness through cross-border knowledge exploitation and exploration in international R&D. It is conventionally assumed that for subsidiaries to effectively access co-location advantages in knowledge milieus abroad, high levels of resource commitment are required. This paper analyses the relationship between resource commitment and access to co-location advantages, first theoretically and then through a case study of two MNEs in high-tech industries. We disaggregate the composite concept of resource commitment and demonstrate the dimensions accentuated, respectively, by the resource-based view, transaction cost economics and institutional theory. Next, we analyse the relationship between resource commitment and co-location advantages for 11 R&D subsidiaries of the two MNEs. Based on this analysis, we discuss the relationships between the empirical findings and the theoretically differentiated resource commitment dimensions. The study finds that high resource levels are less important for access to co-location advantages than conventionally assumed, while the level of commitment associated with allocated resources appears consistently to be important, lending more support for the relevance of institutional theory-related dimensions of resource commitment than the resource-based view-related ones. We also find support for the claim that more flexible governance arrangements promote access to co-location advantages in asset exploration.

1. Introduction

Access to external local knowledge and the ability to absorb it are of critical importance to the innovative performance of multinational enterprises (MNEs) (Chesbrough, 2006; Figueiredo and Brito, 2011; Laursen and Salter, 2006; Perri et al., 2017). To access and absorb local knowledge, MNEs are required to mobilize internal or relational assets and commit them over time. When innovation processes involve external partnerships, crucial trust and legitimacy can be strengthened by a parent company that mobilizes and commits sufficient amounts of resources to the endeavour (Kuemmerle, 1997; Mellahi et al., 2016; Wagner and Bukó, 2005). R&D units that do not receive such resource commitments are argued to be less able to access so-called co-location advantages: advantages gained from the access to intangible (localized knowledge) and tangible (e.g., equipment, shared facilities) resources of local actors. On the other hand, ceteris paribus, firms have a general interest in reducing resource commitment to maintain efficiency and flexibility. Hence, aligning resource commitment with effectiveness, efficiency and flexibility of innovation processes and the contingent trust and legitimacy with external partners is a major strategic challenge in organizing international R&D.

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It is conventionally assumed that to be successful, international R&D requires relatively high levels of resource commitment (Kuemmerle, 1997; Perri, 2015). However, some MNE R&D units seem to be able to access local knowledge/resources by adopting low resource commitment configurations (le Duc and Lindeque, 2018; Gollnhofer and Turkina, 2015; Li and Xie, 2016) and many MNEs successfully operate small R&D units (ranging from 2 to 25 people, indicating low resource commitment) that are relatively flexible. Examples of such units in the literature are listening posts (Gassmann and Gaso, 2004, 2005), monitoring units (UNCTAD, 2005), sensing units (Patel and Vega, 1999), innovation labs, or innovation antenna (Onetti and Marinucci, 2017). Considering the inherent limit to firm resources and the differences in resource commitment to MNE R&D units, it is of interest to better understand how differences in resource commitment influence the access of MNE R&D units to local knowledge/resources, especially considering the critical importance of such local knowledge for MNEs (Gammelgaard et al., 2012; Perri et al., 2017). Considering the above, this paper seeks to answer the following research question:

How does MNE R&D unit resource commitment explain access to co-location advantages?

The literature rarely specifies concretely what constitutes resource commitment or why and how it is important. We contribute to better specifying and disaggregating the concept of resource commitment and its relationship with co-location advantages by observing it through three theoretical lenses: the resource-based view, transaction cost economics, and institutional theory. Each theoretical perspective focuses on different aspects and accords them with different significance. By implication, heterogeneity in cognitive, normative and valuative dispositions towards these perspectives, at the levels of organizations and managers, is likely to produce different governance and resource commitment preferences and modalities for international R&D. We show that resource commitment has substantive, transactional, and institutional dimensions and that the relationship between resource commitment and co-location advantages is approached differently in the resource-based view, transaction cost economics and institutional theory.

We combine a theoretical discussion of resource commitment dimensions with findings from a qualitative, embedded, multiple-case study research design. Data were collected by interviewing R&D managers from two companies, both large MNEs from small developed-market countries (Sweden and Denmark) that produce high-tech equipment and sell it to other companies. R&D managers from both headquarters and eleven R&D units, each with its own resource commitment position, were interviewed.

The findings suggest that the influence of an R&D unit's resource level on its access to co-location advantages is less important than previously reported and seems to be affected by the R&D unit's commitment level. This lends more support for the institutional theory-related dimensions of resource commitment than the resource-based view-related ones. We also find support for the claim that more flexible governance arrangements of R&D units promote access to co-location advantages in asset exploration. These findings contribute additional insights to the ties between organizations (in terms of their establishment and effectiveness), which may help scholars to better understand MNE behaviour. These findings also contribute to literature that emphasizes the relationship between resource commitment and firm insidership in local networks (Johanson and Vahlne, 2009; Vahlne and Bhatti, 2019; Valentino et al., 2018). Lastly, the findings may provide policy-makers new insight regarding the type of MNE activities that would both benefit from and deepen the potential of networks they are trying to establish in their country/region.

The next section discusses co-location advantages and how the resource-based view, transaction cost economics and institutional theory each accentuate different dimensions of the concept of resource commitment. Next, the study's research design is described (Section 3), before the cross-case findings are presented (Section 4). The study concludes with a discussion of these findings and their implications.

2. Resource commitment dimensions and co-location advantages

To be successful, R&D internationalization involves resource-, transaction- and institution-related dimensions. Correspondingly, resource commitment has substantive, transactional, and institutional dimensions. It can arise from a firm's internal allocation of assets, e.g., investment in (specialized) equipment. It can also arise from durable governance arrangements established to manage costs and risks in transactions across firm boundaries, e.g., contracts, joint ownership, or putting-out systems. Finally, the regularization of norms, values and routines through recurrent (value-adding) external interaction involves both application and commitment of resources. Or more succinctly, resource commitment is manifested in assets, governance arrangements and external relationships. The overall resource commitment is constituted by the combination of these types of commitment.

In the following, we first define co-location advantages, which are argued to be a special subgroup of location advantages, and then consider the constitution of the relationship between resource commitment and co-location advantages in the context of R&D internationalization for three theoretical perspectives: the resource-based view, transaction cost economics, and institutional theory.

2.1. Co-location advantages

MNEs are organizationally and spatially complex systems with the ability to take advantage of differences in availability, quality, and price of location-bound assets (Dunning, 1977). Location-bound assets are a set of characteristics associated with a location, and thus external to the firm, and may be resources, formal and informal institutional structures, or other location-specific factors (Dunning, 1988, 1993, 2001; Singh and Kundu, 2002). Location-bound assets that are relevant to a firm are also referred to as location or 'L' advantages (Dunning, 1977, 1979).

Co-location advantages are a special type of L advantages, as they are derived from their spatial proximity to other actors such as institutes of higher education, research institutes, or other firms. More specifically, co-location advantages are gained from the access

to assets of local actors, both intangible (localized knowledge) and tangible (e.g., equipment, shared facilities). Access to local knowledge is often equated to the concept of local knowledge spillovers, which occur when localized knowledge leaks beyond a local actor's organizational boundaries and is internalized and used by other local actors (Perri, 2015). The term makes no distinction between flows that are the outcome of free sharing agreements, economic transactions, or some agent's failure to secure the outcome of their own innovation efforts (Breschi and Lissoni, 2001). The latter may cause harm and may therefore represent a co-location disadvantage (Alcácer, 2006; Perri et al., 2013; Santangelo, 2012). Access to the indivisible goods of local actors (which may lower costs and/or risks) also constitutes a co-location advantage.[1]

Co-location advantages are only available to those that have invested time in a location to acquire knowledge of institutions and actors (Forsgren et al., 2005; Narula and Santangelo, 2009; Tallman et al., 2004). That is, benefitting from proximate innovation network relationships requires intentional investments in such relationships (Maskell, 2002) and building up relationships with proximate actors (analogous with trust and relational capital) is time-consuming and expensive. However, once created, these relationships can be maintained at a low marginal cost (Mudambi et al., 2018). Since co-location advantages mainly stem from the development of local relationships, being co-located does not automatically result in meaningful co-location advantages (Lorenzen, 2007; Maskell and Lorenzen, 2004; McCann and Mudambi, 2005).

The investments needed to access and exploit co-location advantages seem to be highly related to the concept of 'network insidership'. It is argued that local firms are better positioned to access L advantages as they are 'insiders' in the local network. Their 'insidership' provides them with significantly more market power compared to foreign firms (Hennart, 2012). Foreign firms may be able to achieve an advantageous local network position, but this is assumed to be a slow process requiring social relationships (Johanson and Vahlne, 2009). While both co-location advantages and 'network insidership' are associated with investments in local relationships, there are two differences: (1) access to 'regular' L advantages requires agency from the firm; access to co-location advantages requires agency from both the firm and at least one other local actor. Moreover, (2) 'network insidership' only enables a levelling of the playing field to access 'regular' L advantages in relation to other firms in a location, while investing in specific relationships in order to benefit from co-location advantages differentiates firms, as not all firms are equally well connected (Bathelt, 2005; Giuliani, 2007; Uzzi, 1997).

In the following sections we analyse how the relationship between resource commitment and co-location advantages is perceived differently when observed with the resource-based view, transaction cost economics and institutional theory, respectively.

2.2. Resource-based view

The resource-based view of the firm emphasizes firm-internal resources, broadly perceived, as the central enabler and constraint of firm evolution and hence the central role they play in firm strategies, growth and competitive advantage (Barney, 1991; Grant, 1991; Penrose, 1959; Wernerfelt, 1984). Firms are defined by their resources; their competitiveness, growth and survival hinge on safeguarding and refining them. Resource heterogeneity across firms produces distinct rent-creating potentials and path dependencies. Resources are diverse, e.g., physical, human, and financial (Barney, 1991) as well as technological and reputational (Grant, 1991), tangible vs intangible, property-based vs knowledge-based (Miller and Shamsie, 1996), and regular vs higher-order, the latter enabling integrating, building and reconfiguring resources over time (Teece et al., 1997). The firm itself is often perceived as a bundle of resources.

Applying a resource-based perspective to resource commitment for the internationalization of corporate R&D highlights resources as both means and ends: resources are the central driver/rationale of R&D internationalization, whether it is motivated by exploiting existing strengths abroad, further refining or complementing existing resources, or acquiring or developing resources that are lacking, and whether the resources deployed or sought are tangible assets or intangible routines or practices. As a means, the process of R&D internationalization aims to augment the size or value of firm resources by identifying opportunities and capturing them by allocating resources and bundling them with complementary locational assets. Yet, committing resources represents both assets, liabilities and imperatives: to generate value locally, whether through exploration or exploitation, invariably requires a certain investment of resources. Given value-generating opportunities through the bundling of firm resources with local assets, the firm benefits from committing resources. At the same time, commitment introduces opportunity costs, sunk costs and rigidities as the firm forecloses alternative future growth opportunities, particularly when path dependencies are pronounced.

Within RBV, the primary focus is on the assets R&D internationalization is intended to acquire or augment, and on requisite initial resource provision and further acquisition, augmentation and opportunity generation through bundling with local complementary resources, while less focus is on external relationships. In this sense, RBV is more concerned with the resource than the commitment dimension of resource commitment.

2.3. Transaction cost economics

Observing resource commitment from the perspective of transaction cost economics (TCE) accentuates other dimensions. TCE

[1] Sometimes other agglomeration externalities, besides knowledge spillovers and the sharing of goods, are also referred to as co-location advantages. These include the availability of specialized inputs (services, infrastructures) or the presence of skilled labour due to the co-location of many actors. However, we consider these to be 'public goods' L advantages, as access to them does not require the development of particular relationships.

enables analyses of governance choices based on the relative costs of interacting in markets vs. hierarchies, including analyses of the existence of the firm (Coase, 1937; Williamson, 1975, 1985, 2000). It is reductionist in the sense that it considers institutions to be fully reducible to underlying economic principles and the firm is often perceived as a nexus of contracts. Behaviourally, TCE assumes bounded rationality and often-contested opportunism (Alchian and Woodward, 1988; Conner and Prahalad, 1996; Donaldson, 1990; Foss and Weber, 2016). The governance form that prevails for a given transaction is contingent on its frequency, uncertainty, and asset specificity.

Much of the strength of TCE resides in its succinct and parsimonious specification, which concurrently limits its scope. Hence, with its (unilateral) focus on cost, efficiency, risk mitigation and control, it has little to say about value creation (Zajac and Olsen, 1993). It is widely argued that its behavioural assumptions may imply governance forms that do not properly incentivize learning, innovation and creativity (Bartlett and Ghoshal, 1993; Conner and Prahalad, 1996; Ghosal and Moran, 1996; Madhok, 2002; Mayer and Argyres, 2004). Its delimitation to transactions and their governance, rather than value-adding activities, facilitates only a partial outlook on the internationalization of corporate R&D and resource commitment, as it applies mainly to activities that involve transactions.

Hence, as opposed to RBV, TCE has little to say about the ends of R&D internationalization. Rather, presupposing the ends, it offers certain insights on the means. Transactions, internal as well as external, are costly and expose the firm to contracting and appropriability hazards, so fewer and cheaper transactions are better and entail less risk. This is, however, only a partial perspective on the value creation potential of international R&D, which can require frequent and rich interaction, especially when it is collaborative. In TCE, transactions that are frequent, uncertain and involve specific assets should be internalized rather than be relational. This would disfavour, for example, instances where assets are mutually developed through incremental co-specialization. Asset-augmenting international R&D is usually expressly collaborative and, particularly when it involves radical and basic R&D, can require frequent, highly uncertain interactions and joint investments in assets whose alternative uses, or uses altogether, are often opaque. In fact, R&D expenditures are usually considered sunk costs (Stiglitz, 1987), which in turn are specific assets, and hence TCE would generally underscore the benefits of internalizing such activities. Thus, the transactions and relationships promulgated by TCE, while supporting efficiency, control, and risk reduction, may be less conducive to asset augmentation than to exploitation.

In TCE, resource commitment emerges mainly as a liability since asset specificity, assuming bounded rationality and opportunism, brings about unforeseeable risks and costs. TCE focuses on the costs of transacting at the expense of the benefits, e.g., learning and innovation. Pertaining to firms' R&D internationalization, failures in markets for knowledge have a prominent place in explaining firms' boundary choices in units abroad (Buckley and Carter, 1999; Kogut and Zander, 1993; Teece, 1998). In other words, in a TCE perspective, knowledge-related activities abroad primarily emerge as costly and risky, both of which incentivize firms to internalize.

Presupposing value-enhancing outcomes of activities, TCE is concerned with how governance forms such as hierarchies, contracts or hybrids can be devised unilaterally in ways that reduce costs and risks for given transactions. Resources and their augmentation, especially jointly, are not a main concern and more weight is attached to the commitment dimension of resource commitment, mainly as a liability.

2.4. *Institutional theory*

Unlike RBV and TCE, institutional theory (IT) is not a single theoretical approach but comprises an eclectic set of perspectives that emphasize the importance of institutions in economic activities (DiMaggio and Powell, 1983; Meyer and Rowan, 1977; North, 1990; Scott, 1995). In International Business (IB), IT typically focuses mainly on institutions in a firm's environment and economic activities are perceived as a nexus of relationships. In a broader conception, IT includes firm-internal institutions, in which case IT becomes a superset encompassing (most of) RBV and (all of) TCE, even though TCE operates with institutions primarily as explanandum and IT as explanans. The breadth of the concept of institutions contributes to both the appeal and the intractability of IT approaches. In institutional theory, social life is mediated by institutions, which are emergent and irreducible to any underlying plane. North (1990) considers institutions 'humanly devised constraints that shape human interaction' but in terms of definition, it is perhaps easier to consider the inverse, what institutions are not: institutions are not phenomena, which are non-anthropocentric (e.g., a material good), non-relational (e.g., a person's capabilities), or non-regularized (e.g., random or one-off).

Hence, an institutional perspective on resource commitment tends to focus on a firm's external relationships, and the often intangible but also tangible assets invested in them. The intent to institutionalize external relationships supporting the acquisition, exploitation or development of assets is often an important goal of international R&D, particularly of augmentative R&D, perhaps even the most pervasive one. The literature identifies institutions as an important enabler of successful performance outcomes in international R&D (Doh et al., 2005; Inkpen and Tsang, 2005; Li and Xie, 2016). Successful collaboration or co-specialization with local agents, particularly in R&D activities that often do not lend themselves well to formalization or contracting, is promoted developing relatively stable and durable relationships.

While both formal and informal institutions are crucial to all business activities, informal institutions assume relatively greater importance when formal institutions do not apply well (Gollnhofer and Turkina, 2015). This is the case in R&D, for example, particularly in explorative and more basic R&D, where activities cannot easily be formalized and are more prone to institutional voids and market failures (not least information and coordination failures, and appropriability issues). Achieving successful outcomes in international R&D is hence promoted by investment in local embeddedness, legitimacy, and norm and trust formation (Zaheer and Venkatraman, 1995), which are inherently long-term and durable, and accumulate into social capital (Putnam, 1993). Legitimacy derives partly from adaption to the local environment through isomorphic pressures (Meyer and Rowan, 1977; Zaheer, 1995), which can in turn produce tensions between internal and external embeddedness (Andersson and Forsgren, 1996; Zanfei, 2000).

While a few assets relevant for international R&D can be acquired in spot transactions, the significant assets firms aspire to obtain

and develop through R&D internationalization are usually institutions themselves, or are preconditioned by institutions and institution-building as indispensable enablers. With learning and trust-building, successful institutionalization promotes effectiveness and efficiency and can substitute for formal contracting (Poppo and Zenger, 2002; Ring and van de Ven, 1992), even at greater efficiency (Dyer and Singh, 1998; Gulati, 1998). On the other hand, institutionalization processes are complex, uncertain and potentially costly, and can also lead to overembeddedness and ensuing rigidities and inflexibilities (Granovetter, 1985; Uzzi, 1997). With its focus on regularization of interactions across firm boundaries without presumptions of specific (resource-related) rationales, IT is more focused on the (bi- or multilateral) commitment dimension of resource commitment, as antecedent as well as outcome. Table 1 presents an overview of the three theoretical perspectives on co-location resource commitment.

The above sections show that each theoretical perspective accentuates a different dimension of resource commitment. As both an imperative and an outcome of successful R&D internationalization, RBV accentuates resources that are the rationale for internationalization; IT the relationships involved in creating, deploying and maintaining them; and TCE ways of organizing the firm and its relationships efficiently. Having established theoretically distinct dimensions in the relationship between resource commitment and access to co-location advantages, we proceed to empirically investigate the impact of resource commitment on this access. The next section explains the data collection method and subsequent approach to the analysis, after which the findings are presented.

3. Data and methods

A qualitative, embedded, multiple-case study research design (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Piekkari et al., 2009; Yin, 2013) has been adopted. This design is well suited for this exploratory study, which seeks to understand the relationship between resource commitment and access to co-location advantages. Reflecting IB disciplinary convention (Piekkari et al., 2009), the case study design tends towards a more post-positivist positioning (Guba and Lincoln, 2005). This paper follows a 'deductive bottom-up theorising' approach (Shepherd and Sutcliffe, 2011), which favours a sound a priori conceptualization of the main constructs (Gioia and Pitre, 1990; Ridder et al., 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 generalization (Yin, 2013).

A literal replication logic (Yin, 2013) was used to select two companies for intensive study. Both are large MNEs that produce high-tech equipment, both are business-to-business companies, and both are headquartered in small, developed-market countries (Sweden and Denmark). These characteristics are linked to strong R&D internationalization (Gammeltoft, 2006; Gerybadze and Reger, 1999), which increased the likelihood of identifying at least one R&D unit for each resource commitment configuration. Despite following a literal replication logic, the case companies do differ in their locations, products, and knowledge base, as is typical for case research.

R&D units (embedded units of analysis) were selected within each company following a theoretical replication logic (Yin, 2013)

Table 1
Theoretical perspectives on co-location resource commitment.

	RBV	TCE	Institutional theory
Explanans	Firm-internal resources and routines; heterogeneity; exploitation and augmentation of firm resources; firm growth	Transaction costs; economic efficiency; market imperfections; incentive alignment	Extra-firm institutions (cognitive, normative, regulative; formal vs informal/distant vs proximate); institutional failure/voids; embeddedness
Explanandum	Spatial resource distribution; operation modes	Firm governance forms; corporate governance; market vs. hierarchy; operation modes	Legitimacy; isomorphism; firm behaviour
Ontology			
Firm	Resource and revenue growth; profit maximization	Efficiency	Co-evolution
Agency	Bounded rationality; asymmetric information	Bounded rationality; uncertainty; asymmetric information; moral hazard, opportunism	Collective rationality; bounded rationality; imperfect information
Theories	OLI paradigm; resource-based view/ knowledge-based view; ownership advantages; resource dependence theory	Transaction cost economics; internalization theory; agency theory; capital market theory	New institutionalism; institutional economics; innovation system; cluster theory; economic history
Resource commitment			
Ontology	Resource augmentation Complementarity/synergy	Liability	Relational asset
Imperatives	Resource bundling	(Discrete agent) exchanges; incentive alignment	Socialization; co-evolution
Assets	Resource augmentation and acquisition	–	Trust; differentiation; efficiency
Liabilities	Commitment costs; resource dependency; path dependency	Costs and risks of opportunism and asset specificity	Over embeddedness; lock-in; determinism
Example studies	(Bercovitz et al., 1996; Hutzschenreuter et al., 2007; Kuemmerle, 1997; Mellahi et al., 2016; Wagner and Bukó, 2005)	(Brown et al., 2000; Grover and Malhotra, 2003; Heide and Stump, 1995; Klein et al., 1978; Lui et al., 2009; Parkhe, 1993; Rokkan et al., 2003; Wang, 2002)	(Bureth et al., 1997; Heide and John, 1990; Kang et al., 2009; Larson, 1992; Lin et al., 2012; Lui et al., 2009; Parkhe, 1993; Perri, 2015; Perri and Andersson, 2014; Uzzi, 1997; Yoshino and Rangan, 1995; Young-Ybarra and Wiersema, 1999)

based on differences in both resource levels (high/low) and commitment levels (high/low) (see Table 2). What constitutes a high or low resource level is based on the tangible and intangible resources (financial, physical, and human resources) that are allocated to an R&D unit, accounting for the relative size of the allocation to the size of a firm's global R&D network. After all, an R&D unit of 15 people may be a relatively large investment for some MNEs, while this is a minor investment for firms with multiple large R&D centres around the world. The level of commitment is based on the irreversibility of deployed resources (resulting in sunk costs) (Ghemawat and Del Sol, 1998; Williamson, 1985). Commitment levels are often measured by asking interviewees directly about the extent to which investments lose value if they are re-deployed (Pedersen and Petersen, 1998; Randøy and Dibrell, 2002; Tan et al., 2007). Other common methods are determining the number of years a company is active in a location (Petersen and Pedersen, 1999) or determining the annual change in R&D expenditure (Neelankavil and Alaganar, 2003). See Table 3 for a more detailed overview of commitment measures.

For the purpose of the analysis, we abstract combinations of resource and commitment levels into just four categories: 'low resource/low commitment', 'low resource/high commitment', 'high resource/low commitment' and 'high resource/high commitment'. While this is a somewhat crude reduction of the conceivable variance, it allows for a conceptually more clear analysis. The limited number of R&D unit cases in the analysis also constrains achievable granularity. The selection and first assessment of the resource and commitment levels of R&D units was based on exploratory interviews with R&D managers at the headquarters of both companies and an analysis of publicly available information about the R&D activities of the companies. Only explorative R&D units were selected, as the potential of co-location advantages is more important to such units than to exploitative R&D units. Exploitative R&D activities are often subordinate to the MNE's market-seeking activities (although some exploitative activities are efficiency-seeking). They follow the location of other MNE activities, such as production and sales (Narula and Santangelo, 2012). It is important to note, however, that the distinction between exploitation and exploration is often a matter of degree and should therefore be viewed as a continuum: R&D units rarely employ only one or the other (Criscuolo et al., 2005; Gammeltoft, 2006).

Data were collected through semi-structured interviews, ensuring that key topics were covered while allowing themes to emerge, in conversation, in a relatively broad and flexible way (Fylan, 2005). This cross-sectional interview-based data collection reflects IB disciplinary convention in case study research (Piekkari et al., 2009). A total of fifteen interviews were conducted, with R&D managers from the headquarters and each R&D unit (see Table 2). Headquarters officials were interviewed both at the beginning of the study, to help in the selection of the R&D units, and also at the end, to achieve stronger construct validity through data triangulation. The use of such archival data as company annual reports and corporate news releases served a similar purpose. In addition, the use of this secondary data helped to fill in some blanks as some interviewees were not able to supply more technical data.

The interviewees were purposively sampled using a snowballing strategy (Biernacki and Waldorf, 1981). This allowed for the identification and access to even the smallest R&D units. To compensate for potential biases with snowball sampling, the interviewees were matched by type across the cases, reflecting a theoretical sampling logic for interviewee types (Morse, 1995). Interview questions were designed to uncover the resource commitment position of the specific unit and the unit's access to co-location advantages.

Measurements for resource levels, commitment levels, knowledge sharing, and goods sharing (the latter two being co-location advantages) were partly adopted from existing measures. Table 3 lists all the identified measurements.

Some identified measurements were adapted for use in the semi-structured interviews, while others were discarded as their direct measurements were impossible (e.g., managerial experience and transferred property rights) or because they were deemed less relevant (e.g., professional expatriates intensity). Table 4 shows the measurements adopted for this study. A few example interview questions are provided. The full interview question protocol is available upon request.

All interviews were recorded (with permission), transcribed and subsequently thematically analysed using NVivo (Payne and Payne, 2004; Ryan et al., 2003; Saldana, 2012). Due to the large geographical distribution, most interviews were conducted using video-conferencing software. Initial interviews in Denmark and Sweden were conducted face-to-face. However, due to the coronavirus outbreak, follow-up interviews were conducted online as well.

Leveraging the strengths of a deductive bottom-up case study design (Shepherd and Sutcliffe, 2011), initial thematic codes for the analysis were derived from theories on resource commitment and co-location advantages, while others emerged from the data

Table 2
Units of analysis and interviewees.

	Location	Country	Resource	Commitment	Interviewee
Company 1	*HQ 1*	Denmark	–	–	Research Management Specialist
	Location 1.1	Germany	Low	High	Manager
	Location 1.2	USA	High	Low	Technology Director
	Location 1.3	Denmark	Low	Low	Director
	Location 1.4	India	High	High	Director
	Location 1.5	Portugal	High	High	Head of Engineering
Company 2	*HQ 2*	Sweden	–	–	Corporate Director Research
	Location 2.1	Italy	Low	High	Research & Innovation Manager
	Location 2.2	Canada	High	Low	Manager of Operations
	Location 2.3	Japan	Low	Low	General Manager Research Japan
	Location 2.4	USA	High	High	Head of Research
	Location 2.5	Hungary	High	High	Head of Technology and Innovation
	Location 2.6	India	High	High	Head R&D operations

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

Table 3
Existing measurements.

Variable	Measurement	Used by	Operationalisation
Resource level	# of employees in a location (as proportion of total employment)	Pedersen and Petersen (1998) Petersen and Pedersen (1999)	Survey question
	Economic involvement	Randøy and Dibrell (2002)	The firm's economic involvement in a given country (1–5 scale)
	R&D intensity	Hung and Chou (2013), Luo (2004)	R&D expenditure/sales
	Resources invested in specific activities	Wagner and Bukó (2005)	Resources spent on: search for partners, confidence building, coordination, relationships, monitoring, adaptation (1–5 scale)
		Kleinschmidt et al. (2007)	On average, sufficient resources are committed so that [different activities] can be undertaken (1–5 scale)
	Managerial experience	Özsomer and Gençtürk (2003)	International and local experience of interviewed managers
	Transferred property rights intensity	Luo (2004)	The value of property rights transferred from the MNE to the subsidiary during the past three years divided by start-up investment
Commitment level	# of years active in location	Petersen and Pedersen (1999)	Which year did the first contact with the market take place?
	Irreversibility	Pedersen and Petersen (1998)	To what extent has the firm dedicated assets in a given country that cannot be re-deployed without the loss of value (1–5 scale)
		Randøy and Dibrell (2002)	To what extent can investments not be transferred to other markets? (1–5 scale)
		Tan et al. (2007)	
	Investment intensity in a location	Luo (2004)	New investment in the subsidiary during the past three years/start-up investment
	Annual change in R&D expenditure	Neelankavil and Alaganar (2003)	Annual increase/decrease (%) of money spend on R&D in different locations
	Relationship-specific investments	Maitland and Sammartino (2009)	Frequency of the sample firm investing in equipment specific to its local long-term suppliers (4 point scale) and human capital investments specific to its suppliers (4 point scale)
	Professional expatriates intensity	Luo (2004)	Total salaries of expatriates divided by a subsidiary's total salary
Sharing of knowledge	Perceived knowledge sharing performance	Lefebvre et al. (2016)	How well performed the 'network' with regard to the extent of knowledge sharing between network members (1–7 scale)
	Degree of knowledge sharing	Wagner and Bukó (2005)	Degree of knowledge sharing with suppliers, customers, and research institutions. Separately measured (1–5 scale)
Sharing of goods	Resource sharing	Bouty (2000)	Past experiences of resource exchanges (incl. Equipment and facilities) with external partners (interview)
	Special equipment	Melin (2000)	What was the major reason for the collaboration? (incl. Special data/equipment) (survey)

(Bourque, 2004). Each of the two individual cases was first analysed separately, after which a cross-case analysis was performed with a view to analytical generalization (Eisenhardt, 1989; Eisenhardt and Graebner, 2007), thereby increasing external validity (Yin, 2013).

4. Resource commitment and co-location advantages in selected R&D locations

In this section, the findings from the four resource commitment positions across the two case companies are presented. This is followed by a cross-case analysis (Eisenhardt, 1989; Yin, 2013) in which the implications of the comparison are discussed in light of the existing literature on co-location advantages and resource commitment. This section starts by establishing the resource commitment positions of each R&D unit.

4.1. Establishing resource commitment positions and governance structures

The R&D units were selected on the basis of an initial assessment of their resource commitment positions. Using the gathered data on the different resource and commitment measurements, the resource commitment positions of the R&D units have been formally established (see Table 5). The units are grouped on the basis of their established resource commitment positions. Each of the four groups are analysed separately in the following sections.

In addition to differences in resource commitment to the selected R&D units, the governance of local relationships also varies. These governance structures are important to consider, since the way resources are committed is a key dimension of resource commitment. Table 6 provides an overview of the types of governance structures, as well as the type of R&D performed and the main goal of the firm at each location. The overview shows a large variety in the governance of resource commitments of the selected R&D units. On a scale of 'strictness', at one end of the spectrum are arrangements that involve strict contracts concerning the use of equipment, invested resources, and intellectual property rights (IPR). A good example is the contract that unit 2.1 has with the local university: "our research contract with [the university] stipulates some specific activity they do for us and anything that is generated

Table 4
Adopted measures.

Variable	Measurement	Adapted from	Example interview question
Resource level	# of employees in a location (as proportion of total employment)	Pedersen and Petersen (1998) Petersen and Pedersen (1999)	How many people work in R&D here? How many people work in R&D in the entire firm?
	R&D intensity	Hung and Chou (2013), Luo (2004)	How much of the total R&D expenditure of the firm is allocated to this R&D unit?
	Resources invested in specific activities	Wagner and Bukó (2005)	How much of the total expenditure of this location are salary costs? What kind of equipment does this unit operate? Does the R&D unit have the resources to build and maintain relations with local actors?
Commitment level	# of years active in location	Petersen and Pedersen (1999)	When was this unit set-up?
	Irreversibility	Pedersen and Petersen (1998) Randøy and Dibrell (2002) Tan et al. (2007)	How difficult would it be to relocate or sell the equipment that is currently used in this R&D unit?
	Investment intensity in a location	Luo (2004)	Could you tell about the investments made in this locations and any planned investments?
	Annual change in R&D expenditure	Neelankavil and Alaganar (2003)	Is there a fluctuation in R&D expenditure in this location over the last five years?
	Relationship-specific investments	Maitland and Sammartino (2009)	How much has the firm/R&D unit invested in local relations?
Sharing of knowledge	Knowledge sharing	Lefebvre et al. (2016) Wagner and Bukó (2005)	With which local actors does this unit maintain relations? How would you characterize the knowledge sharing with these actors?
Sharing of goods	Resource sharing	Bouty (2000) Melin (2000)	Does this R&D unit make use of resources (laboratories, equipment, and data) of local actors? Does this R&D unit share resources with local actors?

Note: As the access to knowledge is difficult to observe from an external perspective, inferences regarding knowledge spillovers must be made indirectly by examining less detailed patterns of close spatial interactions. The perceived access of insiders is considered a fair way of measuring (Yu et al., 2010).

within this agreement is owned by [Company 2], in terms of patents". Company 1 works with similar research contracts, as is mentioned by the manager from unit 1.1: "we cover any risks by agreeing on intellectual property rights with our partners".

Towards the other end of the scale, we find fellowships and funding of local university staff members. Collaborative research agreements fall somewhere in the middle of the scale, depending on the specific agreements regarding mutual benefits and funding. Like the stricter research contract, these collaborative agreements have clauses on topics like IPR and investments. However, in the case of unit 1.2, the interviewee indicated that the MNE "does not have a deciding say" in the collaboration. Yet another governance structure that may be placed towards the middle of the scale is the use of engineering consultancy companies. The director of unit 1.4 stated: "we use consultants to quickly ramp up and scale down. Between 20 and 40 per cent of our department consists of external consultants".

There does not seem to be any clear relationship between the governance structures of local external R&D relationships, the resource commitment to R&D units, and the main type of research activity performed. Furthermore, the adopted governance structures are similar for both case companies. However, the data seem to indicate that most low-commitment units are focused on exploratory research projects. Furthermore, the R&D activities in emerging economy locations are less related to research in a strict sense and more to design, development and/or engineering, which is in line with existing research (Cantwell and Piscitello, 2000; Gammeltoft, 2006). This is probably one of the reasons why we see engineering consultancies used only for low-risk activities in emerging economies.

4.2. Low resource/high commitment R&D units

Managers of the low resource/high commitment R&D unit (units 1.1 (Germany) and 2.1 (Italy)) provided insights suggesting that commitment levels in particular are important for accessing co-location advantages (see Table 7). Despite low resource levels, both units actively explore and exploit the knowledge and resources of local partners. In both locations, these partners include several universities (local and regional), and knowledge institutes. In the case of unit 1.1, these partners also include six important suppliers. Both units share and absorb knowledge while working with their partners on new products and/or while conducting basic research.

Interviewees expressed their belief that their commitment to their partners and their parents' commitment to the location in general was important, as it smoothed access to local resources and thus enabled them to do more with less. They regard the people and equipment of their partners as extensions of themselves. Both units work with equipment from their local partners which is important for their work. This is especially the case for unit 1.1, as most of the work conducted at this location involves the co-development of products that Company 1 buys from suppliers in this location. Company 1 and its local suppliers thus have a shared interest. Relatedly, employees of unit 1.1 spend a relatively large amount of their time visiting these suppliers to discuss and work on new product

Table 5
Resource commitment per R&D locations.

	Location	Resource	Illustrative quote	Commitment	Illustrative quote
Company 1	*Unit 1.1 (Germany)*	Low	- "It's small. We are 13 people in total" - "We have no hardware in the office".	High	- "It now exists for 12 years… It is definitively bigger than in the beginning". - "We invested a lot in those relationships, … and they also did. We need each other in the long-term". - "I see a strong commitment to the region, … therefore I would say it is hard to transfer this department".
	Unit 1.2 (USA)	High	- "We invested a lot in it and one of the [equipment] belonged to us".	Low	- "The activities have not been overwhelmingly large for a period". - "It is still running today, but we don't have any activities at that site anymore".
	Unit 1.3 (Denmark)	Low	- "We started with 5 people, and at its peak we had about 8 to 10 people" - "It is mostly an office site".	Low	- "There was no management for about 6 months, … It was like a kind of administrative peddling around in a vacuum, … The budgetary things also went from growing to no direction".
	Unit 1.4 (India)	High	- "This office oversees the work of around 700 people¸ … Maybe 30 per cent are consultants".	High	- "This R&D office opened in 2007". - "We have gained dedicated ownership of areas that only take place here".
	Unit 1.5 (Portugal)	High	- "It's 335 people, of which 330 are engineers and researchers". - "We have a test wall, … and a cyber security lab".	High	- "… grown from 0 to 335 in less than 3 years". - "These are not things you can sell again. There is no market".
Company 2	*Unit 2.1 (Italy)*	Low	- "A small centre with 20 people".	High	- "..launched in 2007, … We multiplied by a factor of four". - "I do not exclude another period of growth, because we are investing in other areas as well".
	Unit 2.2 (Canada)	High	- "I have about 50 people here" - "[company name] invested close to 1.3 billion USD in this brand-new centre"	Low	- "We opened barely one year ago, but we will be closed again at the end of the year". "We will try to find a buyer for the equipment". - "The lifespan of the equipment is 3 to 5 years, … so it is very easy to take away too".
	Unit 2.3 (Japan)	Low	- "At the peak, there were about 12 people. … Salary cost is the major part of the expenditures". - "We do not have any large assets"	Low	- "The unit was set up in 1998–1999". - "We abandoned measurement equipment when we downsized". - "My colleagues could be relocated within Japan".
	UNit 2.4 (USA)	High	- "There are roughly 200–230 people" - "We have testbeds and do trials. But it is not much"	High	- "Research activities were established here in 2008–2009" - "We used to be a lot bigger. Four years ago there were 1500–1600 people here. Now only 230". - "A super-important part of what we are doing here is our work with local partners, customers, and universities, and so forth".
	Unit 2.5 (Hungary)	High	- "[We number] about 1700".	High	- "R&D was founded in 1992". - "We just moved into a brand new building made for us".
	Unit 2.6 (India)	High	- "Now we are about 400". - "The majority of the expenditure would be salaries, and some IT infrastructure".	High	- "Migrating to a different place, going out of [city name], cannot be thought of". - "We are looking to build again". - "We started in 2010, … we have been here for more than 10 years already".

development. Clearly, these local relationships are a key reason for Company 1 to have a unit in Germany. This is also apparent from the interview with the manager of unit 1.1, who spoke about the importance of the local relationships and the need to maintain these relationships for the long-term: "We invested a lot in those relationships, in time and money. And they did, too. We need each other in the long-term."

While unit 2.1 also depends on the equipment of its local partners, its local relationships differ from those of unit 1.1. Unit 2.1 does not work with suppliers, but with several higher education and research institutes. More than unit 1.1, unit 2.1 is focused on basic research. The Research & Innovation Manager at unit 2.1 projected a resource-based view as he explained that the high competence level of his team, in combination with the strong research ecosystem in the region, enables the R&D unit to innovate successfully. This, despite the lack of a critical mass of employees. The same manager also stressed the importance of local networks (an IT perspective),

Table 6
Types of governance, research, and goals per location.

	Unit	Country	R[a]	C[a]	Governance	Type of research	Goal
Company 1	*1.1*	Germany	Low	High	Contracts and legal agreements	Technology development	Developing/improving critical parts
	1.2	USA	High	Low	Collaborative research agreement	Exploratory research projects	Incubator for new ideas
	1.3	Denmark	Low	Low	Ad hoc fellowships and project-based contracts	Exploratory research projects	(Re-)engaging with local university and attracting talent
	1.4	India	High	High	Engineering consultancy companies	Engineering solutions and feasibility/concept studies	Gaining competencies at the right cost level
	1.5	Portugal	High	High	–	Engineering solutions and feasibility/concept studies	Gaining competencies at the right cost level
Company 2	*2.1*	Italy	Low	High	Research contract	Basic research	
	2.2	Canada	High	Low	–	Testing	Cost-saving by combining testing equipment in one site
	2.3	Japan	Low	Low	Funding	Exploratory research projects	Developing and strengthening R&D relationships with customers
	2.4	USA	High	High	Contract for shared-use research facility	Technology outpost: working with customers and partners	Bringing learnings from interaction with (potential) customers to the development organization
	2.5	Hungary	High	High	Contracts and legal agreements	Product/technology development	New business opportunities by developing technology domains
	2.6	India	High	High	Fellowships and project-based contracts	Product/technology development	New business opportunities by developing technology domains

[a] R = Resource, C = Commitment.

Table 7
Analytical table – low resource/high commitment locations.

Factor	Main findings	Illustrative quotes
Knowledge sharing	- Low resource levels do not seem to negatively affect knowledge sharing - Relation-specific investments (increasing commitment) are important to access knowledge	- "Our local suppliers act like development partners, we co-develop [product] together with them" (Manager, unit 1.1). - "We have very strong collaboration with them [universities], not just for hiring" (Manager, unit 1.1). - "We meet and work with professors and researchers on a daily basis" (Research & Innovation Manager, unit 2.1). - "They [the universities] have their network, we have our network, and we basically merge the two" (Research & Innovation Manager, unit 2.1).
Resource sharing	- Despite low resource levels, the locations are able to use equipment of partners. - Established relationships are important in order to access external resources.	- "The hardware we work with all belongs to our local partners" (Manager, unit 1.1). - "Even though we do not have a critical mass of [company name] employees here, we have kind of a joint lab with the university, … we can use their lab" (Research & Innovation Manager, unit 2.1). - "Especially in [discipline], labs are quite expensive, … exploiting their lab is a huge advantage" (Research & Innovation Manager, unit 2.1). - "Good relationships can facilitate the funding of research activity" (Research & Innovation Manager, unit 2.1).

saying, "we have strong local networks … we basically merge our network with the university's network of relationships. This is key."

4.3. High resource/low commitment R&D locations

Managers of the high resource/low commitment R&D units (units 1.2 (USA) and 2.2 (Canada)) provided evidence suggesting that large amounts of resources do not necessarily result in meaningful local interaction (see Table 8), which again is consistent with literature (Lorenzen, 2007; Maskell and Lorenzen, 2004; McCann and Mudambi, 2005). The evidence suggests that a lack of commitment, however, does inhibit access to local knowledge/resources.

While units 1.2 and 2.2 occupy similar resource commitment positions, their background and main goals differ. Through unit 1.2, Company 1 has invested resources (expensive equipment and knowledge) to a research program run by a government agency. If necessary, the company could sell or relocate their equipment relatively easily, hence the low commitment level. The company is hoping to profit from whatever new insights come out of the research program. In the past, the company successfully implemented an improved design of its product based on the research conducted at this location. However, the interviewee, who is in charge of the collaboration, acknowledged that progress is slow, in part because the company does not have any employees on the site. They used to have engineers relatively nearby, but these engineers had been let go a couple of years ago (signalling low commitment).

Table 8
Analytical table – high resource/low commitment locations.

Factor	Main findings	Illustrative quotes
Knowledge sharing	- High resource levels do not necessarily lead to knowledge sharing - The level of knowledge sharing used to be higher in location 1.2, when the company had some engineers stationed nearby (signalling more commitment). - Low commitment is a barrier to knowledge sharing.	- "We do not have a deciding factor in it. It is their site and we just leverage the partnership" (Technology Director, unit 1.2). - "The whole idea of building this shared research facility was for it to act as an incubator for ideas, … some of the work that has been done in [unit 1.2] was leveraged back into our system" (Technology Director, unit 1.2). - "Things are going slower than it was supposed to go, … it is obviously difficult since we do not have people there" (Technology Director, unit 1.2). - "The centre's main goal is to provide added-value to our own engineers all over the world", (Manager of Operations, unit 2.2).
Resource sharing	- Unit 2.2 does not share resources locally. This is explained partly by the specialized nature of their activities and partly by their low commitment level. - Unit 1.2 is able to use resources from their partner because they also allocated (relatively uncommitted) resources themselves.	- "The cost-sharing with U.S. entities is another aspect, … the idea you can cost-share your research, … It's a shared effort" (Technology Director, unit 1.2). - "We bought one of the [equipment] and they bought the other two" (Technology Director, unit 1.2). - "The centre's main goal is to provide added-value to our own engineers all over the world, … we are self-sufficient" (Manager of Operations, unit 2.2). - "Our customers are able to connect remotely to our [equipment], … we do not have any local partners using our [equipment]" (Manager of Operations, unit 2.2). - "We internally discussed some options to open up our centre to partners or others, but we did not have enough time" (Manager of Operations, unit 2.2).

Unit 2.2, on the other hand, houses expensive equipment (including test walls and a large data centre) that is mostly used by the engineers and customers of Company 2. As such, this unit is less focused on sourcing/sharing knowledge or resources locally. Despite having invested USD1.3 billion into setting up unit 2.2, Company 2 announced its closure barely one year after it opened. At the time of

Table 9
Analytical table – low resource/low commitment locations.

Factor	Main findings	Illustrative quotes
Knowledge sharing	- Low resource levels require prioritization of external projects/partners. - Units 1.3 and 2.3 gain knowledge from their local collaborations. This is limited to theoretical discussions and has decreased since resources were decreased. - Low commitment levels partly explain the decrease in partner commitment and knowledge transfer.	- "I would open the window and yell over to the [university] researcher in the building next to me" (Director, unit 1.3). - "The intention was to be close to the university, … but it only worked for a short time" (Research Management Specialist, HQ 1). - "We locally discussed with customers and potential customers to try and find new joint projects or research collaborations, … They [local partners] could give their views and outside-in requirements" (General Manager, unit 2.3). - "We have a lot of collaboration going on with [unit], but that was not because or with the local office" (Director, unit 1.3). - "We have some problems with less resources and insufficient headcount, … we had to prioritize" (General Manager, unit 2.3). - "What we do is particularly theoretical discussions" (General Manager, unit 2.3).
Resource sharing	- Units 1.3 and 2.3 do not have access to substantial external resources. - This is explained partly by the nature of their activities, and partly by the low resource commitment level.	- "We do not and did not use any assets from the university or potential customers" (General Manager, unit 2.3). - "We are not able to do any kind of trials or tests locally" (General Manager, unit 2.3). - "We occasionally use some sensors from the university, although we now do most of it ourselves, … and we use their land of course, for our [equipment]" (Director, unit 1.3).

data collection, the unit was set to close in eight months. This is a strong signal of low commitment. The company cited rapid technology development as the reason for the closure, as the company believes new technology will enable it to consolidate test activities to two other centres. The company expects the closure to save the equivalent of USD46 million a year. The short lifespan of the unit has made gaining access to co-location advantages basically impossible. After all, such access requires relationships with proximate actors and building these relationships takes time, which unit 2.2 has not had. Perhaps as a result, the interviewee at unit 2.2 mostly focused on the resources invested in the unit over its short life, taking an RBV perspective on resource commitment.

4.4. Low resource/low commitment R&D locations

Interviewees at unit 1.3 (Denmark) and unit 2.3 (Japan) provided evidence suggesting that low resource/low commitment R&D units struggle to access co-location advantages, even over longer time periods (see Table 9).

Both units scaled down over the last few years, decreasing their already low resource levels while also signalling lower commitment. Both units have collaborations with local universities and the Japanese units also have R&D collaborations with (potential) customers. Due to its lowered resource level, the Japanese unit (2.3) has been forced to prioritize some external relationships over others. According to the interviewee, the unit is increasingly focussing on its (potential) commercial partners. With this change, the unit is moving from more explorative R&D to more exploitative R&D. For example, the interviewee frequently has meetings with customers to discuss how to incorporate new technologies into existing systems. Knowledge spillovers from the university are limited and are mostly through direct contact with the headquarters, not through the unit. The Danish unit (1.3) does not need to prioritize relationships as it works predominantly with just one partner (the local university). Nevertheless, the interviewee from unit 1.3 also indicated lower levels of local knowledge sharing after their resource level was lowered. The collaboration with the university initially revolved around one major project and the unit's decrease in resources coincided with the end of this project. Afterwards, no new substantial collaborative projects were started, due to a lack of resources from Company 1. The location choice was, in part, based on "long historical cooperation with the research site and the university." In fact, according to the Research Management Specialist at Company 1 headquarters, "the whole idea of establishing the unit was to get more collaboration and more cooperation with [local university]." When the collaborations stopped, Company 1 only retained a small office, which was used "as a kind of meeting room for our people visiting the site, needing to collect and analyse data, or analyse problems with the [equipment] and go back and fix it."

Access to external equipment is limited for both units. This is partly explained by these units' main activities (predominantly working with software and data), but can also be linked to their low resource commitment positions. Both units have insufficient resources to get involved in projects that involve the shared use of equipment. The Japanese unit's local access is limited to theoretical discussions with external partners, while all testing is done at the headquarters. The Danish unit has just enough people to work on their own projects and to have similar theoretical discussions with the local university. Their projects are explorative in nature.

The decrease in knowledge sharing and the limited use of external resources seems to be caused partly by low resource levels. However, the reported decrease in knowledge sharing is greater than would be expected from a resource-based view, since the overall decrease in resource level has been relatively limited. The impact of the R&D units' decrease in commitment may explain this difference. Interviewees report that, increasingly, local external parties are directly contacting the headquarters of their respective companies. This indicates that commitment from external partners to the local R&D unit has decreased, while they are still committed to the corporation. This is in line with findings from Bureth et al. (1997), showing that low commitment makes it difficult to secure partner commitment.

Table 10
Analytical table – high resource/high commitment locations.

Factor	Main findings	Illustrative quotes
Knowledge sharing	- High/high locations are able to set up and maintain many different partnerships/projects in part because of their high resource levels and long-term commitment.	- "We have access to the research knowledge of the universities and we have colleagues cooperating with them, … There is sharing from both sides" (Head of Technology and Innovation, unit 2.5). - "They [local partners] learn from us and we are learning from them" (Head of Research, unit 2.4). - "We have access to these [local] universities, … we interact, we have discussions and collaboration going on, … We are sharing some things as well as gaining some knowledge from them" (Head R&D operations, unit 2.6).
Resource sharing	- High/high locations source from and share resources with local partners.	- "We have some collaboration projects which involve hardware, where we are sharing laboratory equipment" (Head of technology and Innovation, unit 2.5). - "We regularly visit the university campus to make use of what they have there" (Head of R&D operations, unit 2.6). - "We have a shared research facility with [name partner]" (Head of Research, unit 2.4).

4.5. High resource/high commitment R&D locations

Insights provided by managers of the high resource/high commitment R&D units (units 1.4 (India), 1.5 (Portugal), 2.4 (USA), 2.5 (Hungary) and 2.6 (India)) suggest their high resource commitment position has a positive impact on their ability to access co-location advantages (see Table 10). Most selected high resource/high commitment units have multiple partners (universities, customers and suppliers) and/or many collaborations with just one or two partners. Insights from the interviews suggest that their R&D units were able to set up and maintain so many relations/projects because they have the resources to contribute to these partnerships. This is consistent with theories on the importance of reciprocity for access to co-location advantages (Perri, 2015; Perri and Andersson, 2014).

Generally, the high resource/high commitment units are long-time locals and that continue to invest in local partnerships (such investments are highly usage-specific), signalling commitment to the location and partners. Several managers mentioned that investing in relationships takes time and is not always straightforward. For example, the director of unit 1.4 (India) stated that building relationships "was not without problems because we have a lot of cultural clashes and a lot of biases and opinions from Denmark. It has been a longer journey; it has taken years". The unit in Hungary (2.5) employs fifteen people to support collaborations with local universities and knowledge institutes.

Naturally also, high resource/high commitment units differ in the degree to which they can access co-location advantages. Two units (1.4 and 1.5) seem to have limited access to external actors' knowledge and resources. However, this has little to do with adopted resource commitment positions. For example, unit 1.5 (in India) performs a relatively high number of more exploitative R&D activities next to its explorative R&D activities. Co-location advantages are therefore less relevant to this location. Unit 1.5 (in Portugal) was only recently set up and therefore has not yet had the opportunity to develop deep relations with local partners. After all, building meaningful relationships is a time-consuming process (Maskell, 2002).

5. Discussion

We discussed how three theoretical approaches, the resource-based view, transaction cost economics and institutional theory, accentuate particular aspects of the relationship between resource commitment and co-location advantages. Succinctly put, RBV brings focus to resources applied, developed, and acquired in the venture TCE accentuates the governance arrangements applied to committing the resources, and IT places emphasis on the relationships involved in the commitment. Our empirical analysis sheds light on the validity and, in a managerial context, the utility of the three theoretical perspectives when applied to the relationship between resource commitment and co-location advantage. The empirical findings indicate that the resource level of an R&D unit is less relevant than its commitment level to access co-location advantages. Some units with low resource levels have successfully accessed local knowledge and other resources, yet some units with high resource levels experienced difficulties doing the same. High resource levels do seem to facilitate access to co-location advantages, but by no means guarantee it. In all cases, interviewees provided evidence that commitment is crucial in gaining access to local knowledge/resources.

Abstracting from these observations to a more general theoretical assessment, out of the three theoretical approaches institutional theory offers the most promise for understanding, and producing, value-enhancing outcomes of co-location advantages. Several interviewees echoed the institutional theory perspective on resource commitment as they focused on the relationships involved in creating and maintaining successful R&D internationalization. This is in line with the perceived importance of commitment levels, as we show in the theoretical foundation of this paper that the institutional theory is more focused on the (bi- or multilateral) commitment dimension of resource commitment, as antecedent as well as outcome. Statements indicating that a unit's resource level was relatively low, yet it was able to develop effective collaborative relationships, are in line with these findings. After all, RBV is more concerned with the resources, which R&D internationalization is intended to acquire or augment, and less on the commitment needed to build external relationships.

TCE also attaches more weight to the commitment dimension of resource commitment. However, within TCE, commitment is mainly viewed as a liability. Our data does not indicate a clear relationship between the governance structures of local external R&D relationships, the resource commitment to R&D units, or the main type of research activity performed. However, we do find support for the claim that more flexible governance arrangements promote access to co-location advantages in asset exploration. This aligns with the need for corporate flexibility in explorative activities. A firm needs to be able to relocate or shut down an R&D unit if no useful knowledge or partners can be found in a particular location, or after useful relations have run their course. The need for flexible explorative activities is also highlighted by Geiger and Makri (2006), who find that 'slack resources' (resources that are readily available, as they are not in use) provide firms with the flexibility needed for explorative activities.

Our findings on the influence of resource levels on the access to co-location advantages differ from those found in the literature (Kuemmerle, 1997; Perri, 2015; Perri and Andersson, 2014). According to the literature, high resource levels are needed to enable MNE units to gain legitimacy and trust (crucial for accessing co-location advantages), as they allow for reciprocation of benefits received from local partners with some of their own knowledge/resources. In addition, the literature suggests that (relatively) high resource levels are needed to achieve frequent and deep external linkages (Kuemmerle, 1997; Mellahi et al., 2016). While interviewees indicated the usefulness of high resource levels to access co-location advantages, they also signalled that low resource/high commitment units are able to access the knowledge and resources of local external actors. This suggests that the influence of an R&D unit's resource level on its access to co-location advantages is less important than previously reported and seems to be affected by the unit's commitment level. While resources facilitate reciprocity, commitment may be more effective in attaining legitimacy and trust (an IT perspective). The relationship between an R&D location's resource level and co-location advantages in Fig. 1 below is therefore marked with a '+/0' sign.

Inferring from the data, a potential reason for the contrasting findings regarding the influence of resource levels on the access to co-location advantages is that a company's suppliers or customers may benefit from a strong relationship with the corporation. Such self-interest (or perhaps shared interest in the company's performance) may explain why the company's local resource level can be less of an issue. Data from unit 1.1 in Germany provides evidence of this alternative logic. The unit works mostly with direct suppliers whose businesses rely heavily on Company 1 as a customer. The fact that Company 1's R&D unit in Germany has a low resource level does not influence their perceived legitimacy much. Unit 2.3 in Japan also offers evidence of a self/shared-interest logic at play. The unit mostly works with (potential) customers that rely in large part on Company 2 to stay competitive. Collaboration with unit 2.3 is thus of importance to these firms despite its low resource/low commitment status.

5.1. Contributions to the literature

Access to co-location advantages is a strong driver of explorative R&D by MNEs. As this access is conditioned by resource commitment to R&D units, the relationship between resource commitment and co-location advantage access is an important strategic concern. This study's analysis of this relationship can contribute to balancing the respective risks of over commitment (e.g., strategic rigidities and excess costs) and under commitment (e.g., ineffectiveness and value dissipation) in an MNE's R&D decisions. Overall, commitment levels emerge from the study as relatively more important to firms' value-creating processes and resource levels as relatively less important than what extant literature leads one to expect.

The literature usually approaches resource commitment exclusively from a behavioural and operational perspective. In this study, we extend the understanding of the concept by disaggregating it theoretically into its substantive (resource-based), transactional, and institutional dimensions. We show that an R&D unit's resource commitment position is affected by a firm's allocation of assets to its R&D units, by governance arrangements established to manage costs and risks associated with transactions across firm boundaries, and by the regularization of norms, values, and routines through recurrent external interaction. This contributes to the existing resource commitment literature (Ghemawat and Del Sol, 1998; Johanson and Vahlne, 1977; Pedersen and Petersen, 1998; Randøy and Dibrell, 2002) and has applicability to academic analyses. Furthermore, we extend this behaviourally and venture that managers' cognitive orientation vis-à-vis these three theoretical perspectives likely influence the process and efficacy of MNE R&D units' co-location access.

Our finding concerning the lower importance of high resource levels for access to co-location advantages differ from those found in the literature (Kuemmerle, 1997; Perri, 2015; Perri and Andersson, 2014). However, our finding that an R&D unit's commitment level seems to have a stronger effect on its access to co-location advantages than a unit's resource level is in line with existing research showing that commitment is needed for stable cooperation (Bureth et al., 1997), and securing partner commitment (Kang et al., 2009). Thus, this study contributes additional insights into the establishment and effectiveness of ties between actors, which is important because the success of firms is linked to their ties to other organizations (Powell, 1998). Investigating the conditions under which such ties are most likely to be established and/or most value creating may help scholars to better understand MNE behaviour.

5.2. Limitations and future research

One limitation of this study is the varied backgrounds of the MNE R&D units selected for analysis. While cross-comparative analysis was possible because units with similar resource commitment positions were selected, each operates in its own niche and focuses on a particular type of local actor. These differences may influence the importance accorded to resource commitment to access local knowledge/resources. Additionally, the relatively small number of interviewees for each resource commitment position limits the extent to which our theoretical inferences can be generalized.

At least three directions for future research are identified here. Firstly, there is a need to better understand how changes in resource commitment over time influence an R&D unit's access to co-location advantages. This study suggests that local actors respond to decreasing resource and commitment levels, and future work could focus on how this specifically works. Secondly, some data suggests physical distance impacts how (potential) partners perceive MNE commitment levels. For example, the unit of Company 1 in the United States seems to suffer from the large geographical distance between itself and both the headquarters and the nearest R&D unit,

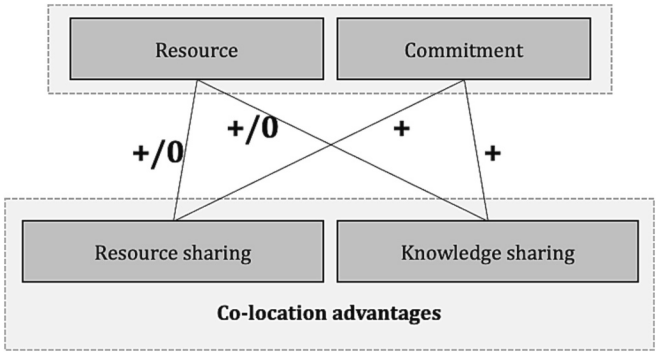

Fig. 1. The influence of resource commitment on the access to co-location advantages.

which are in Europe. Future research should investigate how this works. Finally, it would be interesting to better understand how much of a firm's access to co-location advantages can be explained by the briefly touched upon self/shared- interest logic of its existing or potential customers and suppliers.

6. Conclusion

This study set out to gain a better understanding of the role of MNE R&D units' resource commitment on their access to co-location advantages. The research builds on the literature concerning co-location advantages (Narula and Santangelo, 2012) and the concept of resource commitment (Ghemawat and Del Sol, 1998; Johanson and Vahlne, 1977; Pedersen and Petersen, 1998; Randøy and Dibrell, 2002). We theoretically disaggregated the relationship between resource commitment and co-location advantage access and demonstrated how the resource-based view, transaction cost economics and institutional theory each accentuate dimensions of the relationship. We show that it is affected by a firm's allocation of assets to its R&D units, by governance arrangements established to manage costs and risks associated with transactions across firm boundaries, and by the regularization of norms, values and routines through recurrent external interaction.

We combined the theoretical discussion of the different resource commitment dimensions with findings from a qualitative embedded multiple-case study research design. The empirical analysis of the relationship between resource commitment and co-location advantages indicates that high resource levels are less important for access to co-location advantages than conventionally assumed, while commitment levels consistently appear to be important, lending more support for the institutional theory-related dimensions of resource commitment than the resource-based view-related ones. With respect to governance arrangements, which are of greatest interest to TCE, we find support for the claim that more flexible arrangements promote access to co-location advantages in asset exploration.

This study's findings are of interest to MNEs that are increasingly in need of external resources to cope with growing global competition, intense technology interrelatedness, and increasing product complexity. Access to co-location advantages is, therefore, considered to be of critical importance for MNEs. This paper's 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 attract MNE R&D activities utilizing committed resources, and this study suggests that units with such resources are, indeed, able to develop long-term mutually beneficial relations with local actors.

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Data availability

Data will be made available on request.

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