Available online at www.sciencedirect.com

Revista de Administração

RAUSP Management Journal

Revista de Administração 52 (2017) 176–188

http://rausp.usp.br/

Technology Management

Determinants of reverse knowledge transfer for emerging market multinationals: the role of complexity, autonomy and embeddedness

Determinantes da transferência reversa de conhecimento em multinacionais de mercados emergentes: o papel da complexidade, da autonomia e da integração

Factores determinantes de la transferencia inversa de conocimiento en multinacionales de mercados emergentes: el papel de la complejidad, la autonomía y la integración

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Received 29 June 2016; accepted 19 August 2016
Available online 2 January 2017
Scientific Editor: Maria Sylvia Macchione Saes

Abstract

Subsidiaries conduct innovation activities in foreign markets either to capture valuable knowledge that is necessary to adapt their products to local markets or to create valuable knowledge for headquarters. For emerging market multinationals, most studies have overlooked the determinants of successful reverse knowledge transfer from subsidiaries located in emerging and developed markets. This paper analyzed the responses of a survey administered to 78 Brazilian multinationals that own subsidiaries in developed and emerging markets. We found that knowledge complexity developed at the subsidiary, its autonomy and embeddedness in the foreign market determine the successful reverse knowledge transfer to headquarters of emerging market multinationals. This paper contributes to previous studies of reverse knowledge transfer by underlying the main drivers for emerging market multinationals.

Keywords: Reverse knowledge transfer; Emerging multinationals; Brazilian multinationals

Resumo

Subsidiárias realizam atividades de inovação em mercados estrangeiros, quer para capturar o conhecimento valioso que é necessário para adaptar seus produtos aos mercados locais ou para criar conhecimento de alto valor para a sede. No contexto de multinacionais de mercados emergentes, a maioria dos estudos têm negligenciado os determinantes da transferência de conhecimetno provenientes de subsidiárias (transferência reversa). Foram analisadas as respostas de uma pesquisa realizada com 78 multinacionais brasileiras que possuem subsidiárias em mercados desenvolvidos

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Peer Review under the responsibility of Departamento de Administração, Faculdade de Economia, Administração e Contabilidade da Universidade de São Paulo – FEA/USP.

http://dx.doi.org/10.1016/j.rausp.2016.12.007

e emergentes. Verificou-se que a complexidade do conhecimento desenvolvido na subsidiária, bem como a sua autonomia e inserção no mercado externo determinam o fluxo de transferência reversa de conhecimento na empresa multinacional emergente. Este trabalho enriquece estudos anteriores sobre transferência reversa de conhecimento destacando os principais drivers para as multinacionais dos mercados emergentes.

Palavras-chave: Trasnferência reversa de conhecimento; Multinacionais emergentes; Multinacionais brasileiras

Resumen

Filiales realizan actividades de innovación en los mercados extranjeros, ya sea para capturar el conocimiento valioso que es necesario para adaptar sus productos a los mercados locales, o con el fin de crear conocimiento de alto valor para su sede. Respecto a las multinacionales de mercados emergentes, en la mayor parte de los estudios no se ha dado la debida atención a los factores determinantes de la transferencia de conocimiento a partir de filiales (transferencia inversa). En este estudio se analizan las respuestas de una encuesta realizada a 78 multinacionales brasileñas que poseen filiales en mercados desarrollados y emergentes. Los resultados indican que la complejidad del conocimiento desarrollado en la filial, así como su autonomía e inserción en el mercado externo determinan el flujo de transferencia inversa de conocimiento en la empresa multinacional emergente. Con este trabajo, se colabora al desarrollo de los estudios acerca de la transferencia inversa de conocimiento, con énfasis en los principales *drivers* para las multinacionales de mercados emergentes.

Palabras clave: Transferencia inversa de conocimiento; Multinacionales emergentes; Multinacionales brasileñas

Introduction

The multinational enterprise (MNE) is a differentiated network in which its controlled subsidiaries vary widely in terms of duties and responsibilities (Nohria & Ghoshal, 1994). For example, while some subsidiaries evolve through the headquarters' mandates others focus on their own initiatives (Mudambi, Piscitello, & Rabbiosi, 2014). Since the late 1990s, the recognition that headquarters operate as knowledge receivers from their internationally dispersed subsidiaries has gained significance in international business research (Ambos, 2015). The strategic importance of the MNE' subsidiaries has continued to grow, in that it is an access pathway to knowledge and to the technology situated at the subsidiaries' local markets (Borini, Oliveira, Silveira, & Concer, 2012; Criscuolo & Narula, 2007; Frost & Zhou, 2005), which can actively contribute to value creation and subsequent gain of competitive advantage for the entire MNE (Bartlett & Ghoshal, 1989; Cantwell & Mudambi, 2005; Yang, Mudambi, & Meyer, 2008).

An underlying idea is that MNE make use of knowledge generated by foreign subsidiaries. From this perspective, subsidiaries upgrade their competence enhancing role such as market expansion, cost reduction and supplier adaptation and begin to play a more active role through knowledge development. For example, foreign subsidiaries might develop new products, new technologies, create new practices, new skills that will later shape their own competence creating pathways as well as accumulate different degrees of technological capability (Birkinshaw, 1997; Borini et al., 2012; Borini, Costa, Bezerra, & Oliveira, 2014; Cantwell & Mudambi, 2005; Figueiredo & Brito, 2011; Frost, Birkinshaw, & Ensign, 2002; Ghoshal & Bartlett, 1988; Govindarajan & Trimble, 2012; Mudambi, Mudambi, & Navarra, 2007; Nohria & Ghoshal, 1997). Moreover, competence creating subsidiaries could enhance their innovation outcomes which enables them to compete domestically and internationally (Bell & Pavitt, 1995; Cantwell & Mudambi, 2005; Figueiredo & Brito, 2011). From a subsidiary perspective, reverse knowledge transfer (RKT) gives visibility to subsidiaries that could leverage their strategic position in the multinational network (Borini et al., 2012; Holm & Pedersen, 2000).

These factors have highlighted that reverse knowledge transfer is a key variable in the study of cross-border knowledge flows in MNEs (Ambos, 2015). As a result, the knowledge transfer in the reverse direction, that is, from subsidiaries to MNE headquarters, has emerged as a prominent theme in international business studies (Ambos, 2015; Ambos, Ambos, & Schlegelmilch, 2006; Criscuolo, 2005; Frost & Zhou, 2005; Gupta & Govindarajan, 2000; Håkanson & Nobel, 2001; Rabiosi, 2008; Rabiosi & Santangelo, 2011; Rabiosi, 2011; Yang et al., 2008). While a number of articles explore the antecedents, success amount and success key-factors in different functional conFigurations at the multinational corporation (Ambos, 2015), additional research is needed (Michailova & Mustaffa, 2012). First, since the transfer of knowledge in MNEs has grown considerably in recent years, becoming therefore more prone to various definitions and measurements of the same constructs resulting in conclusions, often contradictory and ambiguous. Second, while recognizing the importance of investigating the relationship of the subsidiary with external companies located in the host countries, the literature often focuses only on the research of knowledge flows within the MNE. This narrow attention considers subsidiaries are primarily recipients of knowledge (Michailova & Mustaffa, 2012).

From emerging multinationals enterprises (EMNEs)'s viewpoint, the ability to transfer knowledge in reverse direction seems to be even more crucial. For example, authors say that the EMNEs strategic models are guided by the pursuit of foreign capabilities, such as technological knowledge, which can

be combined with the existing resources (Bartlett & Ghoshal, 2000). That is so because, instead of internationalizing to utilize existing advantages, emerging market multinationals will internationalize aiming at acquiring new advantages and capabilities (Guillén & García-Canal, 2009; Mathews, 2006; Ramamurti & Singh, 2009) and should to do it quicker than traditional multinationals did in their expansion paths (Mathews, 2006).

In the context of Brazilian multinationals, recent studies have sought to understand the primary factors that influence the RKT. The study of Borini et al. (2012) argues that the reverse knowledge transfer is a function of the strategic guidance of the: (1) subsidiaries' R&D laboratories, (2) integration (communication) between headquarters and subsidiaries, (3) subsidiary entrepreneurial orientation, (4) subsidiary lifetime and (5) entry via greenfield investments. Moreover, the study of Bezerra and Borini (2015) tests the impact that a nation development exerts on the reverse innovation transfer in products and processes. In this study, they sought to understand which determinants of RKT are present in Brazilian multinationals. In our study, we show that RKT is related to the degree of: (1) knowledge complexity that is being transferred, (2) subsidiary autonomy and (3) external embeddednes. As highlighted by numerous authors (Minbaeva, 2007; Van Wijk, Jansen, & Lyles, 2008), such aspects are identified as key ones for understanding the RKT phenomenon. Although there are many kinds of knowledge to be transferred through conventional and/or reverse direction, this study focuses specifically on the technological type of knowledge (of product and process). Our findings are based in an analysis of the survey responses administered to78 Brazilian multinationals that own subsidiaries in developed and emerging markets.

As a contribution, it is expected that our study adds knowledge to the international businesses theory, since the knowledge transfer has been treated as a key factor of competitive advantage of MNEs (Borini et al., 2012, 2014; Govindarajan & Ramamurti, 2011) and, specifically, of the emerging multinationals companies (Cuervo-Cazurra, 2012; Immelt, Govindarajan, & Trimble, 2009; Ramamurti, 2008). Since most research that explains this phenomenon is based on MNEs with subsidiaries and headquarters in developed countries, less affected by institutional distance (Rabiosi, 2011; Yang et al., 2008), one can not assume that the factors that influence RKT from for MNEs are the same as those for EMNEs (Borini, Costa, & Oliveira, 2016). A practitioner contribution of this study seeks to inform EMNE managers about the strategic drivers of RKT.

This paper is structured as follows: the next section, "Conceptual framework" section presents the proposed determinants of reverse technology transfer. "Methodology" section outlines our research strategy and field procedures. "Findings" section presents our results and discusses the implications of our findings for firms in emerging markets. Finally, "Conclusion" section presents our main conclusions, some limitations of the study, and avenues for further research.

Conceptual framework

The literature argues that knowledge transfer, whether arising from internal or external sources, has an important impact on organizational performance and innovation capacity (Lyles & Salk, 1996; Powell, Koput, & Smith-Doerr, 1996; Tsai, 2001; Van Wijk et al., 2008). The underlying idea is that the transferred knowledge contributes to the development of organizational capabilities that are difficult to imitate and can later lead to better performance (Szulanski, 1996). Knowledge transfer stimulates the combination of the existing knowledge with the newly acquired one and increases the capability of a unit for carrying out new combinations (Jansen, Van Den Bisch, & Volberda, 2005).

However, transferring knowledge between units of a same organization is not easier than conducting external knowledge transfers (Kogut & Zander, 1992). This is particularly the case when it comes to RKT. This process can be even more challenging, since while "[...] the conventional transfer is a process of teaching, the reverse transfer is a process of persuading (Yang et al., 2008)". In this case, the effort is much higher because its effectiveness depends on convincing headquarters. Therefore, the transfer depends on headquarter's assessment that the features and relevance of the subsidiary's knowledge is crucial so that the reverse transfer does occur. The RKT is defined as "an intra-organizational exchange of information, technology or know-how from international subsidiaries (located in host countries) to corporate headquarters (home countries). The term 'reverse' is used to distinguish these transfers from the more conventional form of 'forward' transfers – from headquarters to subsidiaries –, and 'lateral' transfers between subsidiaries" (Ambos, 2015).

Some studies have highlighted that subsidiaries create competitive advantages for MNEs when valuable knowledge is transferred to the headquarters (e.g. Gupta & Govindarajan, 2000; Håkanson & Nobel, 2001; Rabiosi, 2011; Yang et al., 2008). For MNEs, some of the determinants of RKT include the: (1) knowledge features being transferred (Minbaeva, 2007), (2) organizational characteristics (size, age, autonomy) (Frost et al., 2002; Gupta & Govindarajan, 2000), (3) role of organizational mechanisms (Håkanson & Nobel, 2001; Rabiosi, 2011), (4) the subsidiaries' roles (Ambos et al., 2006; Rabiosi, 2011; Yang et al., 2008), (5) the host country economic development (Cantwell & Mudambi, 2005; Frost et al., 2002; Gupta & Govindarajan, 2000), (6) the absorptive capacity (Ambos et al., 2006), (7) the knowledge relevance (Yang et al., 2008), (8) the internal embeddedness (subsidiary/headquarters) and (9) the external embeddedness (subsidiary/partners) (Figueiredo, 2011; Meyer, Mudambi, & Narula, 2011).

Following, it is explained how knowledge characteristics, such as complexity, autonomy, and external embeddedness influence RKT from subsidiaries to headquearters of EMNEs.

Subsidiary's autonomy

Subsidiary's autonomy could be defined as the extent to which a subsidiary is allowed to make decisions on its key strategic issues (Mudambi & Navarra, 2004), without a headquarters direct intervention (Roth & Morrison, 1992). A higher level of autonomy is often related to knowledge creation and development at the MNE (Ghoshal & Nohria, 1989; Gupta

& Govindarajan, 1991; Nohria & Ghoshal, 1994), since independent subsidiaries, (1) have strategic mandates (Birkinshaw, Hood, & Jonsson, 1998), (2) make quick decisions (Cantwell & Piscitello, 1999), (3) recognize and take advantage of local opportunities (Frost et al., 2002), (4) develop new knowledge as of local knowledge bases (Andersson, Forsgren, & Holm, 2002), (5) generate intrinsic motivation on individuals (Mudambi et al., 2007), (6) have initiative and willingness to share the knowledge acquired (Gupta & Govindarajan, 2000; Tsai, 2002). On the contrary, a low level of autonomy, may limit the subsidiary freedom, hindering its knowledge creation and development capability (Ghoshal & Bartlett, 1988). Foss and Pedersen (2002) also explain that high levels of subsidiary autonomy – associated with loss of control – could be overcomed by the increase in knowledge exchange amongst subsidiaries. While opposite results have also been reported (Frost et al., 2002; Gammelgaard, Holm, & Pedersen, 2004), most researches have suggested mainly a positive relationship between knowledge decentralization and transfer (Cantwell & Mudambi, 2005; Foss & Pedersen, 2002; Van Wijk et al., 2008).

Recently, Rabiosi (2008) argued that RKT is coupled with subsidiary autonomy, i.e. mechanisms of personal communication between subsidiary and headquarters. Yet, regarding subsidiaries of EMNEs, it is argued that, due to their recent progress in the international market and, therefore, due to their early age, they are strongly dependent on headquarters' decision making power (Dunning, 1993). This might not be different in Brazilian MNEs, that tend to be more centralizing, limiting therefore their subsidiaries' knowledge creation possibilities (Chu & Wood, 2008). This is an unfavorable situation for the development of existing and new knowledge at the headquarter. However, in the same way as traditional MNEs, the internationalization process of EMNEs requires the capability to acquire and develop knowledge (Mathews, 2006). Hence, subsidiaries play a central role in the pursuit of new knowledge (Borini & Fleury, 2011). Different authors state that EMNEs survival depends even more heavily on resources that have been developed abroad when compared to the multinationals from developed countries (Guillén & García-Canal, 2009; Mathews, 2006). Therefore, this study advocates that subsidiary autonomy is critical for RKT in EMNEs, which allows us to hypothesize that:

H1. The greater the subsidiary autonomy, the greater the reverse knowledge transfer.

Knowledge complexity

The increasing specialization and sophistication in R&D requires companies to integrate distinct knowledge areas to develop new products. As a result knwoledge turns to be highly complex and difficult to conduct intra-knowledge transfers. A paradox emerges: the greater the number of functional areas and scientific disciplines necessary to develop new products, the more complex it is to transfer the knowledge (Ciabuschi & Martín, 2012). Knowledge complexity is associated to the amplitude which is the extent of specialization fields (Grant, 1996) and the ambiguity of the referenced knowledge (Reed & DeFillippi, 1990). The greater the number of techniques, organizational routines, people and resources involved that are connected to a particular knowledge, the more complex it becomes. These conditions moderate the information amount that must be processed for the understanding of components involved (Simonin, 1999). Thus, management scholars tend to agree on the idea that complexity hinders knowledge transfer since it decreases the receiver's ability to identify, understand and integrate the knowledge to be acquired (Simonin, 1999). Yet, opposite results have been found in the literature (Minbaeva, 2007). Since, complex knowledge is the most valuable to the company's competitiveness. Studies have shown, for example, that global teams are able to share complex knowledge through rules and codes common to the exchanging area (Reddy, 2011).

In the EMNE perspective, additional efforts to share this kind of knowledge can be advantageous since, as its imitation and substitution is hampered, it may be useful to the building of strategic capabilities (Nair, Demirbag, & Mellahi, 2015) due to the prevailing need to use the available foreign resources (Mathews, 2006). A study conducted in Indian multinationals, for example, found that RKT happens regardless of the knowledge complexity. In Brazilian MNEs, it is suspected that only less complex knowledge from subsidiaries is transferred in reverse direction, considering that the foreign subsidiaries role is determined by the Brazilian headquarters (Galina & Moura, 2013) which still holds greater centralization in the decisions and innovations. Accordingly it was formulated the following hypothesis:

H2. The lower the complexity of the subsidiary's R&D knowledge, the greater the degree of reverse knowledge transfer.

Local embeddedness

Embeddednes is related to the notion that MNE's competitive performance can be facilitated through the social relationships they create with several business players such as customers, universities and local research institutions (Grabher, 1993; Granovetter, 1985; Uzzi, 1996). More specifically, embeddedness refers to the mutual adaptation of activities between two companies as much as a common understanding of the collective targets and appropriate ways to work in a social system (Tsai & Ghoshal, 1998). Therefore, it is considered as a strategic resource for MNEs. It provides easy access to the resources and capabilities that are outside the company (Andersson et al., 2002; Uzzi & Gillespie, 2002) that are able to generate a large knowledge transfer among the partners (Figueiredo, 2011; Uzzi & Gillespie, 2002).

The degree of embeddedness by foreign subsidiaries, measured by the proximity to local partners, reflects subsidiary's ability to absorb knowledge from its local network, which sometimes might result in new knowledge creation (Andersson et al., 2002). This scenario tends to directly foster subsidiary's innovative capacity, i.e. improvement of existing products and services or new product, service, technology development (Andersson, Björkman, & Forsgren, 2005; Cantwell & Mudambi, 2005; Frost et al., 2002; Håkanson & Nobel, 2001; Yamin & Otto, 2004).

Indirectly, local subsidiary embeddedness can foster knowledge transfer to other MNE's units (Powell et al., 1996; Yamin & Otto, 2004), constructing, in turn, the subsidiary's power relationships within the MNE (Andersson, Forsgren, & Holm, 2007).

Higher levels of subsidiary embeddedness are related to an understanding of the context in which the local knowledge resides. Frequently, subsidiaries interact with its closest network of local companies and institutions in order to learn about customers and technologies and, therefore 'capture' the local knowledge (Figueiredo, 2011). Subsequently, it must use the connectivity already established within the MNE network for transferring the knowledge in reverse direction (Meyer et al., 2011; Najafi-Tavani, Giroud, & Andersson, 2013). Regarding MNEs of emerging markets, Child and Rodriguez (2005), Mathews (2006) and Luo and Tung (2007) emphasize the importance of relationships and knowledge opportunities available at subsidiaries hosting markets. For example, providing easy access to technologies found in developed markets (Figueiredo, 2005). Ramamurti and Singh (2009, pp. 126–127) show that EMNEs can pursue several different strategies, such as "low-cost partners", "global consolidators" and "global first movers". Based on these arguments, the following hypothesis is suggested:

H3. The greater the embeddedness of a foreign subsidiary, the higher the reverse knowledge transfer.

Methodology

Sample and data collection

The sample of this study consists of Brazilian MNEs with manufacturing, sales or R&D subsidiaries abroad. We expected that subsidiaries with more strategic activities would have more opportunities of transferring knowledge to the headquarters in reverse direction. The data was collected using an eletronic survey with Brazilian MNEs subsidiaries established abroad (see Appendix 1). Due to the non-existence of an official number of Brazilian multinationals owning subsidiaries with either manufacturing or R&D centers installed abroad. The first step was to identify Brazilian multinationals presenting these characteristics from secondary data sources, such as GINEBRA Project (*Management System for the Internationalization of Brazilian Enterprises*) that resulted in the publication 'Business Management for the Internationalization of Brazilian Companies' (coordinated by Fleury, 2010), an annual survey of the Fundação Dom Cabral (*Dom Cabral Foundation*), Valor Econômico (*Economic Value*), and SOBEET (*Brazilian Society of Transnational Corporations*) surveys as well as data from the Brazilian Multinationals Observatory (*Center of Brazilian Multinationals*) of the ESPM (*School of Higher Education in Advertising and Marketing*).

In this secondary sources, 63 multinational companies were listed, being possible to identify 240 subsidiaries with foreign manufacturing operations and/or R&D centers. Of this population, 39 Brazilian multinationals participated in the survey (61.9%), with 78 responses, corresponding to 32.5% of all subsidiaries. This means that in some cases responses were received from more than one subsidiary per headquarter.

In the attempt to identify possible shortcomings or misunderstandings in the survey, a pre-test was conducted together with specialists from academia and industry (Cooper & Schindler, 2003) which help to generate new insights and adjustments in the questionnaire. Following, the electronic survey was sent to participants, with a follow-up phone-call to clarify any questions from respondents. The total period of data collection was five months, from October 2013 up to February 2014. Responses were collected from R&D offices and the respondents ranged from subsidiary director, international business and R&D director, and engineering managers.

Measures

Dependent variable

The dependent variable (reverse knowledge transfer – RKT) represents, over the last three years, the rate of RKT of technology and market knowledge that the subsidiary transferred back to the headquarters. In order to detail the types of technological content, it was applied the Iammarino, Padilla-Pérez, and Von Tunzelmann (2008) scale, which was validated previously by other authors (Lall, 1992; Bell & Pavitt, 1995; Ariffin and Figueiredo (2003)), who rank the technological knowledge transfer in terms of product and process. On a five-point scale (ranging from 1 "not at all" to 5 "to a very great extent"). For ensuring the robustness results, it was also inserted a dummy variable which allowed the respondent to indicate the cases in which the subsidiary had never done or had done the reverse transfer of a specific product or process knowledge (0 or 1).

Independent variables

The knowledge complexity construct measures the number of interdependent technologies, routines, individuals, and resources linked to a particular knowledge or asset (Simonin, 1999). Moreover, the complexity construct was measured using a six-item Likert scale based on responses (1 = strongly disagree; 5 = strongly agree) (adapted from Simonin, 2004; Zander & Kogut, 1995). The subsidiary autonomy measure indicates the extent to which a subsidiary is allowed to make decisions about its key strategic issues (Rabiosi, 2011). The measure of subsidiary autonomy was based on a scale originally developed by Ghoshal and Nohria (1989) and later used by Birkinshaw et al. (1998) and Rabiosi (2011). A five-item Likert scale assessed it. The subsidiary embeddedness indicates the collaboration degree with the local networks. In particular, this study focuses on the subsidiary embeddedness with local customers and suppliers. This construct was developed based on Andersson et al. (2002, 2005). A five-item Likert scale assessed it.

Controls variables

The MNE literature suggests several factors that might be correlated to RKT. In particular, it is expected that subsidiaries located in developed countries and more ancient subsidiaries are more likely to transfer reverse knowledge.

Subsidiary location. The host country has been related to factors that impact the subsidiary development and positioning (Birkinshaw & Hood, 1998; Gupta & Govindarajan, 2000; Cantwell & Mudambi, 2005; Rabiosi, 2011) as well as the nature of RKT (Yang et al., 2008). Particularly, this happens because the subsidiary's capabilities and skills could reflect the country technological and institutional forces, such as legal and institutional factors (for example patent protection and industrial incentives) that ensure the proliferation of innovation. The assumption, therefore, is that companies in emerging markets get involved in less innovation than companies in developed markets, due to the lack of high technology in emerging markets (Vernon-Wortzel & Wortzel, 1998). Thus, the higher the economic development of the subsidiary's host country, the greater the benefits earned by the headquarters arising from the transferred knowledge (Frost et al., 2002).

For emerged market MNEs, subsidiaries located in developed or high-income countries can impact the rate and speed of RKT, since the resources available in these markets can help increase the headquarters breadth and novelty (Mathews, 2006). On the contrary, Aulakh (2007) and Cuervo-Cazurra and Genc (2008) argue that emerging market MNEs have the same knowledge resources than those operating in developed countries. In the specific case of Brazilian companies, Bezerra, Borini, and Maclennan(2015) have concluded that MNEs' Brazilian subsidiaries located in developed countries transfer more knowledge in reverse direction than subsidiaries located in emerging countries. In order to capture the subsidiary location effects on the levels of RKT, the dummy variable low-income countries (0) and high-income countries (1) were added to the model.

Subsidiary's age. More ancient subsidiaries could have some advantages over newer ones due to (1) the increased information and resources, (2) the higher development of R&D skills, (3) acquired experience and expertise, and (4) increased learning curve effects. Therefore they might be less dependent on knowledge from headquarters (Foss & Pedersen, 2002; Yamin and Otto, 2004). Previous studies show both positive and negative effects of organizations's age regarding the learning and innovation outcomes (Sørensen & Stuart, 2000). While positive effects are justified by the knowledge increase, accumulated experience and possession of stronger relationships with suppliers, and customers that enable the innovation process improvement (Cohen & Levinthal, 1990). Negative effects are associated with upgrade difficulties of more mature companies with external technological advances, at the risk of becoming inert and limited for learning and adapting to new circumstances. In other words, there is a loss of innovative capacity (Sørensen & Stuart, 2000; Tushman & Anderson, 1986).

In this regard, in the Brazilian multinationals context, Bezerra et al. (2015) found that the younger a subsidiary, the greater its extent of RKT. Thus, despite the inconclusive findings of subsidiaries' age, it is expected that older subsidiaries are more likely to develop and transfer back knowledge to headquarters than recently established subsidiaries. Particularly, due to the period of existence of Brazilian subsidiaries is much lower when compared to emerged market subsidiaries. In order to capture the subsidiary age effects on the levels of RKT, the dummy variable young (0) and old subsidiary (1) were added to the model. The details of each variable, including indicators and authors, used as background is presented in Appendix 1.

Data analysis

A descriptive analysis was carried out to identify the frequencies of respondents' answers for all constructs comprised in the survey. The Partial Least Square – Structural Equation Modeling (PLS-SEM) was used to assess the determinants' influence of RKT (Hair, Hult, Ringle, & Sarstedt, 2014). The structural model was estimated on SmartPLS 3.0 (Ringle, Sarstedt, & Schlittgen, 2014) using the 'path' weighting scheme. The decision to use this method took into account a number of criteria, including (1) the fact that the indicators do not have a normal distribution, which is one of the assumptions for the use of the maximum likelihood method (ML); (2) the use of interval scales (Joreskog & Wold, 1982); (3) its ability to deal with more complex models as compared to LISREL (Henseler, Ringle, & Sinkovics, 2009); and (4) the small sample size.

Since the PLS algorithm formulation (Hui & Wold, 1982; Lohmöller, 1989) is recognized that it is biased and is only "consistent at large", which means that the bias decreases as the number of indicators by latent variable is increased. This issue occurs because the relationships amongst latent variables (correlations and path coefficients) are estimated as from the factorial scores, which are obtained as a sum or a weighted average of their indicators, including the measurement errors. This fact is treated as correlation attenuation in the methodological references related to psychometrics, for example (Nunnally & Bernstein, 1994, p. 212). However, despite this bias, Hair et al. (2014, p. 79) mention some simulations where it is identified that the bias is small for practical purposes. For four and eight indicators by latent variable, Chin and Newsted (1999, p. 333) found a bias equal to 0.05. To minimize this bias (attenuation) the latent variables were measured with five to six indicators each, reaching reliability values (composite reliability and Cronbach's alpha) higher than 0.8 (Table 2).

Additionally, to assess this bias size, the disattenuated correlations were calculated (or "correction" for attenuation as explained by Nunnally and Bernstein (1994, p. 241) of the dependent variable (RKT) with the other independent variables (Table 1).

It is observed that the highest bias was equal to 0.053. As this is a small bias for practical purposes and is in the conservative direction (underestimating the population parameter), the results were considered adequate for purposes of results interpretation from the point of view of statistical significance and practical importance.

Another way to check the sample size adequacy is through analyzing the statistical power sensitivity, performed with G*Power 3 software (Faul, Erdfelder, Buchner, & Lang, 2009). For a sample of 78 respondents, with a significance level of 5% and statistical power of 0.80 (Cohen, 1998), the test 'sensitivity analysis' found that the model is able to detect an effect size of 0.1574, which is considered a medium effect (Cohen, 1998).

Table 1
Disattenuated correlations of the dependent variable RKT.

Statistics	1. Age	2. Country	3. Complexity	4. Autonomy	5. Embeddedness	6. RKT
Correlation with RKT	−0.150	0.350	0.270	0.300	0.410	1000
Composite reliability	1	1	0.890	0.880	0.900	0.870
Disattenuated correlation with RKT (using CR)	0.161	0.375	0.307	0.343	0.463	
Attenuation	−0.011	0.025	0.307	0.343	0.053	

Using the population effect formula $f^2 = R^2/(1 - R_2)$ (Cohen, 1998), it was concluded that the research will detect a minimum R^2 of 0.1507.

Findings

The respondents included a large variety of Brazilian multinationals ranging from natural resources (12%), consumer goods (21%), basic inputs (32%), manufacturing (19%), system assembly (10%) and raw materials for construction (6%). The responding subsidiaries locations were: Latin America (42%), North America (24%), Asia (14%), Europe (14%) and Africa (5%). At the country level, the largest number of subsidiaries are in the U.S. (15%), Argentina (15%), Colombia (10%) and Mexico (9%). Moreover, China (6%) already appears as an important destination for Brazilian subsidiaries. As to the size and number of employees at the subsidiary, 56% of responding subsidiaries are in the range 100–1000 employees, followed by 14% of subsidiaries employing more than 1000 workers. This descriptive statistics shows that a relative percentage of subsidiaries consist of consolidated companies abroad. As regard to the subsidiaries' age, the majority (69%) is under ten years of age, 22% are between ten and nineteen years and only 9% are more than 20 years of activities. The entry mode of Brazilian subsidiaries abroad represents 77% acquisitions and 23% direct investment or greenfield investment.

Evaluation of the measurement model

In measuring the constructs, the model was conducted by evaluating the convergent, discriminant and reliability validity. As presented in Table 1, the constructs (also called latent variables) were measured using reflective indicators to verify the adequate reliability of the Cronbach's alpha values. In addition, all latent variables achieved convergent validity, that is, they have an average variance extracted (AVE) higher than 0.5, and composite reliability higher than 0.7 (Hair et al., 2014; Henseler et al., 2009; Tenenhaus, Vinzi, Chatelin, & Lauro, 2005). However, three items of the scales had to be removed from the model so that the AVE reached the reference value (3.7; 4.2; 4.4 in Appendix 1). The discriminant validity is verified by the Fornell Larcker criterion and was evaluated through the cross-loads analysis. This facilitated to determine whether a construct is truly distinct from other constructs through empirical patterns. Based on this result, it was noted that all correlations amongst the latent variables were smaller than the square root of the average variance extracted of their latent variables (Fornell & Larcker, 1981). Thus, it can be said that the model presented convergent, discriminant and reliability validity. The means, standard deviations, reliability estimates and factor correlations are reported in Table 2.

Assessment of the structural model

The structural model is able to specify the relationship patterns amongst the constructs. The model was assessed using five criteria: (i) path coefficients (β); (ii) path significant (p-value); (iii) variance explain (R^2); (iv) effect size (f^2) and (v) predictive relevance (Q^2). According to Hair et al. (2014), the main criteria for the structural model evaluation are the coefficient of determination (R^2) and the level and significance of the path coefficients (β). To calculate them, the path weighting scheme and a bootstrapping technique were used with 78 observations and 500 random samples to estimate the t-values in order to assess the significance. For social science researches, R^2 values of 0.26, 0.13 and 0.02 are considered strong, moderate and weak, respectively (Cohen, 1998).

Continuing Fichman and Kemerer (1997), in addition to the full model, we have evaluated two nested models (control model and theoretical model). In total, these three models were accessed to evaluate the true impact and the additional explanatory power of the theoretical variables after the variance explained by the control. The full model includes all this study variables, the control model includes only the control variables, and the theoretical model includes the hypothesized relationships. Comparisons amongst the three models are summarized in Table 3.

The R^2 value results for the full model (including control variables) indicate that the variance of 36% in RKT was explained by the model. This result is considered substantial and provides evidence that the model is capable of explaining the dependent variable (Cohen, 1998). When comparing the results of the adjusted R^2 (33%) with the sensitivity analysis on statistical power, it is found a R^2 value well above the minimum detectable by the model, which is 15%.

A comparison between the full model and control model (location and age) shows that the control model explains an incremental variance on R^2 of 19% on the dependent variable (RKT). The delta between the control model and the full model was ($\Delta R^2 = 0.17$). This result suggests that, despite having presented a moderate result, control variables alone do not provide a solid basis through which one can understand and predict RKT patterns.

Table 2
Evaluation of the measurement model.

Variables	Mean	S.D.	AVE	C.R.	C.A.	1	2	3	4	5	6
1. Age	10.8	11.1				**1.00**					
2. Country	–	–				0.13	**1.00**				
3. Complexity	3.7	1.1	0.61	0.89	0.86	−0.18	0.19	**0.78**			
4. Autonomy	3.2	1.0	0.55	0.88	0.90	0.07	0.17	0.03	**0.74**		
5. Embeddedness	3.0	1.0	0.53	0.90	0.87	0.08	0.28	0.02	0.07	**0.73**	
6. Reverse Transfer	3.0	1.0	0.54	0.87	0.83	−0.15	0.35	0.27	0.30	0.41	**0.73**

Note 1: In bold on the diagonal, there are values of the square root of the average variance extracted.
Note 2: AVE, average variance extracted; C.R., composite reliability; C.A., Cronbachs alpha.
Note 3: AVE benchmarks: 0.5; composite reliability: 0.7; Cronbach's alpha: 0.6.

Table 3
Significance test results of the structural model path coefficients.

H	Path from	To	Full model		Control model		Theoretical model		Effect size (f^2)
			β	p-Values	β	p-Values	β	p-Values	
	Age	RKT	−0.182	0.01**	−0.212	0.00***			
	Country	RKT	0.195	0.04*	0.408	0.00***			
H1	Autonomy	RKT	0.188	0.04*			0.252	0.01**	0.05
H2	Complexity	RKT	0.246	0.01**			0.262	0.00***	0.08
H3	Embeddednes	RKT	0.351	0.00***			0.395	0.00***	0.15
Reverse transfer R^2			0.36		0.19		0.30		
ΔR^2					0.17		0.06		

Values of t were calculated through bootstrapping with 500 resamples and 78 cases per sample.
* $p \leq 0.05$.
** $p \leq 0.01$.
*** $p \leq 0.001$

Comparing the full model and the theoretical model, the incremental variance derived by the model is around 30% for RKT. Results indicate that the theoretical model in this study is substantive enough to explain the variance in the research model. However, control variables were responsible for a considerable proportion of the variance in the R^2 value of RKT. As the predicted paths for the structural model, all the hypothesized were statistically significant. The confidence level in the prediction model was measured by the indicator Q^2 which must be higher than zero. The Q^2 value to construct 'RKT' is 0.171 ensuring the model predictive relevance (Hair et al., 2014; Henseler et al., 2009).

The effect size (f^2) measures the magnitude of an independent variable on a dependent variable (Tabachnick & Fidell, 2007). The exogenous constructs omission of the model can be used to assess in which case these omitted constructs have substantial impact on the endogenous constructs. Cohen (1998) provided values of 0.02, 0.15 and 0.35 considered weak, moderate and strong, respectively. The f^2 is also calculated by R^2 included $= f^2 - R^2$ excluded/1 $- R^2$ included (Hair et al., 2014). Following, Table 3 shows the significance results of each path amongst the latent variables and the effect size.

The results support two of the three hypotheses statements. Hypothesis H1 shows that autonomy has a positive and significant effect on reverse transfer ($\beta = 0.19$, $p \leq 0.05$). The effect size (f^2) of 0.05 indicates that the construct subsidiary autonomy has a weak effect on the endogenous latent variable RKT (Cohen, 1998). Hypothesis H2 states that the lower the complexity of subsidiary's R&D knowledge, the larger the rate of reverse technology transfer to headquarters. Surprisingly, this study's results showed that knowledge complexity has a significant, but positive effect on reverse transfer ($\beta = 0.25$, $p \leq 0.01$). This relationship is characterized by a weak effect (0.08) on the endogenous latent variable 'RKT' (Cohen, 1998). Finally, the results showed that subsidiary embeddedness has a significant and positive effect (0.15) on RKT, which confirms H3 hypothesis ($\beta = 0.35$, $p \leq 0.001$). This relationship is characterized by a moderate to strong effect on the endogenous latent variable 'RKT' (Cohen, 1998).

With regard to the control variables, the localization effect was positive and significant ($\beta = 0.19$, $p = 0.05$) for RKT, indicating that subsidiaries located in developing countries are more likely to transfer knowledge in reverse direction. Also for the subsidiary age variable the coefficient is significant ($\beta = -0.18$, $p = 0.01$) but the negative sign indicates that RKT is more likely to occur from young subsidiaries, confirming the findings of Bezerra et al. (2015).

Discussion

Despite ambiguous evidence about RKT in Brazil (Fleury & Fleury, 2011), this study found that Brazilian subsidiaries with a high autonomy degree are more capable of transferring knowledge back to headquarters, confirming our hypothesis H1. An argument on the positive effect of autonomy for RKT is based on the idea that the subsidiaries independence provides

greater access to local knowledge databases, knowledge from local partners and possibilities to innovate (Andersson et al., 2002; Ciabuschi & Martín, 2012; Gupta & Govindarajan, 1991; Cantwell & Mudambi, 2005). Hence, subsidiary autonomy is recognized as an important predictor of reverse knowledge transfer in the context of EMNEs. Autonomy empowers subsidiaries to explore their own business and market opportunities so that they can make use of external sources to their competitive advantage. Taking into account that Brazilian multinationals are still at an early stage of internationalization, it is a new phenomenon the fact that their subsidiaries have been seeking for autonomy and independence from their headquarters' decisions.

This paper identified that knowledge characteristics and subsidiary characteristics determine the rate of reverse knowledge transfer from subsidiaries to emerging market MNEs. First, from the knowledge characteristics viewpoint, it was possible to show that the knowledge complexity level has a positive impact on the extent of RKT. This finding is contrary to this study's hypothesis (H2), which suggested that the lower the subsidiary knowledge complexity, the greater the RKT. It is suspected that one of the reasons for this intriguing, but interesting result, may be related to the knowledge complexity paradox, because, while knowledge transfer encounters higher costs problems, it is the most compensatory type of knowledge to the headquarters. Thus, it is suspected that the Brazilian multinationals try to transfer the most complex knowledge developed in their subsidiaries, regardless of the complexity levels associated, which includes the involvement to a greater extent, of the headquarters so that this type of transfer actually materializes (Nair et al., 2015). Such a result is also in line with the framework of learning and effective leverage (Mathews, 2006) of the EMNE's resources and networks abroad (LLL chart). Other possible explanation is the effect of subsidiary's role. For example, more innovative subsidiaries might transfer more complex R&D knowledge, which suggests that implementer and contributor subsidiaries may not transfer (or transfer to a lesser extent) complex type knowledge. In summary, although the initial H2 was not supported, this result provides an opportunity to suggest that innovative subsidiaries may engage in complex knowledge transfer and thus become a competitive player.

Our results also support the hypothesis H3 which proposes that local embeddedness impacts the rate of RKT. It was found that embeddedness with suppliers and customers, in other words, local business networks increase the possibility of gaining access to new knowledge, which can subsequently be transferred to EMNEs. This paper confirms that subsidiaries from emerging market multinationals become internationalized in order to explore knowledge and existing capabilities in foreign markets as well as to develop new knowledge and capabilities through knowledge available in the subsidiaries' host environment (Narula, 2012). For subsidiaries is essential to be embedded in local business networks to obtain distinctive knowledge development. New connections with local networks allow subsidiaries to perform innovative tasks for headquarters, instead of tasks limited to adaptation of products and processes to the local market (Borini & Fleury, 2011).

With regard to the first control variable (location), the results indicated that subsidiaries located in developed markets, such as North America and Europe, are probably the ones that most transfer knowledge to their headquarters. This result is in line with several contributions in the literature which state that the innovation capacity of subsidiaries largely depends on the host countries advantages (Gupta & Govindarajan, 2000; Cantwell & Mudambi, 2005; Yang et al., 2008).

Based on previous findings about EMNEs, two perspectives can be presented. The first perspective, led by Cuervo-Cazurra and Genc (2008), Ramamurti (2008), Khanna and Palepu (2011), Cuervo-Cazurra (2012) and Ramamurti (2012), argues that EMNEs have a new type of capability, unlike the traditional MNEs capabilities, which is related to the ability of coping with the institutional deficiencies to which they are exposed. This current advocates that emerging MNEs, for having operated in environments presenting difficult conditions, such as underdeveloped premises, corrupt bureaucracies, poor educational institutions and unstable governments, have the "advantages of adversity." The second perspective, led by authors such as Mathews (2006) and Child and Rodriguez (2005), argue that MNEs place their subsidiaries in developed countries as a way to leverage their productive, technological and marketing efficiency, following an asset-seeking strategy, looking for their competitive advantages increase. Therefore, the preferences of emerging MNEs for developing markets exemplify their tendency to explore the "*institutional voids*". However when it comes to subsidiaries that transfer knowledge in the reverse direction, they are more likely to be in countries where there are better infrastructure conditions, business support institutions and favorable legal environment.

Regarding the second control variable (age), the results surprisingly indicated that there was a significant correlation, though negative, between age and RKT. Thus, the younger the subsidiary, the more likely the existence of RKT. A possible explanation for this unexpected result is the fact that experience leads to efficiency gains, but on the other hand, in environments where changes occur very rapidly, the adjustment between organizational capabilities and market demands declines, as the subsidiaries grow older, having in view that more mature companies take longer to incorporate the most current technological developments (Sørensen & Stuart, 2000). It is in this perspective that age and accumulated skills can become disadvantages when compared to younger subsidiaries. Particularly, this occurs with regard to the company's ability to adapt or develop major technological changes (Sørensen & Stuart, 2000; Tushman & Anderson, 1986). With respect to the group of emerging MNEs, younger subsidiaries may be more influential in the headquarters' knowledge exactly because they are able to be more agile and dynamic in relation to technological developments.

Conclusions, limitations and further research

This paper explained reverse knowledge flows in subsidiaries of emerging market multinationals and tested the impact of three determinants in Brazilian multinationals (Govindarajan &

Ramamurti, 2011). Hence, several contributions to the knowledge flow of RKT in Brazilian MNEs are suggested. First, in comparison with traditional MNEs, Brazilian MNEs have a higher interest in reverse technology transfer, due to the higher importance of subsidiaries for headquarters. Second, subsidiaries of Brazilian MNEs will transfer products' knowledge just with a basic and intermediate level of technological complexity (Ariffin & Figueiredo, 2003; Iammarino et al., 2008). Third, on the process of RKT in foreign subsidiaries of Brazilian MNEs, this work explored the impact of knowledge complexity characteristics as well subsidiary characteristics, i.e. autonomy and embeddedness. The results showed that RKT is positively affected by knowledge complexity, subsidiary autonomy and embeddedness of foreign subsidiaries with customers and suppliers. Fourth, it was assessed the effect of the subsidiary's location and age on the RKT. The results indicate that subsidiaries located in developed countries are more likely to transfer knowledge in reverse direction as well as younger subsidiaries. This paper's empirical implications suggest that subsidiaries with higher access to local knowledge will be better positioned to acquire new knowledge and consequently transfer it back to headquarters. The external embeddedness has been indicated as an important determinant of RKT. From the viewpoint of practical implications, it is necessary that subsidiaries invest in mechanisms of relationship and knowledge exchange to establish strong collaborations with local partners. These findings may also be useful for policy makers in as much as understanding the innovation transfer pattern is a key component of a country's innovation system.

An important limitation of this study is that this research is limited to the narrow context of Brazilian subsidiaries, which therefore imposes limits to the results generalization. Second, the sample size and sample composition turn it difficult to make far-reaching generalizations of its results. Third, the survey method provides a snapshot that reduces the information source credibility, the access to the right people, the responses control, and the utilization of only one respondent by company. Fourth, its choice of control variables, which could have covered other aspects, possibly stakeholders in the achieved result. Finally, it is assumed some restrictions related to the unit of analysis and the information from headquarters. Further researches could explore the autonomy and integration degree of subsidiaries from emerging markets multinationals.

Conflicts of interest

The authors declare no conflicts of interest.

Appendix A. Operational definition of model variables

	Indicators	Authors
Dependent variables		
Reverse knowledge transfer (RKT)	1.1 Development of new production process; 1.2 Development of new equipment and/or tools; 1.3 Development of new products; 1.4 Know-how and expertise in the form of plans, models, instructions, guides, formulas, specifications, designs, plans, technical drawings, and/or prototypes to design new products; 1.5 Results of research into new materials and specifications; 1.6 Results of research and development (R&D) into new product generations.	Ariffin and Figueiredo (2003); Bell and Pavitt (1995); Iammarino et al. (2008); Lall (1992); Yang et al. (2008)
Independent variables		
Complexity	2.1 Its understanding requires prior learning from other related technological knowledge; 2.2 Its understanding requires a large amount of information; 2.3 It is the product of many interdependent routines, individuals and resources; 2.4 It includes many different skills or competencies; 2.5 It is technologically sophisticated and difficult to deploy; 2.6 It is complex (vs. simple)	Simonin (2004); Zander and Kogut (1995)
Autonomy	3.1 Implementation of changes in products and services; 3.2 Development of new products and services; 3.3 Implementation of changes in production processes; 3.4 Entry into new markets in the country; 3.5 Procurement and supply chain management; 3.6. Management of Purchasing and Supply Chain; 3.7 Hiring and firing of the subsidiary workforce.	Ghoshal and Nohria (1989); Birkinshaw et al. (1998); Rabiosi (2011)
External embeddedness (with customers, suppliers)	4.1 Customers/suppliers has fully participated in the development of technological knowledge in the subsidiary; 4.2 Customers/suppliers showed important initiatives for the development of technological knowledge in the subsidiary; 4.3 Customers/suppliers satisfied the requirements in developing technological knowledge in the subsidiary; 4.4 The technological subsidiary knowledge was partially developed within this Customers/suppliers' premises; 4.5 The cooperation with customers/suppliers has been characterized by frequent interactions.	Lane and Lubatkin (1998), Andersson et al. (2005) and Najafi-Tavani et al. (2013)
Moderating variables		
Subsidiary's location	5.1 Low-income countries (0); 5.2 High-income countries (1)	Cantwell and Mudambi (2005)
Subsidiary's age	6.1 subsidiaries under 10 years old (0); 6.2 Subsidiaries with over 10 years old (1)	Ambos and Schlegelmilch (2007); Rabiosi (2011)

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